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The Aviation Consumer®

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The Aviation Consumer

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DROP-IN AVIONICS REVIVAL

There are seemingly more signs of stability in the avionics market with Scottsdale, Arizona-based TKM/Michel Avionics under new leadership. It says it has an improved product line and is currently planning the next generation of slide-in replacement navcomms, while it ratchets up support for existing units in service—roughly 37,000 radios.

Recall that TKM dominated a niche market with its MX-series slide-in replacement navcomm radios. Compared to old mechanically tuned radios like the King KX170, Narco Com11 and Cessna 300, the MX rigs had appeal, sporting digital tuning and frequency flip-flop transfer. Better yet, shops didn't have to tear the radio stack apart to rewire the connectors and change the mounting hardware. That's an MX170C in the main photo. It plays with the venerable King KX170B wiring harness and mounting tray, while a quick-release camlock has it installed in seconds.

As popular as the radio was in its prime, an unsupportive shop network and a nonexistent marketing program made TKM go silent. Although factory repair never went away, it just came with long lead times, yet reasonable repair costs, from my experience. But the TKM line wasn't perfect, either.

When I was the avionics editor of *Aviation Consumer* and a tech in the 1990s (the heyday of the TKM line), I didn't recommend slide-in radios as a cure-all. In many cases, it was the existing wiring and antennas that needed replacement and not the radio. Even the mounting hardware could be compromised. I once got a MX radio wedged in a broken Cessna mounting rack, which had to be cut to free the radio. On the bench, the MX radios were easily outperformed by King's KX155, Narco's MK12D and even Cessna's 28-volt RT385/485-series radios.

Still, Ken Beckemeyer, TKM's new president and CEO, thinks the underserved lower end of the avionics market will benefit from the revived MX line, even though the product is physically unchanged and with the same features from the early 1990s. TKM said it made some improvements to the receiver and transmitter circuitry, improving the audio quality. But I think even lower-end buyers will demand more gee-whiz appeal than the current line delivers.

As Beckemeyer attempts to solidify the current product line and step repair support up to a higher level (TKM turns around an average of 80 radio repairs per month), he's put the brakes on designing the next-generation TKM slide-in until he surveys the market to understand what additional features lower-end buyers are looking for. He also understands the rigors, challenges and delays that tag along with FAA certification. Beckemeyer spent years at the helm of AmSafe—the company that pioneered the STCd airbag seatbelt.

"If I'm reading the market correctly, there are still a lot of aircraft owners that just fly on Saturday mornings. When they get in the aircraft and their old radio doesn't work, they've got a problem that we can solve. I've sensed a lot of frustration from buyers because larger manufacturers—and high prices—have dominated the market for so long," Beckemeyer told me.

As we report in the budget IFR avionics article on page 8 of this issue, $15,000 is likely the starting point for basic retrofits. That won't get you much when you factor in the extra costs that tag along with a full teardown upgrade. Beckemeyer believes that the average slide-and-fly radio buyer will tolerate a price point of $2500 per radio. While he plans on releasing a slide-in radio for the King KX155 navcomm, it's unlikely that it will have advanced features that I think the market is looking for. That should include integral GPS, a color display and perhaps an app interface. What features do you think the next-gen budget slide-in radio should have? TKM is all ears.—*Larry Anglisano*

CERTIFICATION WOES

I read with interest your article on the FAA and the new Part 23 revision in the December 2014 issue of *Aviation Consumer,* and would like to share my experience of obtaining STC certification and PMA approval.

I began work on a new fiberglass cowling STC for Grumman AA5B Tigers in 2000 and had it ready to fly in 2002. I flew with the first cowling—without approval—for almost two years. The reason I didn't start the actual STC approval process earlier was because of fears of what might be involved. I finally hired a DER in the spring of 2005.

The first hiccup came when the DER told me I couldn't fly my plane with the installed cowling. The DER claimed he couldn't prove the conformity of my parts or the tooling because he hadn't been involved in the project since the beginning. He also hired his own CAD technician to redo my drawings—someone who knew nothing of my requirements or my previous drawings that were already in place. To my surprise, he never incorporated the updated drawings I sent, which were a work in progress during the ongoing and critical fabrication process.

From the first mockup to the issuance of the STC took nine years. The entire project cost me about $250,000 if I factor in my labor at my shop rate. Fabrication (for two cowlings) and tooling was about $30,000. Correcting the baffle drawings cost me another $4500, plus $5500 worth of scrapped aluminum used on no fewer than 10 sets of baffles that didn't fit like I wanted. The DER cost me over $100,000 over a period of four years.

I've been involved in other projects that required PMA approvals, including a fiberglass instrument panel overlay and eyebrow assembly for the Grumman. These PMA approvals took four years and cost $10,000.

My point is that most of my negative experiences have come from the DERs I've hired to work with the FAA, and not from the FAA itself. For the most part, the FAA has been extremely helpful.

My next project is a parallel valve IO-360 engine mod for the Grumman Tiger. The engine is on and the plane is waiting for me to find some time to finish it. I plan on doing most of the work on the STC myself and only hire a DER if absolutely necessary.

I don't develop these parts, go after STCs or get PMAs because I expect to make money at it. I do it because it's my passion. My wife and I work only on Grumman Cheetahs and Tigers, and we maintain about 40 planes a year. Most of our profits go back into the business.

Gary Vogt, AuCountry Aviation
Auburn, California

SWEATING ADS-B INSTALLS

Larry Anglisano's commentary on botched ADS-B installations in your January 2015 issue made me wake up in the middle of the night in a cold sweat. Unfortunately, I think his words are right on the money.

I recently had a Garmin GDL88 installed in my twin by a shop that talked a good game, but it took them three tries to make it all work properly. To be fair, I had a bunch of other work done, but I didn't think the interface was that complex. I can only wonder what the consequences would have been for my Part 135 operation had I waited until the last minute and couldn't penetrate ADS-B airspace.

Arthur Harrington
via email

In an answer to a reader's letter in your December 2014 issue, you state that Garmin's new low-cost GDL84 interface doesn't have a ADS-B mandate-approved WAAS GPS.

Since the GDL84 definitely has a WAAS GPS, is there something you know about it not being approved as a primary position source?

I prefer the GDL84 for its Bluetooth wireless tablet interface over other systems that require a panel display.

David Abrams
via email

When we said the GDL84 wireless interface didn't have a mandate-approved WAAS GPS, we were referring to the Garmin FlightStream Bluetooth transceiver. This is the remote device that serves as a communications hub between the tablet and the GDL84 ADS-B transceiver. While it has an integral WAAS GPS, it is not an approved position source for satisfying the mandate. The GPS inside the GDL84 is fully compliant.

WHICH AERODIESEL FUEL?

I have a question about aerodiesel engines. One thing not discussed in your ongoing diesel engine coverage was actually using real diesel fuel versus Jet A. Can these engines burn the diesel fuel we get at gas stations? Keep up your great work.

Craig Schwab
via email

The Continental CD-200 engine, for example, is approved for Jet A or road diesel, or a blended combination for European approvals.

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Used avionics and steam gauges like the ones in this Cessna Cardinal panel, left, might be a good option for a budget upgrade. Still, the Garmin GMA340 audio panel, GNS430W, SL30 navcomm and GTX330ES ADS-B in that stack could run close to $20,000.

Budget IFR Upgrades: Used Garmin 430W Wins

But put a sharp pencil on new equipment first. Expect sizable cost overruns to replace supporting accessories and for adding ADS-B equipment.

by Larry Anglisano

We'll cut to the chase. The typical basic ground-up IFR avionics upgrade is going to approach, if not exceed, $20,000. This won't buy an autopilot or primary flight display, so you're stuck with steam gauges unless you can spend around $35,000.

Sadly, we've witnessed enough buyer remorse over the years when owners upgrade entry-level aircraft for IFR on the cheap. Whether it's an unsupported IFR GPS found on eBay or passing on a PFD that can save money in the long term, it's imperative to price all options before pulling the trigger on the upgrade, including pricing flagship packages.

Moreover, we think many good shops miss the mark when it comes to helping buyers make the right decisions for their mission and budget. In this article, we'll do what shops should do up front and present the realistic costs and worthy choices for basic IFR capability.

MORE THAN RADIOS

You'll need to have the aircraft inspected by a trusted and experienced shop before the aircraft hits the installation floor because there is more to the upgrade than primary systems. The budget-busting gotcha with IFR upgrades (and VFR upgrades, too) is the accessories that might be required to support the installed equipment. For starters, this includes antennas, altitude encoders, avionics cooling system, circuit breakers and electrical bus wiring, flight instruments, pitot/static system and instrument panel lighting.

If the aircraft has been operated under VFR, it's possible that it hasn't undergone a thorough pitot/static and altimeter system inspection required by FAR 91.411. A static system rebuild and instrument overhaul for even basic vintage Cessna and Piper models could require a sizable teardown and extra costs.

It's not uncommon for an aging and neglected static system to have cracked lines and fittings. Our advice is to have this inspection accomplished first, because it really is the first step in readying the aircraft for IFR flight.

Basic models might not even have a heated pitot tube. You'll need one for IFR flying.

Antenna work can snowball the job, too. Replacing communications antennas often means removing headliners and opening the aircraft floor, plus replacing old coaxial cabling. New comm antenna systems could run as much as $2000, including labor and supplies, and modifications to the navigation antenna system to receive a glideslope signal could require sizable effort.

It could also be a good time to remove abandoned antennas and inoperative ADF and Loran-C systems. The bottom line is to make sure the shop makes an accurate assessment of existing and required accessories and include them in the proposal. The same is true for any systems that needs rewiring. On the other hand, prepare for surprises once the aircraft is disassembled. There are certain issues that the shop can't spot until the job is underway.

The upgrade might be a good opportunity to equip for the ADS-B mandate, and the equipment you choose should be based upon its ADS-B compatibility. Expect to shell out an additional $5000, on average, for an ADS-B-compliant system. We've included ADS-B systems in the

CHECKLIST

- Used GNS430Ws add bang-for-buck capability and supports ADS-B.
- Antenna work, old wiring and instrument repair can drive costs up.
- Primary flight displays and autopilots are useful for IFR missions, but can easily outcost the aircraft.

SAMPLE ENTRY-LEVEL IFR PACKAGES WITH ADS-B

Used GNS430W/GI106A	$11,500
Used KX155/KI209	$4500
New KT74 ADS-B transp.	$4800
APPROX. INSTALLED	$20,800
WAAS GPS approach, dual glideslope, KT74 has partial plug-and-play with KT76A transponders for ADS-B Out capability.	

New GTN650/GI106A	$14,500
New GTR225 comm radio	$2300
New GTX330ES ADS-B	$5800
APPROX. INSTALLED	$22,600
Touchscreen WAAS GPS with airways, single glideslope, ADS-B Out, secondary comm radio with GTN navigator data interface.	

New GNC255/GI102A	$7500
New GTR225 comm radio	$2300
New GDL84 ADS-B	$5800
APPROX. INSTALLED	$15,600
Navcomm with glideslope, secondary comm radio, ADS-B Out and In that doesn't need a panel display. No panel GPS capability.	

Approximate pricing in all options assumes the aircraft has an appropriate audio control system and supporting comm and nav antennas already installed. If sourcing used equipment, it also assumes the equipment comes with installation kits, small parts and FAA 8130-3 airworthiness approval paperwork needed for installation and return to service.

sample IFR packages chart above. Even if you don't install the ADS-B equipment now, ask the shop if there is any spare data wiring that might be added while it builds the harnessing. This might save money later.

As we've preached for years in these pages, the aircraft audio system should be the system to address before any other major equipment is added. Aside from creating more work for the shop that has to piece together audio system wiring that should really be replaced, it makes little sense to connect new equipment to old audio switch panels and wiring that can shortchange the interface. Many older switching panels lack a speaker amplifier, so it's possible that you'll be without a cabin speaker if you retain some of these older systems. Think there isn't a need for a speaker? Think about a headphone circuit failure in IMC.

IT'S A GPS MISSION

Before venturing on an IFR upgrade project, it's worth skimming FAR 91.205. It lists the bare-bones equipment required for flying in the clag. But the regulation primarily addresses flight and engine instruments, and not necessarily the avionics you'll want for your mission.

For instance, if your plans include instrument training, the occasional climb and descent through friendly cloud decks and shooting approaches to high minimums, you can get by with what we call old-school IFR avionics. At an absolute minimum, that includes a navcomm with glideslope, OBS indicator and a reliable transponder with Mode C altitude reporting, although for actual IMC we think a second comm radio is required equipment.

We asked Garmin's Jessica Koss what the company considers modern entry-level IFR equipment. Surprisingly, the answer was not a GTN650/750, but instead, the $4995 GNC255 navcomm and the $2500 GI102A navigational indicator. While we think that's a good choice for minding a lower budget, it could also leave you disadvantaged in the IFR environment. These days, it's all about GPS, and for practical IFR ops, you'll likely want an approach-approved model. If you're scanning the used market for IFR GPS systems on the cheap, caveat emptor. You could be throwing good money after bad.

The money snag with first- and second-generation systems is the required accessories needed to make the installation IFR legal. This includes a CDI and GPS mode-annunciation. These indicators—that might top $1500—display GPS course data and are integral to IFR GPS operations. Understand that a complete vintage IFR GPS installation could easily top six grand and that won't get you WAAS capability. Plus, older models like the Apollo GX-series and BendixKing KLN89 don't exactly have a user-friendly feature set, in our view. Instead, we favor the Garmin GNS430W. Although it's out of production, we have no reason to believe that it won't be supported for the long term. Garmin's FlightStream

The key to saving money (at least up front) is utilizing existing equipment. Dropping a used GNS430W/GI106A system in an existing stack of vintage radios, top, could yield an $11,000 investment. Thinking of adding an Aspen Evolution PFD (bottom) to the mix? Pony up an additional $13,000, on average.

wireless interface recently gave the GNS430W and larger GNS530W a new lease on life, adding a victor airway/flight planning interface through a tablet computer.

BANG FOR THE BUCK

That's an accurate description of the hugely successful GNS430 because it does so much in a single box, making it a good choice for budget IFR upgrades. But given its high resale value, don't expect a huge cost savings over Garmin's current-production GTN650 GPS navigator, especially if the GNS430W has to go back to Garmin for repair. Shops told us that the cost delta between a quality used GNS430W and a new GTN650 is around $2000. But that savings can get eaten in repair costs.

Garmin has flat-rate pricing of almost $900 for the GNS430W, which means you want to buy from a reputable source (preferably an established avionics shop) that can test the unit for signs of failure. This includes display problems, navigation receiver issues and even cosmetic imperfections like faded display lenses and worn bezel nomenclature. Beware of older 28-volt GNS430s—these aren't supported by Garmin and will require a voltage converter for use in a 14-volt electrical system. We wouldn't necessarily avoid a non-WAAS GNS430 or GNS530, but understand that these old GPS receivers aren't compatible with the requirements of the ADS-B mandate. Some might not have a terrain board.

You could have the unit upgraded to WAAS. Budget over $2000 for the upgrade. But since non-WAAS GNS430 systems tend to sell for around $4000-$5000, you might be better off buying a WAAS model from the start. Non-WAAS GNS530 units can sell for as high as $8000.

Our search of the used GNS430W market (sourced through avionics shops, www.barnstormers.com, eBay and Trade-A-Plane) revealed average selling prices in the $7000-$8000 range, not including an indicator.

Another option might be the Garmin-AT GNS480 or older Apollo CNX80. These are WAAS models with decent capability, but we couldn't find many for sale.

We wish sellers would stop bragging that their used avionics come with "yellow tags." This is marketing propaganda left over from the days when serviceable equipment was labeled with a yellow serviceable sticker. These days, what a buyer really wants is a signed FAA 8130-3 airworthiness approval form. It shows the disposition of the serial number and part number-specific article (either overhauled or serviceable), which shop manuals were used to determine its final status, the repair station number that did the work and signed it off and other data, which shows the part is airworthy and eligible for installation in an aircraft. This paper chase ends up in the aircraft logbooks and certainly adds to the value of the component.

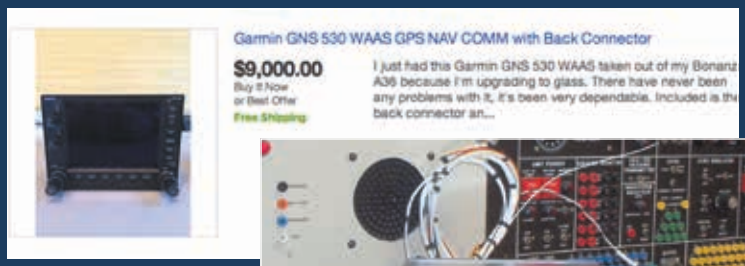
MIXING OLD AND NEW

To save money, this is what you'll need to do. This might include retaining an old navcomm for backup. But for radios that aren't supported, including all Narco models and some ARC/Cessna models, think long term and about their inevitable failure. Consider that the panel is torn open now, making a full stack replacement easier and more cost effective than doing it later.

Prepare to get backed into the corner when you consider installing an entry-level PFD, like the Aspen Evolution. Given the amount of wiring interface that occurs between the Aspen and a GPS navigator (and even an analog navcomm), it's best to install both at the same time. The most common phrase around most avionics shops is "the time to do it is now," and for good reason. But

DEAL CAREFULLY ON A USED GNS530W

While Avidyne's IFD540 plug-and-play GPS navigator is opening the flood gates for removed Garmin GNS530W systems, don't look for steal deals. Private sellers and reputable retailers—which we define as established avionics shops with Garmin and Avidyne dealerships—sell the units for $8000-$9000, on average. This price should include a mounting rack, connector kit, connector backplate and GPS antenna. It likely won't include a navigational indicator, the preferred stand-alone choice being Garmin's GI106A. It's a high-quality OBS resolver-style indicator equipped with integral nav source mode annunciation. Add $2500, on average, to the project for a new one, although there are some on the used market for a bit less. The King KI209A indicator will work, too. The KI209A is often paired with the BendixKing KX155A/KLN-series GPS package found in early 2000-vintage Cessnas and in some later Piper models. Most analog and electronic HSI systems will work, too. Use caution, however, with Sandel SN3308 EHSI displays that have older software. Budget $2000 to have it upgraded so it can display the WAAS GPS glideslope signal from a GNS530W/430W.



Like the GNS430W, Garmin has flat-rate repair pricing in place for the GNS530W, so you want to be sure the unit is in good serviceable condition. This can be verified with a basic bench evaluation, although keep in mind that most shops won't be able to make major repairs or even tweaks to the GPS engine. It will need a trip to the factory for that. Speaking of the Garmin factory, it stopped shipping installation mounting hardware, creating a dilemma in the GNS530W market, and for Avidyne IFD540 projects.

While the Avidyne IFD540 can slide directly into a GNS530W installation it occupies the mounting hardware that will generally be required for reselling the GNS530W. Since Garmin no longer supplies them, IFD540 customers have no choice but to pay for Avidyne's $650 rack and connector kit, plus the shop labor for installation. Several shops we spoke with pinned the cost at around $300, or a few hours of additional installation effort.

Dave Fetherston at Nexair Avionics in Mansfield, Massachusetts, told us that his shop won't take a GNS530W in trade unless it also gets the mounting rack and backplate. Fetherston notes that while this yields an additional expense, most IFD540 retrofits he performs requires the removal of the existing mounting rack anyway to add wiring for additional features, including the audio outputs for terrain warnings.

How about a used GNS530W supplied with an Avidyne IFD540 tray? While the shops we spoke with don't see it as a deal breaker, some admitted it's a grey area they would rather avoid. What helps is that Avidyne achieved PMA approval for the IFD tray and backplate assembly. It says the approved tray may be used in new IFD540 installations and may be used when an existing GNS530W tray is damaged or worn.

Aspen's single-screen Evolution 1000 PFD can be a $13,000-plus buy-in, including installation. For light IFR missions and lesser valued airframes, that could be a questionable investment with little return.

The same goes for traditional HSI systems, including the King KCS55A, Sandel SN3308 EHSI and the more basic Century NSD360A. Unless the prices of the HSI is less than half the cost, the more modern Aspen PFD system is a better investment. Moreover, the money spent on a PFD may be better spent on a basic autopilot.

On a side note, fewer avionics can help tame the learning curve. While not an IFR trainer, that is the approach Sporty's is taking with its Cessna 172LITE project. Sporty's is acquiring used 172 aircraft, modernizing the interiors and equipping them with the most basic avionics and flight instrumentation.

Sporty's Charlie Masters told us it chose the 172 because its panel is extremely scalable, the airframe is certified for IFR and is on the approved model list (AML) for many aftermarket avionics. That is worth considering when selecting an airframe for IFR upgrade.

FINAL THOUGHTS

Our advice is to resist over-equipping and upgrade for IFR based on your mission and the aircraft value. For the most basic and occasional IFR mission, consider traditional navcomms like the Garmin GNC255 and even a used BendixKing KX155 with glideslope, supplemented with a tablet or portable GPS. For under 10 grand, it's the cheapest IFR upgrade.

For more advanced missions, we favor a used GNS430W and a backup navcomm like the KX155, SL30 or a new GNC255. But it's worth pricing the current GTN650 and even a larger screen GNS530W. For heavy IFR, we think sacrificing a PFD for an autopilot is the right decision.

Last, if you're starting from scratch and worried about taking a hit when you sell the plane, the best option might be to just sell it now and buy one that's already equipped for IFR.

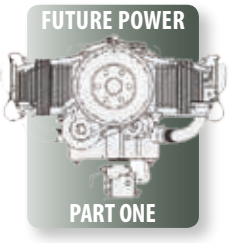
INDUSTRY ANALYSIS

Lycoming 2.0: Survival in a Harsh Market

After a decade of investment and modernization, Lycoming has pulled itself back from the economic brink. It has enough capital for modest R&D.

by Paul Bertorelli

To survive in a market that's a shadow of what it was 40 years ago, Lycoming and Continental have had to reinvent themselves. This is the first of a series explaining changes at the engine companies.



When's the last time your late-model car broke? Not a check-engine light, but well and truly quit? It probably hasn't happened and one reason for that is that modern automotive quality is relentlessly driven by quality control systems that favor high volume in factories that build the very same engine, or transmission or ignition module in which the only thing that changes in 50,000 units are the serial numbers.

At the opposite end that continuum is Lycoming, a company that holds more than 700 engine type certificates, each with different designations, different model numbers, unique accessories and sometimes discrete core components for the same families of engines. A Toyota process engineer used to making 300,000 Camry engines a year would need a fistful of Valium to survive the shock of touring the assembly line in Williamsport.

Yet…Lycoming has confronted the seemingly insurmountable challenge of so-called high-mix, low-volume manufacturing with a careful, if modest, program of reinvestment in a factory whose origins date to the 19th century. Even as the market it depends on flattens or shrinks, the factory has reduced its physical footprint and become measurably more efficient. Twenty years ago, it was outsourcing raw manufacturing at such a rapid clip that it seemed it would evolve into an assembly business with a specialty in drop shipping parts.

Didn't happen. Today, thanks to rapid advances in flexible, computer numerical machine tools and a determination to adapt high-volume quality control methods to trickle volume, Lycoming is bringing vendor work back inhouse.

Now, Lycoming produces many parts that it used to outsource at prices competitive with vendors and at what it says is potentially higher quality. This could be an MBA case study in turnaround management, but it's more accurate

Nicole Johnson, above, applies final torque to valve covers before an engine heads to the paint booth.

to describe it as a survival story in an industry worn down by declining markets and escalating costs. Last fall, I spent nearly three days touring and filming the plant for this report and an accompanying video. Here's what I learned.

BLACK SPIRAL

Modernization and reinvestment is a routine part of the manufacturing landscape. Machines wear out, new ones do a better, faster job and planned capital improvement is a fact of business life. But this gets sticky in industries where there is little or no growth and no prospects for reversing that, no matter how much you spend on new equipment. The promise of efficiency wrought by new machinery is alluring, but you still have to spend the money.

In aviation, there's an understandable tendency to limp along with old equipment, repairing and refurbing and making do, sometimes with machines that are 70 years old.

But competition and technology don't stand still. New machinery, despite its cost, can be markedly more efficient and, more important, flexible in setup, capability and automated operation, the trifecta of modern small-lot manufacturing. An established mainstay in a sunset industry that has to live with aggressive competition—and Lycoming does—can find its internal costs too high to compete. And Lycoming did.

"You can't be caught in an environment where it costs you more to put stuff out the door than the price you can get for it," says Michael Kraft, Lycoming's general manager. During the early 1990s, when Lycoming was tilting strongly horizontal, that strategy made sense because there was surplus manufacturing capacity capable of building parts cheaper than Lycoming itself could.

THE TIDE TURNS

That strategy raises quality control challenges, but it still made no sense for Lycoming to build that capability in-house, or so the thinking went then. So it shrunk. Every time we visited the plant, another bank of machine tools had been mothballed or retired and the floorspace reduced.

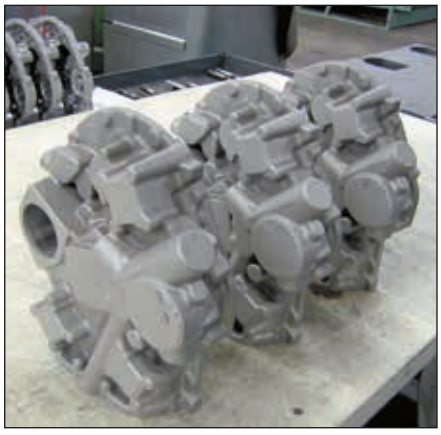
"And then you have reduced volume. But you can't shrink yourself to prosperity. You have to invest internally or you're going out of business," Kraft says, adding that Lycoming faced a "black spiral" of higher materials costs and high production costs that competitors—mainly PMA houses—were able to capitalize on, squeezing profits by building high-volume parts, but not stuck with providing the small-volume stuff that customers expect to keep their aircraft flying.

With no pricing power to raise margins against competitors and no meaningful ability to reduce production costs, Lycoming had nowhere to go. "We were caught in a trap. The costs of raw materials hasn't gone down. Just to compensate for that, we have to drive production costs down," Kraft says.

What changed in Lycoming's favor is a technological evolution in computing power coupled to numerical machining equipment. The tools became more affordable, more capable and more flexible. Single machining centers—although they require skilled operators—can displace dozens of dedicated, hand-operated machines, enabling a trend back toward vertical integration.

Once it's integrated into the manufacturing flow—which sounds easier than it is—modern CNC equipment turns out parts faster, with less set-up time (with fewer errors) and at higher rates of repeatability, the very hallmarks of the automotive-type quality aviation process engineers dream about but struggle to achieve. Kraft said the

All of Lycoming's traditional engines, including overhauls, are assembled on the legacy line, above. Hand operations still dominate, but its record-keeping and statistical process control is mostly digital. General manager Michael Kraft, below: "You can't shrink yourself to prosperity. You have to invest internally or you're going out of business."



CNC machining cells like the OKUMA Space Center, left, replace dozens of hand operations to machine accessory cases, lower left. Crankshafts and other parts are now nitride hardened via ionized nitrogen, ridding the plant of a toxic waste stream generated in the previous process.

factory has engaged in "target shooting" to decide what parts it can produce competitively and what it can't. The size of these investments, as industrial capital improvements go , isn't staggering. Lycoming's automated piston line, for example, took several years to bring online and cost about $4 million. A recently completed nitriding cell was about $1 million and machining centers have tags on them in the $600,000 range. But when revenues are flat and profits are vaporously thin in aviation, managers may have to repeat to themselves that you have to spend money to make money. "We didn't have a choice," Kraft says.

A NEW LANDSCAPE

In the 20-plus years I've been touring Lycoming, the factory has undergone continuous but almost glacial change. But in those two decades, it has gone from a dank and dark old-school factory populated by ancient machinery to one that while not quite a paradigm of European modern, has nonetheless integrated state-of-the art technology at every turn. This became most obvious when Lycoming began what I heard called "the investment" around 2007, ahead of the 2008 downturn when the aviation economy at least showed a pulse.

Some of the major investments include new crankshaft machining cells, a large flexible cell called a Space Center made by the Japanese machine tool giant OKUMA and a custom-made piston line that does everything but turn raw bauxite into finished parts. Less noticeable are the quality systems integrated with this equipment, made possible by machines that faithfully follow well-tested machining programs and record their every mill, broach and bore for the statistical process control that forms the bedrock of modern manufacturing quality.

During my tour of the plant, Lycoming production manager John Hartsock explained how the Space Center has been configured to machine accessory cases, the back end of a Lycoming engine that's a complex machining problem because it's heavily populated with pads, bosses, holes and threaded fittings. Lycoming engines have a variety of accessory cases, each with its own dimensions and hole patterns. Before the advent of flexible CNC, such a part would visit a dozen individual manual work stations, each an opportunity for a set-up error or a mis-machining by an undetected worn tool.

Now, the Space Center and machines like it can process the entire part in a series of unsupervised operations, changing its own tools and compensating for a worn cutting edge. Moreover, says Kraft, advances in such mundane things as cutting fluids and tools have increased production efficiency measurably.

Flexible CNC can—and does—economically accommodate short runs. That plays out for the customer with direct results: Seldom-ordered parts that used to take months to deliver until the factory accumulated enough orders to make building them economical can now deliver on shorter turn times. "It's a better part, we make it faster and there are fewer errors," Hartsock told me. He walked me past a production cart loaded with a half dozen accessory cases with splotches of red paint; an entire year's worth of rejects.

Not that long ago, that might have been a month's worth. And although Lycoming has had statistical process control in place for years, it has more of it now than ever, all tied into CNC tooling that does more than it ever did. And not that long ago, bad parts slipped through QC to the customer.

That's far less likely to happen now, Hartsock said. At every turn, small but constant improvement—the Japanese *kaizen* process that U.S. industry has universally adopted—are evident. In a run of a dozen accessory cases, the first and last in the run are sent to the QC lab for careful inspection by a coordinate measuring machine, a process that requires the part to temperature stabilize for 24 hours. During my visit, Lycoming had just installed a new CMM right next to the machining cell, one that compensates for temperature, eliminating the bottleneck. It's a minor efficiency, but in an industry where the low-hanging fruit has long since been picked, little things add up in the drive toward manufacturing consistency.

When we toured the CMM lab, I asked Lycoming's Mike Everhart, Lycoming's VP of products and services, what long-term effect the integration of CNC and quality systems has had on the plant's CpK trend. CpK is an index of how close a production process is actually running relative to its intended specs; the more consistent they are around the desired specs, such as dimensions and materials, the better. "Our CpKs used to look like this," said Everhart, tracing a zigzag with his finger, "now they're like this," he added, drawing a flatline with his other palm.


1


2


3

THE SECRET LIFE OF PISTONS

For engine builders, pistons require numerous specialized machine operations and inspections, so they've generally come into the plant through the shipping dock. So it was surprising when Lycoming announced in 2010 that it was installing its own piston line.

The machine—actually a series of machines strung together—is an eye catcher, occupying a bay in the plant that looks a block long but is probably about 50 feet (1). It was engineered by the UK automotive and tool giant Cosworth, using mostly Takisawa machine tools as a basis.

It's entirely automated, albeit carefully monitored as it takes raw, near-net aluminum forgings (2) through more than a dozen processes, spitting out gleaming, complete pistons at the end of the line. Few hand processes are required. When the pistons come out of the machine, they're deburred by hand and passed into another cell where they get an automatic wash, a dye bath and a careful inspection for faults under a Zyglo lamp. Minor imperfections get another trip through the machine; major flaws are rare. The pistons also get CMM checking before shipment.

The pistons also have something they didn't have before: Laser-etched bar codes and serial numbers that allow Lycoming to track them in the company's expanding process control architecture (3). GM Michael Kraft said this capability was a gimme that came with the technology at no additional cost, but one that adds incremental quality through additional statistical monitoring.

WHAT CUSTOMERS SAY

In keeping with the *kaizen* philosophy, improvements at Lycoming have been steady. The drama derives from looking at the changes over two decades. Are customers noticing? Frankly, it's difficult to determine this. I checked with several engine shops and distributors and got a generally positive if mixed reaction. The industry has become so small that some companies are simply fearful of saying anything—positive or negative—that might offend their suppliers. One major distributor of Lycoming parts declined to return calls and an engine shop we normally count on for reality checks wouldn't discuss Lycoming at all.

But those that did speak to us suggest that Lycoming quality was, with only a few significant exceptions, never bad to begin with and hasn't noticeably changed, either in the quality of the parts themselves or the speed and accuracy of order fulfillment. Shops do complain about pricing. Where Lycoming has competition, prices are competitive. Where it does not, expect sticker shock. At Certified Engines in Opa-Locka, Florida, Allen Weiss told me cylinders for the TIO-540-AJ1A used in the Cessna 206, which only Lycoming makes, cost about $2800, compared to $1100 to $1300 on cylinders where there's PMA competition. And how's the quality? "I've had a couple of small issues, but I think it's jam up. They're good," Weiss said. He said the supply chain usually has parts on the shelf. As for engines from the factory, Weiss says the introduction of roller tappets has noticeably reduced the incidence of cam and lifter spalling.

"I haven't heard of any fubars on the part of Lycoming. We might have an occasional engine burning too much oil, but I don't think that's the factory's fault," says Charlie Mellot of Zephyr Engines. As far as order filling and accuracy, Mellot says the shop orders through Air Power, but factory direct orders are not better or worse than they ever were.

The low point for Lycoming quality was undoubtedly the massive recall of 1500 crankshafts in 2003, a multi-million-dollar effort that also embroiled the company in litigation. Perusing recent Lycoming ADs, there aren't any nearly as significant as that. The company's Michael Kraft told us another crankshaft catastrophe is less likely to happen now. "We've actually extended Lycoming process control right down to the melting of the crankshaft metal. You have to look three levels down the supply chain. That's where you have to go now," says Kraft, describing an industry-wide trend.

LYCOMING'S FUTURE

Both Lycoming and Continental have made significant investments

LYCOMING'S DIESEL

Although Continental gets most of the ink in coverage of aerodiesels, Lycoming has a thumb in the market, too, with the DEL 120. This project seemed to come out of the shadows reluctantly because its emergence is associated with the General Atomics Predator, the most widely used reconnaissance and weaponized drone. The Predator originally had the then-Thielert Centurion diesel, but when Thielert got into financial trouble, General Atomics sought other options.

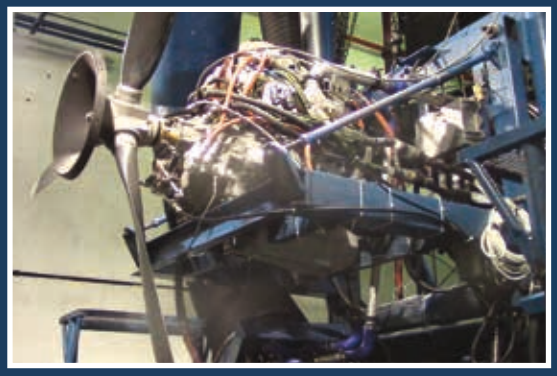
One was an Italian company, DieselJet, that had converted a four-cylinder Fiat diesel for aircraft use, much as Thielert did with the Mercedes OM668. DieselJet found a market among foreign drone manufacturers but General Atomics wanted a U.S. engine maker involved. Enter Lycoming, which has invested in the engine and made substantial changes to it.

But Lycoming was involved both in diesel and what became the DEL 120 even before the Thielert bankruptcy, according to Michael Kraft, Lycoming's general manager. The DEL 120 is Lycoming's fifth diesel initiative. The drone market provided an on-ramp for industrialization of the engine, Kraft says.

When I visited Williamsport, the DEL 120 was being built up one at a time in a small work area off the main assembly line. Lycoming was in the process of proving final production techniques and methods, which have been under the scrutiny of Department of Defense, since the Grey Eagle—the Predator's follow-on drone—is a U.S. Army program. In Europe, a version of the engine is EASA-certified, but if that's in the future for Lycoming, it's some distance away. At 200 HP, the DEL 120 bests Continental's 155-HP CD-155 by 45 HP at a claimed weight of 360 pounds dry, compared to 295 pounds for the Continental.

That makes the DEL 120 65 pounds heavier than the Continental engine, but both are close on power-to-weight ratio. The Continental is at 1.9 lbs/HP while the DEL 120 has 1.8 lbs/HP. Lycoming claims a fuel economy of about 0.37 lbs/HP BSFC, which is a bit more than the Continental engine. Both have gearboxes, but the DEL 120's is designed to last the life of the engine rather than have periodic replacement, as with the Continentals.

What about civil certification? No announceable engine yet, but Kraft says Lycoming has it on the to-do list. "There are areas of the world where diesel makes sense. Unfortunately, where the fuel makes sense are not areas where you have a high volume of aircraft. The economics are tough. But the product has its place," Kraft says. He believes the diesel market will always exist, but for Lycoming, the business case has a 10- to 30-year payback. So if you're guessing on future markets, you'd better guess right.



in modern machine tools. While Continental has been the beneficiary of generous Chinese capital through its AVIC International parent, Lycoming has internally financed its own transformation, both as a means of simple survival and to fund modest future development, with an emphasis on modest.

Kraft has heard the slur "Lycosaurus" so often that he takes grim humor in referencing it. "Ten or 15 years ago, you basically had a business that was not efficient enough to put capital investment and R&D into the business. Therefore, you had Lycosaurus…where's the new product?" Kraft says.

"You dig out of that hole by investing first in manufacturing processes. Here's the hindsight thinking. We invested first in manufacturing technology to be able to get the headroom for R&D because you can't count on the return from the new products. We know it's going to be a long time before the IE2 or the DEL 120 investment pays off," he adds.

Indeed, the expensively developed IE2 FADEC-controlled engine still isn't certified and has only minor OEM commitments in Lancair, Tecnam and Northrop Grumman's Firebird, a pilot-optional aircraft just coming online. Those aren't large-volume customers. In fact, there may not *ever* be large-volume customers. And even though the UAV market is hot, the airframe numbers are low—the multiple dozens, not the hundreds, thus the DEL 120 diesel is some distance from profitable volume. Continental is in the same market straits with its diesels.

Lycoming's strategy will likely remain targeted investments in sharply contained segments of its manufacturing, where it can push costs down and margins up. Take camshafts, for example, which are now bought from vendors. "We're going to have to figure out if we can do solidly better on camshafts for a decade than our supply base can. Can we do it better and more cost competitively than the supply base can?" Kraft asks.

Increasingly, the answer to that may be yes. But don't expect any swing-for-the-fences, cutting-edge engine developments, which can cost $40 to $60 million to develop. Like it our not, that's the reality Lycoming faces.

Aircraft Survival Kits: Vest is Best

Quality costs when it comes to aviation survival equipment. There is a commercially available kit that's right for where you fly.

by Rick Durden

Every pilot considers the aftermath of having to put an airplane down other than where he or she desires. Every year some pilots are required to put such thoughts into action. Contemplating the worst and preparing for it is something pilots are trained to do—and part of being ready to implement an after-accident plan of action is having equipment available to carry it out. That means having a survival kit in the airplane.

There are dozens of commercially available aviation survival kits. We surveyed a cross section—they ranged from unacceptable to excellent, based on the quality and selection of items included as well as weight and size. Because weight and space are at a premium in general aviation airplanes, the best kits did amazing jobs of shoehorning a lot of equipment into a small space and keeping weight under control.

We also noted that quality isn't cheap—a poor-quality knife that breaks when used for prying (a common use) might as well not have even been put in the kit. When lives are on the line, the equipment in a survival kit has to stand up to use in adverse conditions. Cheap gear can be deadly.

In our survey, we saw a tremendous amount of hype. We rapidly learned that terms such as "military grade" or "combat" were often code for poor quality. It made us think of low bidder military contracts.

KITS UNDER $100

The Survival Kit in a Bottle is one-liter water bottle on a carabiner to attach it to your belt or vest. It contains a multifunction tool, whistle, compass, flashlight with batteries, survival blanket, candle, waterproof matches, poncho, two chemical hand warmers and a zipper-lock bag. Available from multiple sources, it's most commonly priced at $24.95.

For $11.50, there is what we considered to be a poor-quality pocket kit, the Ultimate Survival Kit, sold by Aircraft Spruce (www.aircraftspruce.com). A small vinyl pouch contains waterproof matches, signal mirror, flashlight (without batteries) basic fishing kit, emergency blanket, sewing needles, compass, wire saw, poncho, whistle and a sterile blade.

Best Glide Aviation Survival Equipment (www.bestglide.com) offers its Adventurer Pocket Survival Tin for $39.95. We looked at a number of basic survival kits in Altoid-sized metal containers—this one provides a decent selection of materials in a 4.5x3.3x1.2-inch space. Included are a button compass, survival matches, razor knife, sewing kit with safety pins, whistle, fishing kit, vinyl tape, survival instructions, water bag, tie wraps, wire saw, various fire starters, candles and signal mirror.

The Combat Survival Tin from Aircraft Spruce is advertised as

Under $100 pocket survival kits: Upper left, Ultimate Survival Kit has very basic equipment, mostly low quality; Combat Survival Tin, lower left, lacks signaling mirror; AMK Pocket Survival Pak Plus, right, gets our nod for a serious, inexpensive small kit.

CHECKLIST

- Few commercial kits include high-quality equipment.
- For under $100, we recommend the Pocket Survival Pak Plus.
- For under $1000, we recommend the Essentials Aviator Survival Vest.

POST-CRASH SURVIVAL 101

Reduced to its essence, having the gear for post-crash survival is great; being found quickly is even better. The faster you and your passengers are found, the greater the chance of survival. Improving the odds starts before departure and means making sure someone knows where you are going. Being on an IFR flight plan has historically meant the least delay in post-crash rescue. Next best is being on a VFR flight plan or making sure someone is in position to start search and rescue (SAR) if you don't show up when expected.

The next step is to be able to effectively signal potential rescuers. Carry a Personal Locator Beacon (PLB)—the device that revolutionized SAR by not only announcing that you are in trouble, it guides rescuers right to you. We feel that every pilot should have a PLB on their person during every flight. We'll cover PLBs in a future issue of *Aviation Consumer*.

Because signaling forms the basis of getting rescued, we think a survival kit should include a signaling mirror that can be aimed, such as the Rescue Flash—less than $10. It should also have a whistle—it's easier than shouting and the good ones can be heard for a mile. In the good-to-have department is a laser flare; it can be seen for over 20 miles at night. However, they start at just over $100 for a red one—figure on $300 for the better version, which is green.

Once signaling is covered, it's surviving until help arrives (stay with the aircraft). A person can theoretically survive with a good knife (figure on at least $100 for one you can bet your life on and can be operated with one hand—you may not have two available) and a way to start a fire (waterproof matches at the very least). However, doing so requires training and a lot of work. Having additional equipment ups the odds. The next priorities for the survival kit are first aid, fire, shelter, water and food. Because most of us can't afford the perfect survival kit, and weight is a consideration, we think aviation survival kits should focus most on signaling, first aid, fire and shelter.

What you pick depends on the type of flying you do. At a bare minimum for pilots who don't fly over remote areas or large quantities of water, we recommend every pilot carry a PLB, good knife, signaling mirror and top-quality pocket survival kit on his or her person. If your flying is regularly over remote areas, peace of mind for you and your passengers may require a more sophisticated kit.

If you do have to put an airplane down in the boonies, you're having one of those low-probability, really bad days. Because things are already going wrong, there's a good chance that you won't be able to get to the survival kit after the crash—it's buried under heavy wreckage, burned up or you can't ambulate—so we recommend that your survival kit be in a vest you wear while flying.

designed for the British SAS and also comes in a pocket-sized tin. For $29.95, it includes such things as a compass, whistle, candle, basic fishing kit, survival instructions, wind- and waterproof matches, pencil, cable saw and a flimsy folding knife with scissors, but no signaling mirror. We weren't impressed.

For the best value and quality in a kit that will fit in a pocket, we recommend either the Adventure Medical Kit (AMK) Pocket Survival Pak or Pocket Survival Pak Plus. Both were designed by noted aviation survival expert Doug Ritter (full disclosure: Ritter was a contributing editor to Aviation Consumer and wrote several survival equipment articles).

Priced at $26.99 through PilotMall, the Pocket Survival Pak weighs 3.9 ounces and includes a 110 dB whistle and the Rescue Flash signal mirror. Also included are 10 feet of nylon cord, 15 feet of steel wire, one-hand operable spark light fire starter and tinder, instruction card, 20 mm survival compass, duct tape, aluminum foil, fishing kit, scalpel blade, pencil and note paper.

The AMK Pocket Survival Pak Plus is available for $69.99 from PilotMall and includes all of the equipment in the basic Pak and adds the RAK Mk5 Survival Knife, a serious compact steel fixed-blade knife, LED flashlight sterile water bag, water purification tablets, 28-inch stainless ball chain and waterproof pouch. It weighs a total of 5.9 ounces.

At $69.95, Sporty's (www.sportys.com) ill-named Complete Aviation Survival Kit provides a chance to save money by not buying it. There is no signaling mirror or knife, just a whistle and razor blade.

Sporty's Emergency Ditching Survival Kit is a backpack kit produced by Mayday Industries. Mayday's emphasis is on survival kits that will keep you alive for a few days rather than on rescue. (Mayday makes a large line of kits for situations where rescue may take a while.) For $89.95 and combined with a PLB, signaling mirror and a good survival knife, we think it is a fair kit for under $100. It contains a basic first aid kit, water and food, flashlight, orange survival tent, emergency blankets, waterproof matches, ponchos, a combination whistle and compass, gloves (something we think is too often overlooked), AM/FM radio, camp stove and boxcutter (a poor survival knife).

KITS FROM $100 TO $1000

The Wilderness Survivor Survival Kit from Best Glide is priced at $299.95 and comes in a 8x8x15-inch Denier Cordura bag. For the price, we think this kit contains a good cross-section of equipment. For signaling it has a compact signal mirror, whistle, three light sticks and an Inova LED light.

The 22.6-pound Ultimate Aviator Survival Pak, right, is the best commercially available aviation survival kit we've found. The Essentials Aviator Survival Vest, below right, is our pick for best personal aviation survival kit.

It also includes some food and water, survival guides, assorted means of starting a fire along with candles, a two-person survival blanket, two basic knives, a pocket saw and can opener, as well as a first aid kit that includes such things that are overlooked as insect repellent and diarrhea treatment. We would still add a high-quality signal mirror, good knife and PLB to this kit.

Another of the many kits offered by Aircraft Spruce is the Crashkit Charlie Survival Kit. It comes in a protective, Pelican case and is advertised as for the pilot with minimal knowledge of survival techniques. Priced at $344.95, it weighs four pounds and has 71 items providing assistance for food, fire, water, shelter, first aid and signaling. It also contains a first aid book and critical action card. The signaling mirror is gridded, which is an improvement over the very basic mirrors provided with most kits. For knives, it has a scalpel and multi-tool, but not a dedicated survival knife. We liked that it provided waterproof matches.

The Flight Level 220 Survival Kit Lite weighs 8.5 pounds and comes in a Pelican case that is 9x7.5x4 inches and is priced at $193.75 at Aircraft Spruce. Contents include a signaling mirror that can be aimed, a 57-piece first aid kit, emergency blanket, but no tent, snare wire but no wire saw, waterproof matches, whistle and a soft plastic water bottle. It has no food, but does have a 15-foot towing strap, of all things. The multi-tool is credit card style, so it has no pliers. We'll take a pass on this $193.75 kit.

The $462.95 Military Pilot Survival Kit from Aircraft Spruce is advertised as having been designed by Oregon Aero for the U.S. Navy. It comes in a 6.5x5.5x2-inch pouch. It is not a complete survival kit by any means, lacking signaling equipment beyond a LED flashlight. We like the Gerber multi-tool and Air Ranger folding knife (a one-hand opening knife) for their quality. However, the remainder of the kit consists of just four items, a compass, sunscreen, balaclava and fire-starting system. For what we'd save not buying this, we'll be able to go a long ways toward a much more complete kit.

At $420, the Canadian-Alaskan Survivor Pak (www.campingsurvival.com) is designed to help sustain two people for up to 14 days. It weighs 31 pounds and includes two 14-day food rations and 24 ounces of water along with fire, signaling and shelter equipment. There is no tent, but there are emergency blankets and a first aid kit. With the addition of a sleeping bag and a pistol, rifle or shotgun and ammunition, the kit is advertised as meeting the Transport Canada summer aviation survival equipment requirements. The kit is heavy enough that it eats into useful load in a smaller airplane, however, for the price, it's attractive.

Sporty's $799 Over Water Survival Kit contains the unimpressive Complete Aviation Survival Kit; despite that, it's a good start for a true over-water survival kit because it has what we consider essential signaling devices. The floating survival bag contains four dual-cell life vests, a Firefly3 rescue light, ResQlink+ PLB and a signal mirror. We recommend wearing the life vests when flying over water. The fact that the kit floats is a plus.

We are aware of only one commercially available survival kit in a vest. It's the Essentials Aviator Survival Vest through www.dougritter.com. At $725, it contains everything we think should be in a survival kit except for a PLB (which we think a pilot should already have). The vest itself is made of cotton (not nylon, which can melt and cause serious burns during a fire) and contains 20 pockets, but has a flat back so it is comfortable to wear in flight. An illustrated in

continued on page 32

Pilot Flight Bags: A Tote For Every Purpose

Our top picks are flexible designs from Jeppesen, ASA and Sporty's. Brightline's FLEX wins for innovation.

by Rick Durden

Flight bags become a part of our aviation lives. We somehow become attached to those glorified grocery bags we use to schlep our flight gear around—so spending a little time making a selection is worth the effort. Chances are you're going to have it for a long time.

There is a bewildering selection of bags—we quit counting at 70 different offerings. However, before even looking at a flight bag, we believe that the selection process should begin with a thoughtful assessment of the type of flying you do, followed by consideration as to what you truly need to have with you in an airplane and how you want it organized. A good flight bag is all about organization and convenience for you as pilot in command.

KNOW THYSELF

Take inventory of all the stuff you normally carry in the airplane on a flight. Get all of it and lay it out on the bed. Go ahead, we'll wait. If you're a student pilot, keep reading: we'll have some suggestions for you.

Look the pile and decide what you really need. We've seen too many pilot who think that flight bags are zero-gravity bins, and 25 pounds of stuff gets tossed into an already overgross Tomahawk, making for some puzzled looks on the faces of PICs on warm day takeoffs. How long has it been since you used that second GPS unit? Why two fuel samplers? Four piddle packs—really?

Pull out the survival gear—it goes in your survival vest that you wear because you may not be able to get at the bag after a quick stop. The vest gets carried in the bag to and from the airport. We've got more on survival starting on page 13.

Next, segregate the stuff—start with the things you normally need on getting into the airplane; such as tablet computer, headset, pen, pad, flashlight. You'll want those things in a convenient location. Second, is there stuff you might need in flight on very short notice, such as the spare flashlight or standby radio? You'll want a flight bag that is set up to allow you to reach and grab—when the adrenalin is flowing, you don't want to be digging frantically for what should quickly come to hand. Finally, make a pile of the stuff that you simply can't bring yourself to get rid of.

Weigh everything. More than you thought, right? See what you can do to weed it down still more.

Now you're in a position to evaluate what you want in a flight bag. Think about where you will put the stuff in those three piles you made each time you look at a contender.

As you look at bags, keep the overall size of the pile of your stuff in mind—buy a bag big enough to hold it without a lot of empty space. The human tendency to fill up suitcases just because there is space available is counterproductive with flight bags. You don't need the weight and the extra junk will be in the way when you're looking for that fuel sampler.

STUDENT PILOT

By the end of the first lesson, a new student has not only been inundated with information about flight, she

The ASA line of flight bags, clockwise from top, Tech Flight Bag, Flight Bag, Dual Headset Bag, Headset Bag, Pilot Bag, Pro Flight Bag and, center, Pilot Briefcase.

CHECKLIST

- Selecting a flight bag starts with an assessment of the flying you do.
- All of the bags we examined were well made and durable.
- The flight bag field is competitive, which keeps prices reasonable.

Lightspeed's Adventure Flight Bag Collection includes the Gann, above right, with carpenter-style main compartment opening and the smaller Markham, below right. Both bags are leather.

or he has also been bombarded with things they should buy. In our opinion, a flight bag shouldn't be purchased right away. Grab an old backpack from the closet and use it—it'll be fine and you won't look uncool. We suggest that you hold off on the flight bag decision until after at least your first solo cross-country. By then you'll have a pretty good feel of what you need and can buy a flight bag that will meet your needs for many years to come. Keep thinking convenience and organization.

To help you with step two of the flight bag selection process—actually looking at bags—we examined some of the best-known and most popular flight bags, and that we felt were durable enough to buy with an expectation that they will hold up as you toss them around over the years.

BRIGHTLINE BAGS

Brightline's FLEX system allows a pilot to combine various modules to create a flight bag that fits his or her needs. Starting with the $96, ultra-thin B-Zero Slim bag that is the line's basic Pocket Cap Front and Flat Cap Rear zipped together, the line progresses, by adding various size center sections and side pockets, up to the B18 Hangar bag, priced at $319.

According to Brightline, the hub of the FLEX system is the Pocket Cap Front, which has three main pockets and six secondary pockets for the pilot to store cords, cables, chargers, batteries and so forth for electronic gear as well as a fuel sampler, multi-tool and small flashlight. The various center sections include movable dividers. Side pockets vary from something for holding pens to one that Brightline says will hold any handheld radio.

While pricey, we like that the modular system allows a user to start small and buy additional modules as the need arises, as well as to make a big bag smaller for a flight where weight or available space will be a consideration.

Brightline offers a three-year warranty.

SPORTY'S

Sporty's Flight Gear line of pilot bags is attractively priced and, we think, extensive enough to have a bag that will fit most any pilot's needs. Starting with a padded headset case for $19.95, it includes seven more cases, topping out with the large Flight Gear Navigator Bag at only $99.95.

We spent some time with three of the bags. The Mission Bag, priced at $62.95, is 10x8x13 inches and is designed for tight cockpits where you may only be able to get at the bag through the top. It's centered around a large center compartment that can be accessed through a top zipper flap or a side zipper that opens up the entire bag. It also has two zipper compartments on the front and small pouches on one side.

For a little less money ($59.95), Sporty's Crosswind Bag is larger (15x9x9.5 inches) and offers a large center compartment and dedicated headset compartment. Sporty's says that the bag was designed for student pilots by the student pilots in its flight school. It has the space for most things a VFR pilot will need and there are enough dividers and compartments to keep things organized.

Sporty's top-of-the-line bag is the $99.95 Navigator. At 10x22x11 inches, it's more than just a Crosswind bag on steroids. It has a padded headset and padded tablet pocket as well as hideaway headset pockets that are accessed from the outside. There are four additional external pockets of varying sizes and shapes as well as fuel sampler-sized pouches so anything from power cords and

THE FLIGHT BAG FOR ALL MY BAGS

by Larry Anglisano

A pilot with a flight bag? What a cliché. For me, a large and well constructed backpack works just fine, thank you. Plus, a backpack works the best for my short motorcycle commute to the airport and is easy to deal with in the cabin. But a recent run to the airfield made me consider using the Sporty's Navigator bag that's been a permanent ficture on my office floor.

The backpack is stuffed with my iPad, at least one cockpit mount, two headsets, comm radio, flashlight, windshield cleaner, eyeglass case, bottled water, snacks, wallet and hand sanitizer.

Since many of my flying missions are for reviewing products, I bring along camera gear—photo and video hardware. I have a dedicated camera bag, which is another small backpack. Then, there is the GoPro action camera. It's certainly small enough for stuffing in the camera bag or backpack, but my growing collection of accessories are not. There are various mounts, battery chargers, housings and audio cables that now live in a dedicated bag. That is three bulky bags of stuff.

The Navigator's main compartment is roomy enough to accommodate the camera bag, the maintenance logbook bag I use for the GoPro stuff, plus the tablet and mounting hardware. The headset bag fits nicely in one of the two side pockets, while a variety of other pockets easily accommodate the stuff I cram into my backpack. At 10 by 22 by 11 inches, it works as a tailpack on the motorcycle. I don't like the amount of space it occupies in the cabin—that's the appeal of a backpack.

While some pilots might not carry as much camera gear, I suspect a growing number are lugging action cameras and accessories, and certainly tablet computers and mounts. For them, I recommend the durable $99 Sporty's Navigator bag. No camera or tablet gear? I say get a high-quality backpack.

batteries to large writing tablets can be carried.

Sporty's posts photos of its product testing. They show a bag filled with bricks to test the straps; it was then dropped from 50 feet to see if it would break (it didn't) and left out in the rain to show that the contents wouldn't get wet. We like the design, durability and competitive price of Sporty's flight bags.

Sporty's warrants its flight bags for one year.

ASA

We looked at four of ASA's extensive line of flight bags. At $29.95, ASA's Pilot Briefcase, is a 15x11x3-inch nylon briefcase that is designed to carry ground and flight school materials. The expandable main compartment will hold a laptop computer and a textbook or two and is protected by a foldover flap that closes with two plastic buckles and has a zippered pouch suitable for long, flat items. It looked to us to be the right bag for ground school, but not for flight.

The Air Classics Flight Bag is a step up from the Flight Briefcase. At $79.95, it is 18x11x7 inches and has a large, double-zippered main compartment with adjustable dividers, compartments at the ends that will each hold a headset, portable GPS or RAM mount and two zippered flat compartments on the side. There are no pouches or small compartments for storing often used items such as a small flashlight or fuel sampler.

The $129.95 Air Classics Pro Flight Bag at 20x10x12 inches has a cavernous main compartment, two large end compartments that can each hold one or two headsets and side pouches with padded storage for a tablet computer. There is also a detachable chart wallet, accessory pockets inside compartments and a roller bag attachment, however, there is an absence of side pockets or pouches for smaller items.

The Air Classics Tech Flight Bag is a cross between a briefcase and flight bag; it felt to us as if it were targeted at the digital pilot, whereas the rest of the ASA line with its large compartments seems aimed at paper chart users. At $99.95 and measuring 17x10x5 inches, the Tech Flight Bag has a main compartment with two removable headset bags, padded laptop storage area and room for a tablet computer. There is a modest exterior pocket for chargers, cords and other small items and two flat, zippered exterior pockets.

LIGHTSPEED

Known for its headsets, Lightspeed Aviation made the decision to enter the crowded flight bag field with three offerings that are not only functional but are finely made and styled pieces of luggage.

Named for aviators who had a certain style of their own, these bags are expected to attract attention on the ramp. Lightspeed's director of marketing, Ed Hansen, told us, "Anybody who wants a quality bag in the classic style will appreciate the ingenuity of the design of the bag." We noted that all seemed to be designed for the digital pilot, with space for tablet computers, chargers, cords and headsets. All have a one-year warranty.

At $249, the Gann is 16x6x13.5 inches, with a main compartment that has a carpenter-style zippered opening, that allows it to open wide for complete access to the large space containing a zippered tablet pocket. Outside is a handheld radio pouch with a section of the flap cut away to allow the radio antenna to protrude, a front organizer pocket and a flat rear pocket with a clever second zipper so it will slide onto the handle or a roll-aboard suitcase.

The $199.00 Markham is more compact at 12x5.5x9.5 inches and has the handheld radio pouch on the end, rather than the side. There is a main compartment that has no dividers or pouches as well as front organizer pocket, an end pouch sized for a water bottle and a flat back pocket for a table computer and documents.

At $179, the Antoine bag is a duplicate of the Markham, but made

of what Lightspeed calls ballistic polyester rather than leather.

Lightspeed offers a $25 organizer insert with a number of pockets for the main compartment of each of its flight bags.

MYGOFLIGHT, JEPPESEN

The 17x13x7-inch MyGoFlight PLC Pro bag is a combination briefcase and backpack targeted at pilots who carry tablets and electronic accessories. The large center compartment will hold two headsets and has pockets and dividers that help keep things organized.

Since the inside of the storage pockets are easy to see, we particularly like that small items don't get lost inside the bag—a problem we have with run-of-the-mill backpacks. Moreover, this makes the bag easy to deal with at TSA checkpoints.

At $159, it's not cheap, but it's one of the highest quality backpacks we've seen.

From a line of six bags, we examined Jeppesen's Navigator flight bag and its Pilot Backpack. At 12x24x12 inches, the $101.95 Navigator is built to carry a lot of stuff—it's especially good if you fly IFR using paper charts. The padded main compartment has movable dividers; the outside has a removable headset bag on each end, an organizer pocket on the front and two pouches on the back.

We particularly liked the $79.95 Jeppesen Pilot Backpack. It's designed for the digital pilot, with numerous pockets for electronic gear and cords. Its dimensions are 21x14x9.5 inches. The padded laptop sleeve is big enough to hold a 15-inch MacBook, which will not fit into the MyGoFlight backpack. In addition to the large central compartment, we counted eight zipper pockets of various sizes and shapes.

If your flight bag of choice is a backpack, we recommend Jeppesen's Pilot Backpack.

Jeppesen's Pilot Backpack, left, is our top choice for best backpack flight bag.

CONCLUSION

With something north of 70 flight bags to choose from, the selection can appear overwhelming. That's the bad news. The good news is all of the ones we examined were of good quality and, we think that because of the level and quality of competition, the prices are reasonable.

As we were discussing flight bags with him, Sporty's Doug Ranly told us, "Each person has his own mission." We couldn't agree more. All of the bags we examined came with shoulder straps, some pilots like them, some throw them away.

Some pilots like a lot of small, zippered compartments; others consider them just more zippers to futz with while trying to find the airplane keys.

We like the ability to tailor a bag offered by Brightline, but we recognize that flexibility (and all those zipper pockets) comes at a price. When dollars are tight, we like that Sporty's, Jeppesen's and ASA's lines are so complete that it's almost possible to tailor a flight bag.

Because all of the bags we examined were good quality, the bottom line is that the most important factor in the selection is for pilots to take the time to determine what they need to have in the airplane and evaluate his or her needs for convenience and organization.

SO VERSATILE IT WORKS

by Frank Bowlin

I extensively tested the Brightline Bags second-generation FLEX System for a couple months. Bottom line: I bought one. So did my wife.

Most standard bags start with a few specific compartments for a headset, GPS or such, and have a large center section for everything else. And, that's the problem; everything else gets dumped in that main compartment. Finding what you need can be a challenge.

The FLEX system allows you to choose the compartments you need for the stuff you carry. Then, all the compartments, pouches, pockets and such zip, clip and Velcro together to make what could be the perfect bag just for you. They don't offer purpose-built components, like just for a headset; instead you buy the compartments that will fit. That way, you've got a place for everything. It also allows you to configure the bag for today's VMC lunch run and quickly reconfigure for tomorrow's long IMC cross country.

Some discipline is required. With all those pockets, pouches and compartments, consistency of where you put stuff is required, lest you be fumbling through literally dozens of zippered pockets for replacement flashlight batteries in the dark.

Everything about this system is thoughtfully designed for maximum utility and versatility. All the intelligent design features, high-quality construction and the flexibility make this a good value. What would you pay for your perfect flight bag designed by you? I paid $200.

Frank Bowlin is the editor of our companion magazine, IFR.

ForeFlight Mobil 6.6: Synthetic Vision, MOS

ForeFlight's app version 6.6 brings synthetic vision, plus MOS weather data to airports without TAFs. We think its imagery threatens panel displays.

Staff Report

As much as we like the ForeFlight Mobil app for iPad, we've been waiting for more advanced features that make better use of the iPad's processing horsepower. The short list included synthetic vision and a better HSI presentation. That's just what ForeFlight has done with the latest version 6.6 upgrade. It includes intelligent, next-gen synthetic vision that we think betters aging certified displays.

There is also a new NOAA weather prediction function, providing supplemental weather data for some airports not served by TAFs.

Since we reported on the major enhancements made in ForeFlight Mobil version 6.1 in our August 2014 issue, we'll concentrate on synthetic vision and weather functions here.

SYNTHETIC VISION

The SV synthetic vision function can replace the traditional attitude indicator display view. Existing users pay the $25 download cost for the function that's created in the apps Map view and activated by tapping the attitude indicator button in the top menu bar.

When connected to an Appareo Stratus 2 ADS-B receiver, the display will also include AHRS-derived pitch and roll horizon data. If you don't use a Stratus 2, you won't get pitch or roll data and the horizon will remain fixed, regardless of the aircraft's attitude. It's stark by SV comparison.

When SV is on, the display includes a 3D depiction of the terrain in front of the aircraft, while familiar terrain awareness coloring depicts threat terrain and obstructions all around. Terrain that is more than 1000 feet below is green, yellow if it's within 1000 feet below and red if it's within 100 feet below or above.

We ran SV on the latest iPad mini 3 and were awed with its graphics—better than many certified displays we've used. Synthetic data should be judged not only by landscape detail, but also by its precision and accuracy as the aircraft progresses within the synthetic environment. ForeFlight SV passes, with synthetic airport markers and runways realistically coming into and fading out of view as you approach and pass them. This keep screen clutter to a minimum, an issue that plagues smaller panel displays.

Runway depiction is based partly on its surface conditions, whether asphalt, dirt or grass, and by the water and land features that surround it.

Terrain signatures are enhanced with grid lines and shadows. Their placement on rolling hills offer a better read on peaks and valleys.

Speaking of landscape, when the iPad is in landscape orientation, the attitude and syn vis display is shown on the left side of the screen. In portrait orientation, attitude and synthetic vision is at the top.

On a side note, one feature that impresses is the automatic night transition mode, where the sky begins to dim gradually 20 minutes before local sunset. Twenty minutes before sunrise, it brightens. It's quite realistic.

MOS FORECASTING

In addition to TAF data, version 6.6 includes MOS, for Model Output Statistics. MOS is new to ForeFlight, but it's a NOAA tool that's been around for decades. In a nutshell, MOS produces forecasts for specific U.S. stations—for our purposes, airports—based on weather prediction models and statistics. This includes prior surface observations and geoclimate data, including elevation, terrain, climatology and time of year. Scott Dennstaedt, ForeFlight's weather

Clockwise from far left: Synthetic vision uses the same terrain color coding as the Map view and can be displayed in split or full screen. Pictorial surface identification—asphalt or soft—makes for realistic runway depiction. MOS data is presented much like TAFs.

SYN VIS: PANEL BATTLES PORTABLE

ForeFlight's synthetic vision release coincided with one of our evaluation aircraft coming off the hangar floor with Aspen's free 10-hour ESV synthetic vision trial, and noticeably slower processing power due to the demand of the added software. That got us thinking about the advantages of tablet-driven syn vis and how it could stifle sales of certified versions. Price and graphics quality rule.

Once you fly off the 10-hour EVS trial on a new Evolution display, Aspen gives the option of purchasing the ESV feature for $2995. Compare that to ForeFlight's $25 buy-in, not including the base subscription. Aspen ESV is AML STC and PMA-certified, while ForeFlight's SV is at your own risk. But for a growing number of buyers, we suspect the difference in price is going to be worth the risk.

How that risk compares to certified version is unknown, but Foreflight's pilot's guide has a legal caveat that says attitude data and synthetic vision is not for use as primary instrumentation in any phase of flight. If you can't keep to the honor system, simply don't crash while using the app.

From a design standpoint, we think uncertified synthetic vision has distinct advantages over panel-mounted versions, including an open architecture for adding new features and tweaks without having to endure time-consuming software and hardware certification. Consider that by the time a graphics chip makes it into a certified display, it could be antiquated, while the processing power and the graphics display of iPad and Android tablets are dominantly maintaining a cutting edge.

Tablets afford a new approach to presenting a virtual landscape, too. ForeFlight says its synthetic vision was never designed to just show terrain and obstacle situational awareness, but designed to be an immersive experience and an extensible "3D canvas." One of the best examples of this is the systems ability to keep the viewer above terrain and runways even if the vertical GPS quality is downgraded. Some other implementations of SV don't do this, allowing the virtual camera to drop below the terrain or runway, leading to odd visual artifacts. We'll look at these tidbits in a detailed operational comparison of certified and tablet syn vis in a future issue.

scientist and MOS feature architect, pointed out that forecasters issue TAFs at only 635 airports throughout the U.S., leaving over 3000 airports without any site-specific data. MOS forecasts are available at approximately 1200 more airports in the U.S.

MOS provides an hour-by-hour forecast projection over a 24-hour period, including ceiling height, sky cover, prevailing visibility, plus wind speed and direction. One tactical approach might be to leverage the MOS forecast to supplement an area forecast. But it's not a TAF.

Since MOS forecasts can have hour-by-hour repetition, ForeFlight takes the hourly MOS guidance and collapses it into forecasting groups that are just similar to what you would see in a TAF. It's not a legal replacement for area forecasts, but intended for supplemental reference. You'll need to be familiar with sizable limitations of MOS data, too.

Dennstaed cautioned MOS cannot forecast multiple cloud layers as you see in a TAF. Except for when the forecast is shown as clear, a single fixed cloud layer is the best MOS can do. It cannot directly forecast showers, thunderstorms and fog in the vicinity, nor can it forecast precipitation intensity.

In advance of version 6.6, ForeFlight added color enhancement to the infrared satellite imaging presentation. Coloring the ground-based IR image is intended to get a better read on cloud temperatures at higher altitudes. The imagery is on a 30-minute refresh cycle and is found in the map mode menu while in Maps view.

The $174.99 per year Pro SV package (and Pro SV for Canada) is the flagship subscription, while the scaled-back Basic SV is $99.99. Visit www.foreflight.com.

Bogert Battery Housings: Improving the Stock Box

Old battery boxes can leak and corrode, trashing the airframe. Bogert's STC replacements are well-made and vented.

CHECKLIST

- Aftermarket boxes from Bogert outdesign Cessna and Piper hardware.
- Neglect can lead to airframe corrosion and charging problems.
- The cost of FAA certification makes these things much more expensive than they need to be.

by Larry Anglisano

While the aircraft battery box is a thankless component that has to be inspected annually, it's often neglected by owners and even by some mechanics. That's a bad thing because a battery box has more critical functionality than you might think. Neglect can lead to unnoticed airframe corrosion, engine starting problems, audio system noise and other electrical system nags.

In our view, some of the OEM boxes weren't made to withstand the harsh conditions to which they're subjected. That makes routine and careful inspection critical. When it's time to replace one, brace for sticker shock. Who would think an OEM battery housing would cost over $3000? Thankfully, there are alternatives.

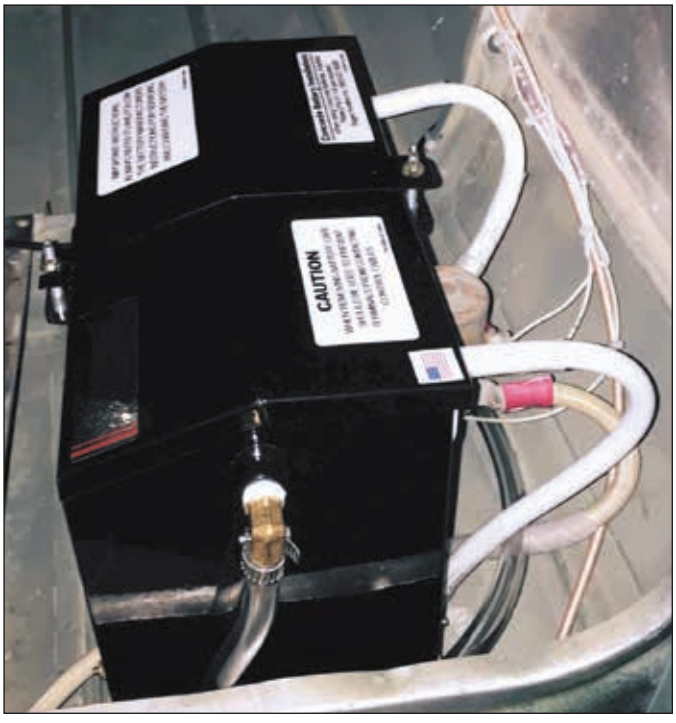
A TOUGH LIFE

Battery boxes can be metal or plastic, depending on the aircraft model and vintage. Consider that the metal box used in many pre-1975 Piper models have been in service for over 50 years. Even plastic housings used in later Cherokee models could have well over 30 years in service. Fluctuations in temperature, airframe vibration and leaking battery acid takes a toll not only on the enclosure, but also on the mechanical and electrical accessories inside the box.

Battery boxes generally house the positive and negative battery terminals. In metal boxes, the terminals are attached to the inside of the box with carry-through studs and insulators. The positive terminal is nothing more than a braided strap that is soldered to the stud on the inside of the box. The negative terminal is simply soldered to the inside of the box, while a ground strap on the outside serves as the main ground. Battery removal and reinstallation, corrosion buildup, overtorquing, airframe vibration and the breakdown of the solder can ultimately stress the connections, causing high resistance and heat which, in worst cases, can melt the positive terminal post off the battery. Corroded terminals can also lead to high resistance and a voltage drop—robbing power to the starter.

Leaking battery acid is an enemy to the box and to the airframe. One job of the battery box is to expel leaking battery acid and vent battery gases. While this isn't so much of an issue with a healthy battery, a battery with a weak cell or a cell with internal resistance causes the acid to boil and come out of the top of the battery.

Some boxes (including those on Piper models) have external vent tubes to catch the sliptream from the belly of the aircraft and push fresh air into the box, while an exit line sends the vented air back overboard. A drain fitting on the bottom of the box expels any liquid that gets trapped in the box. Boxes for most Cessna models, on the other hand, don't have inlet or outlet venting and drainage systems to remove damaging battery gases and liquids. This



Think of an aircraft battery box in the tail of a Cessna 182, left, as a system. The aftermarket Bogert housing shown contains battery terminals, has airflow venting and drainage tubes. It is designed to be rugged enough to handle destructive airframe vibration.

can lead to faster deterioration of the box, particularly aluminum boxes.

Speaking of deterioration, consider the consequences of battery acid that is leaking from a battery box. The acid can end up between the aluminum skins and between rivets on the airframe—a condition that might not be easily discovered.

REBUILD, REPLACE

Mail order supplier Aircraft Spruce and Specialty sells a small variety of aftermarket boxes and hardware, but not all replacement options are FAA approved. It sells a fiberglass box for around $110 and an aluminum box for around $190, but these are for experimental aircraft only. You could fabricate your own and have it signed off as an owner-fabricated component, but unless you're real handy with sheet metal work, we think building a system with appropriate venting and drainage would be difficult. Keep in mind that not all models utilize a battery box, but instead a battery tray, battery lid and vent tube. If the aircraft is type-certificated with a box, you'll need to swap it with an FAA-approved replacement.

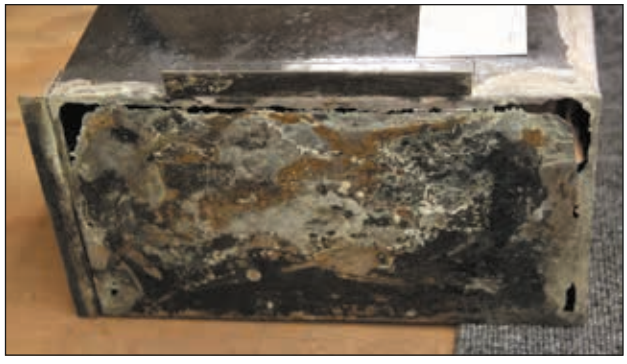
More than one shop told us that sourcing many OEM battery boxes is either ridiculously costly or impossible. For some Cessna models, an OEM replacement box can cost over $3000 and has a long lead time. Unanimously, shops prefer the aftermarket battery boxes made by Bogert Aviation in Pasco, Washington.

Bogert has FAA and PMA-approved replacement battery boxes for Piper and Cessna applications and is currently working on approved solutions for other aircraft. The company's latest box for older Cessna 180 and 182-series applications have provisions for venting, improving upon the design of the original housing, which doesn't have venting.

The retrofit includes a venting system that connects to the battery box. The system requires drilling through the belly of the aircraft for mounting the inflow and outflow venting hardware (forward and aft scoops) for fresh air to enter the box and for air to escape. The kit comes with a drilling template and detailed instructions for performing the mod.

On Cessna 150-and 172-series aircraft (where the battery boxes are mounted on the firewall), the installation process is slightly different. The retrofit requires drilling a single hole in the rear pressurized air inlet baffle of the engine. This is to accommodate a small air pickup tube that mounts directly to the baffle, while the other end of the line connects to the battery box.

Both venting modifications are blanketed under the STC of the battery box. It has instructions for continued airworthiness (ICAW) and requires an FAA 337 form, but doesn't require a field approval. Bogert Aviation's Richard Bogert—an A&P, IA and the product designer with over 30 years of practical experience, told us that the modification can generally be accomplished in a couple of hours. Shops we spoke with praised the retrofit for being easy to accomplish.



Both Concorde and Gill aircraft batteries, top photo, will fit in the Bogert battery box, middle. The bottom photo is an original-equipment battery box removed from a Piper Comanche. You don't want that corrosion to spread to the airframe.

Aside from venting, we think the Bogert box design is superior to most of the original equipment battery boxes we have worked with, and other technicians we spoke with agree. For example, the main battery enclosure and the drain tube fittings are made of stainless steel, and unlike many OEM boxes that are soldered together, Bogert boxes are assembled using a Tig arc welding process and finished with powder coating. The stainless steel vent tube housing is welded to the battery box and attaches to a threaded, adjustable copper fitting on the outside.

If the battery box is in serviceable condition, Bogert offers an STC-approved rebuilding kit (developed and approved back in the early 1980s) that modifies the existing design of OEM battery boxes for the better. This includes new nylon flange shorting guards, plus replacement battery cables that replace the braided straps and ground terminals known for high-resistance connections.

Given the cost of a new Bogert box, which can range from around $800 to over $1100, depending on the application, rebuilding an existing box could be a better option if the housing isn't broken or corroded. Visit www.bogertaviation.com, 800-627-8088.

Beech Model 19/23

The Beechcraft Musketeer, Sport and Sundowner get high scores for comfort, handling and simplicity. They're also easy on the budget.

Beechcraft was never all-in in the training market. Its niche was carved out from day one with the Bonanza, a high-performance traveling machine that the company knew would attract buyers who learned to fly in something made by Cessna or Piper.

That's why when some pilots walk the ramp, they clap eyes on a Musketeer or a Sundowner and can't quite place what it really is. There just aren't that many of them out there and they are far outnumbered by Skyhawks and Cherokees. But to Beech's credit, what it did, it did right, at least in terms of comfort and handling, if not performance.

The Beech 19 and 23 series are far better fliers than their downmarket brethren and more than 30 years after the last one was made, they remain supportable at affordable cost. Owners love them for their big airplane feel and handling and spacious cabins in a market segment dominated by tuna-can construction.

The Sundowner and Musketeer do have some quirks. Weight and balance issues may be one and so is speed, or lack of it. Owners are stoic about that; it just allows a little more flying time.

> *These airplanes have developed a reputation for providing some ego-crushing landings.*

These aircraft represent a buying paradox for used aircraft buyers. You can buy one for a song—a discount song at that. But when you try to sell it, will it even be worth the opening intro notes? We're not sure this matters, as long as buyers going into the deal know the score.

MODEL HISTORY

The Sport and Sundowner first appeared in the early 1960s, specifically the Model 23. It had a 160-HP Lycoming O-320 and could carry four people in comfort, as long as they weren't in a hurry to get anywhere. The original Model 19 debuted in 1966. With 150 horses, it's really a two-seater with a backseat for more stuff. Except for the engines, the two aircraft are essentially identical.

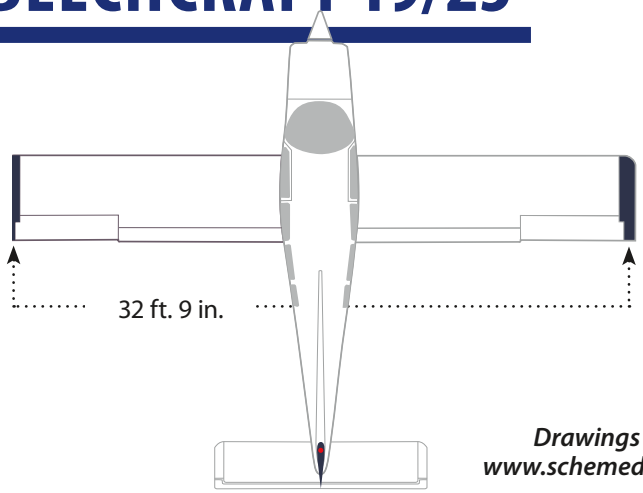
Beech also developed the same aircraft sporting retractable gear and a 200-HP engine; the Model 24 Sierra, an airplane that's the subject of its own UAG report.

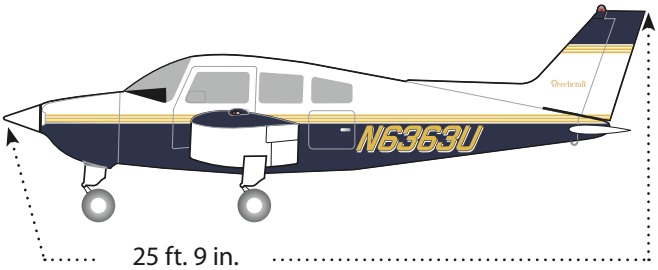
The Musketeer evolved over the years. The original 1963 Model 23 had a 160-HP Lycoming, following the lead established by the Piper Cherokee two years before. But Beech soon re-engined the airframe with Continental's IO-346-A, an oddball engine that was essentially an IO-520 with two cylinders hacked off.

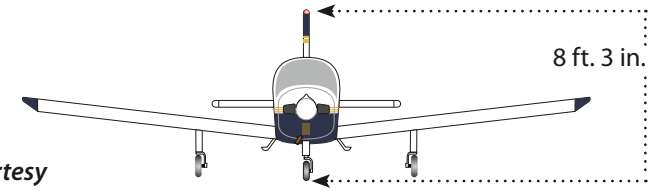
By 1968, Beech switched horses

The little Beech is larger than a Cherokee, but smaller than a Bonanza. That's a Sundowner rolling out in the main photo.

BEECHCRAFT 19/23





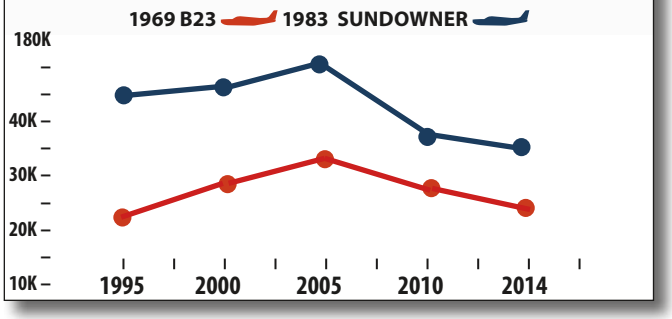


Drawings courtesy
www.schemedesigners.com

SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1963 MUSKETEER 23	LYC. 160-HP O-320-D2B	2000	$21,000	60	900 LBS	110 KTS	$15,000
1964-1966 A23 II	CONT. 165-HP IO-346-A	1500	$21,000	52	700 LBS	114 KTS	±$17,000
1966-67 A 23-19 SPORT	LYC. 150-HP 0320-E2C	2000	$21,000	60	700 LBS	107 KTS	±$16,000
1966-69 A 23-24 SUPER III	LYC. 200-HP IO-360-A2B6	2000	$30,000	60	900 LBS	120 KTS	±$20,000
1966-68 A 23 A III	CONT. 165-HP IO-346-A	1500	$21,000	60	700 LBS	114 KTS	±$20,000
1968-69 SPORT III 19A	LYC. 150-HP 0320-E2C	2000	$21,000	60	700 LBS	107 KTS	±$17,000
1969 M19A	LYC. 150-HP 0320-E2C	2000	$21,000	60	700 LBS	107 KTS	$18,000
1968-71 B, C CUSTOM	LYC. 180-HP O-360-A2G	2000	$21,000	60	900 LBS	107 KTS	±$23,000
1970-74 B 19 SPORT	LYC. 150-HP 0320-E2C	2000	$21,000	52	700 LBS	107 KTS	±$20,000
1972-1976 C23 SUNDOWNER	LYC. 180-HP O-360-A2G, A4G	2000	$21,000	60	900 LBS	114 KTS	±$29,000
1977-1983 C23 SUNDOWNER	LYC. 180-HP O-360-A4K	2000	$21,000	60	900 LBS	114 KITS	±$35,000
1974-79 B 19 SPORT	LYC. 150-HP 0320-E2D	2000	$21,000	58	700 LBS	107 KTS	±$24,000

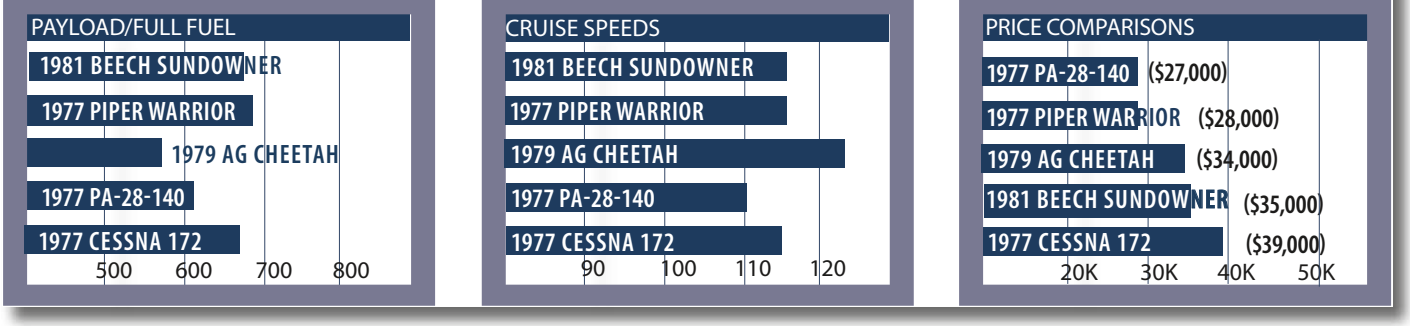
RESALE VALUES



SELECT RECENT ADs

AD 89-24-09	INSPECTION MOD FOR ROD ENDS
AD-87-02-08	STABILATOR HINGE FASTENERS
AD 85-05-02	MODIFY FUEL SELECTOR GUARD
AD 78-04-01	FLAP CONTROL WELD ASSEMBLY
AD 77-03-05	MAIN LANDING GEAR INSPECTION

SELECT MODEL COMPARISONS



The panel in Rick Reaveley's Musketeer, left, has plenty of avionics for serious IFR travel, including an Aspen PFD and dual-axis autopilot.

again, this time back to Lycoming, with a 180-HP O-360-A series, the motor that carried the line through the rest of its production life. Meanwhile, Beech wheeled out the 150-HP Sport as a trainer in 1966. By 1970, the two models had become the B19 Sport and the C23 Sundowner. (If you're confused, you're not alone. If you've owned a Mooney, you'll understand.)

MEDIOCRE PERFORMER

The 19/23 series was never a hot performer. Indeed, by 1973, the FAA determined that when flying at its certificated maximum-gross weight of 2250 pounds, the B19 couldn't meet the certification climb-performance minimums. In response, AD 73-25-04 was issued, limiting the B19's gross weight to 2000 pounds, a heavy performance hit. A Beech kit raised max gross back up to 2150 pounds, but the airplane was no load hauler. After 1973, Sports that rolled out of the factory came with the mods already installed.

The Sport continued in production until 1979, when Beech introduced a clean-sheet design as a replacement—the two-place Skipper, another Beech idea that didn't quite pan out. The Sundowner chugged along for a few more years before being sucked under by the great GA depression and sales downturn of the 1980s.

By 1983, the line was history. Still, some 2400 Sundowners were built and many still fly. The Sport isn't quite so numerous, with only 900 built; some turn up occasionally on training flightlines.

Owners fairly gush about how comfortable these airplanes are but tend to frown painfully when describing performance. Cruise speeds in the 100-knot range are about the best you can expect from the 160-HP models. The Sundowner with the big Lycoming will do 117 knots with a light airframe and a fresh wax job.

In its original incarnation, the Sport got socked with an AD due to poor climb performance at gross weight. But even after the AD-mandated improvements, it was hardly any better. Owners have reported gross-weight climbs in the 300- to 400-FPM range on hot days. Then again, this may vary by aircraft condition. One owner said climb rates of about 500 FPM through 9500 feet were possible. Loaded to gross, Beech claimed only a 792-FPM climb for the Sundowner at sea level. So don't expect much.

The Sundowner is not a STOL ship in the landing department, either. Although the book says you can stop on less than 1000 feet of pavement at sea level with no wind, we say good luck. Allowing for real-world piloting skills, add at least 25 percent to that figure. And if you do manage to shoehorn your way into a 1000-foot strip, you'll probably need a set of wrenches and a truck to get the airplane out. The accident pattern bears this out.

Listed takeoff performance for the airplane is 1130 feet of pavement just to lift off. You'll need nearly 2000 feet of level ground between brake release and the first 50-foot obstacle if you expect to clear it. If density altitude creeps up, you can find yourself needing jet-length runways. At a 2000-foot high field on a calm, 88-degree day, figure on 1700 feet to get off the ground and almost 3000 feet to clear the obstacle.

These airplanes are clearly not suitable for high-elevation airports or even sea-level airports with short runways.

PAYLOAD, RANGE

Okay, so they're slow and tend toward runway piggishness. But they carry a lot, right? In a word, no. Net payload for both the Sport and Sundowner are quite close to other aircraft in their class, which is to say not much.

Range is certainly not outstanding, although acceptable for most owners. In all but the early model Sports, standard fuel load is 57 gallons usable. That's enough gas to carry the Sport about 620 miles, while the Sundowner will cover only 530 miles on the same load. That fuel load may sound impressive, especially when you look at the fuel capacities of the competition.

The Piper Cherokee, American General (Gulfstream/Grumman) Tiger and Cessna Cardinal all carry seven gallons less gas. Yet, all those airplanes can fly just as far because their higher cruise speeds let them cover the same amount of ground on less fuel. Of course, your mileage may vary, especially if you've got any illusions about carrying people and baggage.

Fill the cabin and you can't fill the tanks, it's that simple. The Sundowners can be expected to haul about 900 pounds of useful load in their average equipped condition. If you need full tanks, that means you can only carry three people and 50 pounds of baggage.

If you're in a Sport, toss out the third person and the baggage and

Two doors allow convenient egress and ingress. Once inside, owners and large pets enjoy a roomy cabin. That's Andy Strickland's flying companionlounging across the front seats of his Musketeer, lower right.

you still get to sweat those high-weight climb rates. So, the Sport/Sundowners are cheap to buy, but the payback is lack of performance; there's still no free lunch.

Like most Beech products, the Sport and Sundowner are routinely described as being delightful to fly. In the air, the controls are light and well harmonized, smooth and responsive. They're stable enough to make good IFR trainers, even if their low cruise speeds turn them into one-airplane traffic jams. There are even aerobatic models. But that doesn't mean handling and flying is wart free. The Sundowner, and especially the Sport, can be downright vicious on landing.

These airplanes have developed a reputation for providing some ego-crushing landings for even experienced pilots. Student pilots who were unfortunate enough to endure training in the Sport all too often wound up with more than their egos crushed.

The reason for all this sturm and prang is the airplane's bad habit of porpoising and crow-hopping on landing, a trait it shares with Mooneys but not with other trainer types in this class.

Some experienced Sport pilots can regale hangar-flying crowds with tales of epic wrestling matches as they worked throttle and yoke desperately trying to stop the porpoise before a) the nose gear collapsed; b) the aircraft groundlooped; c) the runway ended; or d) all of the above.

At least part of the reason for this touchdown behavior is the landing gear design. Beech chose a trailing-beam configuration for the aircraft. Normally, this type of landing gear is quite forgiving of botched landings. But Beech went for stiff rubber shock mounts instead of oleos, converting what would have been wonderful cushioning into terrible springs, ready to help the aircraft rebound into the air at the drop of a wheel. With its stiff rubber donuts, the Mooney gear has the same shortcoming with the same results for hapless pilots.

Gentle, mains-first touchdowns are the rule to prevent a crow-hopping excursion across the field. All this is not to imply that good landings are impossible in the Musketeers. Precise speed control is the key. If you're the type who likes to tack on a few knots for the insurance company and another couple for the wife and kids, buy a Cherokee or some similar, more forgiving design.

The Sport and Sundowner demand precision handling down final and into the flare. If your landing technique is off, these aircraft will show you exactly where you're going wrong by magnifying the results out of all proportion to anything you've seen before. Great training, if it doesn't scare you to death.

Speed control is also important in the opposite direction for Sport pilots. Coming over the fence a few knots too slow can result in running out of stabilator in the flare. That, in turn, translates into a nose-first touchdown and at least some crow-hopping down the runway.

Pilots report the Sport is a bit nose-heavy, especially with flaps down. Many have found that carrying some power into the flare provides more controllability into the touchdown. Some owners tell us they carry ballast in the baggage compartment to offset this.

Another strategy for coping with the aircraft's landing habits is to

Despite its wide-stance landing gear, landing crunches are too common for the Sundowner, Sport and Musketeer. The key to success is landing it first on the mains and getting the flaps up before getting on the brakes. Once slowed, the airplane has excellent ground handling.

install the Beech spin kit. One Beech dealership we spoke with some years ago reported that the spin kit, which adds strakes to the nose and stabilator along with a ventral fin to the rear fuselage, seemed to tame the aircraft's landing characteristics.

LANDING FOIBLES

With all this as background, it should come as no surprise that the Sport and Sundowner have their greatest safety troubles in the landing arena. That's true of other types, too, but it's doubly true of this model. See the safety sidebar for the most recent data.

At least the aircraft are consistent in this regard. Consider that an NTSB study reaching back to the early 1970s identified the Sundowner as the worst aircraft in its class for hard landings. We're talking about a rate of hard landings that was five times worse than the Cessna Skyhawk or the Piper Cherokee. Indeed, every time we've looked at the safety records of the Sport and Sundowner, the story has been the same—lots of hard landings and lots of overshot landings. And even today we find the pattern intact. One interesting finding of our studies through the years has been the low rate of groundloop accidents.

Both the Sport and Sundowner have nice, wide-stance main landing gear, so once the aircraft are firmly on the ground, they handle and track quite well. It's getting them to that point that's the challenge. We don't mean to overstate the case by any means, but forewarned is forearmed.

Musketeer ground handling is so good, in fact, that it's possible to get the aircraft to pivot around inside its own wingspan, making maneuvering on the ramp or around the gas pumps a breeze.

Reader Rap McBurney, president of the Beech Aero Club, contends in his letter below that the 19/23 fatal accident rate is actually lower than the GA average of about 1.2/100,000 hours. We can't confirm this, but have no data to counter it.

MAINTENANCE

If there's one thing that really seems to keep Musketeer owners happy, it's that the airplanes are cheap to keep. Maintenance troubles through the years have been mercifully few and far between. Thankfully, Beech—now under the Textron Aviation umbrella—seems able to maintain a sense of proportion as to what's important and what's mere window dressing when it comes to issuing mandatory service bulletins.

Other maintenance items to be concerned with are fairly obvious. The landing gear, for example, should come in for detailed scrutiny at any pre-purchase inspection, as well as during annual inspections.

Given the previously discussed landing troubles, it's a better-than-even bet that some sort of trouble will be found on pre-purchase. By the same token, make sure the firewall gets a good once-over, since bending and warpage of the firewall is a common consequence of excessive crow-hopping and nose-first arrivals.

Another item to scrutinize closely on annual inspections is the fuel caps. The NTSB called for pressure checks of older caps, but simple visual inspection should be able to detect caps that have become too stiff and crusty to provide a good seal to the wing filler port.

Nevertheless, cap replacement and/or overhaul every 10 years is not a bad idea as a prophylactic measure. And, of course, pay attention when checking the sumps on preflight. Engine troubles on these aircraft should be few and far between.

One notable exception is valve sticking, which on the O-320 and O-360 should be considered facts of life. Lycoming Service Bulletin 388B calls for checks of valve guide wear every 400 hours, but we'd cut that

interval in half if you're experiencing normal 50- to 100-hour-per-year utilization. Cut it in half again if you're flying less than that. The inspection is simple, once you've got the proper jigs, and it could save you thousands in later cylinder work.
In the just-plain-annoying category, there are complaints about leaking windshields and windows. This sort of thing is not really a problem limited to the Musketeers, since most of the smaller GA singles seem to suffer from window leaks to one extent or another.

The cure—the real cure, that is—is to remove the suspect window, clean the tracks and reinstall it with new sealant. Might as well put new glass in while you're at it. The route most often taken, though, is to simply slather more RTV around the rim and hope for the best.

On pre-purchase inspection, pay special attention to the sidewall insulation and carpet padding for clues to potential leaks. As with Mooneys, which suffer the same problem, this can lead to serious corrosion.

WATCH THE IO-360

Make no mistake about the IO-346—found in the 1964 through 1967 Sundowners—is an oddball. It was used only in the Musketeer and is found nowhere else. Only 513 examples were built. Despite its origins as a sliced-up IO-520, it's a rare mechanic indeed who's familiar with this engine. If you insist on buying one of these models, be prepared to finance your mechanic's learning curve.

The last time we examined the Musketeer line, pistons weren't available for this engine but since then, Continental has, surprisingly, started making them again for the IO-346.

Owners who contacted us for this review seem to suggest that the IO-346 is a nice flying, supportable engine. But our view remains that the Lycoming models are probably the better choice. They're simply far more numerous and will be familiar to any mechanic who has to service them.

OWNER COMMENTS

I have owned N8894M for a little over three years. She is a 1964 Beechcraft Musketeer A-23 with a 165-HP Continental IO-346. The airplane is based at Airport Manatee (48X); a grass field. I bought her a little more than halfway through my private-pilot training. I have averaged 100 hours or more a year and have flown to and from Memphis and all over Georgia and Florida. This winter, she and I will be entertaining an FAA examiner for an instrument checkride. She is a solid instrument platform and loves the clouds.

I average about 11 to 12 gallons per hour. Annual insurance is $650 per year. Annual inspections have been on average $1000 to $6000 per year. She is properly maintained. No expense is spared to ensure she is mechanically and structurally sound; no corners are ever cut.

Useful load with the wingtips is 750 pounds; in practice, 800 pounds is no problem. Nice roomy cabin and she flies solid and true. Cruise speed is 100 to 105 knots. Short field takeoffs and landings on grass or pavement are equally performed with ease. The Continental IO-346 has never given me any problems. She has no bad habits, unlike the Piper Archer that I started with at the flight school. The solidness of a Beechcraft should be underscored.

In short, I have been honored to own N8894M. It has been a great airplane for my wife, my German Shepherd (Aden) and me for many regional excursions and we look forward to many more.

Andy G. Strickland
via email

I owned a Model 23 Beechcraft for six years. Great experience and a great airplane. Acquisition cost and maintenance expenses are below average. The airframe is very robust, roomy and comfortable; big folks really like this airplane. Some have two doors.

The tradeoff is a bit slower cruise speed, mostly in the 110-knot realm. Range is great with 60 gallons of fuel capacity. It is a very stable IFR training platform and an excellent trainer due to the strong airframe and landing gear. Parts remain in good supply for an airframe that was last produced in 1983.

Properly flown by the numbers, it is safe and stable. There will be those who point to statistics that say the Musketeer/Sundowner/Sport

THE CRASHES: TAKEOFF AND LANDING

Our review of the 100 most recent accidents involving the Beech Musketeer series uncovered very few of the classic poor judgment events such as buzzing (1) and VFR into IMC (4) that we normally see during such accident surveys. That's the good news.

The bad news is that the Musketeer may take more skill than its peers when it comes to takeoffs and landings—we counted 46 accidents that involved either runway loss of control (RLOC), hard landings (often involving pilot-induced oscillation PIO), landing long and being unable to stop on the runway, hitting an obstruction on takeoff and blown go-arounds. In addition, two of the stall/spin accidents were on short final. We didn't count the nearly half-dozen engine-out forced landings where the pilot stalled the airplane maneuvering for a field.

A significant number of the accidents involved student training—either solo students or students with instructors who weren't quite paying close enough attention to what was going on. Nevertheless, with the wide-track landing gear, we were surprised to see as many events in which the pilot lost control after touchdown in a crosswind.

Speed control on final is important in a Musketeer. It may not be very fast in cruise, but it still needs to be slowed down before landing. The number of PIO and runway overshoot accidents indicated to us that extra speed in final is not the Musketeer pilot's friend. In many of the accidents, the pilot reported being fast on final, floating and then trying to force the airplane onto the runway, leading to a nosewheel strike and PIO until the gear broke off.

On the other end of the speed on final spectrum, a Musketeer can develop a significant sink rate if flown too slowly. A number of the hard landings came about when the pilot did not arrest a high sink rate with power.

The roomy cabin led to some optimism with regard to loading on the part of two pilots. Both were more than 200 pounds over gross when they tried to take off from modest runways and hit obstructions off the end. In one case, the runway was only 2000 feet long, uphill and the surface consisted of five-inch tall grass.

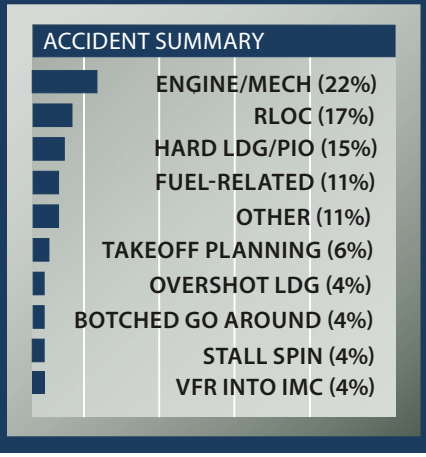
Half of the engine failure accidents were for unknown reasons; which doesn't provide any warm fuzzies.

The need for caution on the first flight after maintenance was apparent in two accidents—both involved fuel lines that were not correctly reconnected, leading to off-airport landings—one while battling a fire.

The curse of multiple fuel tanks showed up with the Musketeer. Of the 11 fuel-related accidents, seven involved running a tank dry and a forced landing when there was plenty of fuel in the other tank. In only four of the accidents did the pilot exhaust all of the usable fuel. Of those, two pilots made intermediate stops on their flights and didn't take on any more avgas.

One pilot was victimized by a fuel selector installed backward during maintenance.

There were two deer strikes, both at night. In one, the deer took off part of the stabilator during the takeoff roll—the pilot continued the takeoff, flew around the pattern and, despite limited ability to flare, made a hard but safe landing.



series is unsafe, but I believe those stats are the result of the uninformed flying airplanes in which they are unfamiliar.

There is safety in numbers, and we have those numbers: Over the past 10 years, there have been approximately 500 Beech Aero Club members (the Musketeer/Sundowner/Sport type club). If those members fly 50 hours annually on average, there will have been 250,000 hours flown. During that timeframe, there has been one club member accident in which there were fatalities, two to be exact. That is 0.8 fatalities per 100,000 hours. That is well below what has been previously written and reported. So, there's safety in type-club numbers. Join a type club, and if you own one of this great series from Beech, join BAC.

Rap McBurney
President, Beech Aero Club

I own a Beech Musketeer A23 with a fuel-injected IO-346 that has 70 hours since a major overhaul and factory-new cylinders. It has 1702 hours on the airframe.

The airframe specifications are a gross weight of 2350 pounds with an empty weight of 1450 pounds. The useful load works out to 900 pounds. My Musketeer is equipped for basic IFR, with a Narco MK12D navcomm, DME, a Garmin 696 portable GPS and an Insight G-1 engine monitoring system.

Insurance for a 300-hour pilot and a $25,000 hull value is $650. Annuals cost roughly $600, not including add-on items, such as the LED landing light I recently added.

The airplane is big, bright, roomy, comfortable and solidly built, with excellent flying characteristics. Cruise speed at 2550 RPM is 120 to 125 MPH at about 8.5 to 9 GPH fuel burn.

A speed of 70 MPH over the fence and touchdown at 65 to 69 MPH works, with flaps up at landing and before using the brakes.

I used to own a 1964 Cherokee 180 and while the Cherokee landed much slower, that big Hershey bar wing picked up every bump in the sky, requiring you to slow down to Musketeer speeds to keep your non-pilot friends comfortable. Still, the airframe feels more substantial than

a Cessna 172 and the Piper Cherokee

I'm quite happy with the fuel-injected IO-346 engine. It's smooth, burns a single quart of oil in 15 hours, it's easy to start and there is no lead buildup on the spark plugs.

I would recommend at least 10 hours of flight instruction in the aircraft before flying it solo, particularly since it lands hotter than some might expect. Also, don't let the nosegear touch first, as it will create a wheelbarrow effect and put stress on the engine mounts and on the nosegear.

Everyone asks how I can afford an airplane. I tell them that it costs less to buy and insure than my 2013 Hyundai Elantra.

Daniel I. Nelson
Plant City, Florida

I decided to purchase a 1975 Beech C-23 Sundowner after receiving my private pilot certificate in 1995. Since January 1996, it has been my first and only aircraft. Although I had not planned to keep the aircraft for more than a few years subsequent to my getting an instrument rating, I found myself continuing to enjoy this Beech for nice weekend cross-country trips.

One of the things my passengers and I especially enjoy about the Sundowner is the great visibility. During a checkride, one CFI who was unfamiliar with the type, commented that the visibility was about as good as a helicopter. While I don't think it is quite that good, it is great.

Another strong point is the entry door's configuration. It is enjoyable not having to enter from the port wing and having to slide across the seats. The cabin is also big and roomy, giving the appearance that it is larger and could carry more than it actually can.

The instrument panel is also roomy, easily accommodating avionics upgrades, like my GNS430W and a GTX-330. I still have nearly a third of the panel available for future toys.

The Sundowner, like other Beech products, has a solid feel and the controls are smooth. I typically fly in the 5000- to 10,000-foot range, which gets me into cooler air—important during Alabama summers. At these altitudes, I can expect to cruise at 115 knots, with a fuel burn of about 8.5 GPH with the Lycoming O-360. This gives the aircraft a theoretical endurance of about six-plus hours, which far exceeds my endurance.

Speeds on the Beech are a little slower than a similarly powered C-172 or PA-28, but this slower speed is more than offset by the comfort of the larger cabin. On a typical 300-mile flight, I am in the air another 10 to 15 minutes more than I would be in a Cessna or Piper. I just consider it an opportunity to fly another 10 to 15 minutes.

Maintenance costs are modest. My annuals run about $1400, and insurance costs me about $1200 annually. The most difficulty that I have had in ownership is getting inexpensive Beech parts.

I believe that the good people at Beechcraft think I am ordering parts for a King Air. Parts also tend to be more difficult to locate on the aftermarket for items such as interior trim, windows and plastic exterior trim pieces such as wingtips.

It is interesting to me that a lot of pilots are not familiar with this particular aircraft or its siblings, despite the fact that 4000 of this family of aircraft were built over the 20-year production cycle. Pilots are always approaching me about the airplane, and telling me how much they like it. The nice paint job makes it even more appealing.

The flying characteristics of the Sundowner are excellent. There are two areas, however, that I would caution prospective buyers to be aware of—weight/balance and approach/landing speeds. The C-23 tends to be nose-heavy and needs be kept at balance or slightly aft. Many owners, like me, carry extra weight in the baggage area to counter this forward CG characteristic.

The other area of concern is landing. I carry a few extra knots of airspeed on approach and landing, to help maintain better control. The nosewheel needs to be kept off the runway until the mains are firmly on the ground. The Beech's short wheel base, along with the tendency to be nose-heavy if the weight and balance are not correct, can result in porpoising, with potentially bad consequences for airplane and pilot

Bill Moran
Birmingham, Alabama

The Aviation Consumer

Survival kits

(continued from page 15)

instruction manual included provides guidance for use of the contents which include the Adventure Medical Kit (AMK) Pocket Survival Pak, Stormproof matches, tinder, water purification tablets, AMK Ultralight First Aid Kit, Micro-Light flashlight, headlamp, AMK Heatsheet (1-2 person survival blanket/shelter), 50 feet of utility line, four water ration packages, flexible water bottle, sturdy gloves, rescue laser light, Ritter RSK Mk1 one-hand folding survival knife (it's a $130 knife) and a Leatherman multi-tool as well as sunscreen, insect repellent, toilet tissue and lip balm.

We think this is the best quality for the value individual survival kit on the market for under $1000—and being able to wear it increases the chances of survival after an accident.

TOP OF THE LINE

While we caution against the word "ultimate" in aviation advertising, the Ultimate Aviator Survival Pak from www.dougritter.com approaches the definition. For the weight and price it is, in our opinion, the most complete aviation survival kit on the market. Quality isn't cheap; the Pak is priced at $2818.

The list of equipment is too long to include here, but we'll note some of the items. For signaling, a Rescue Reflectors mirror, Storm Safety Whistle, Greatland Laser Rescue Light with extra lithium battery. In the tools and emergency devices group, the Ritter RSK Mk3 fixed blade knife, Leatherman Blast multi-tool, Gerber Exchange-a-Blade saw, REI Stormproof Matches, Spark-Lite Aviation Fire Starter Kit and hands-free multi-light. For shelter: an 8x10-foot waterproof tarp, poncho, insect repellent, leather gloves, two ultralight bivy sacks, mosquito headnets, two bandanas and two roll-up sunglasses.

The medical equipment includes the AMK Ulatralight Medical Kit, trauma bandages and a splint. For food and water there are S.O.S. Food Lab Survival Rations, two-liter water tanks, 16 four-ounce water packs, Esbit Wing Stove and fuel tablets, cook set, coffee, tea, and bouillon.

Under miscellaneous, there is everything from parachute cord and utility wire through toilet paper, duct tape, a sleeping pad and illustrated guide to using the kit. As far as we're concerned, the only thing not in this kit is a PLB.

After looking at a far less inclusive kit that weighed 31 pounds, we were surprised that this kit came in at 22.6 pounds.

Delivery normally takes four to six weeks—the kit is made up as ordered due to expiration dates on the food.

There are two add-on modules available. The ".5" provides one more of many of the contents and costs $285. The "Plus 2" is $850 and is an expansion of the basic kit for two more people.

CONCLUSION

The selection of survival equipment depends on personal comfort and the area over which you fly. At a minimum, we recommend wearing a vest containing a PLB, good survival knife, signaling mirror and either the Pocket Survival Pak or Pocket Survival Pak Plus. For flights over rugged or remote terrain, we recommend the Essentials Aviator Survival Vest and a PLB. For serious backcountry flying, the Ultimate Aviator Survival Pak.

No matter what you choose, if possible, we recommend that you have the kit's equipment on your person when flying.

For more reading on the subject of surviving an accident, we recommend an article from our sister publication AVweb, "Crashworthiness, Improving Your Chances When You Have to Put It Down" (http://tinyurl.com/n6hsxfj) and the website of the not-for-profit Equipped to Survive foundation (www.equipped.org).

FEEDBACK WANTED

CESSNA 195

For the May 2015 issue of *Aviation Consumer,* our Used Aircraft Guide will be on the Cessna 195, the classic radial-powered single. 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. Please send correspondence on the Cessna 195 by March 1, 2015, to:

Aviation Consumer
e-mail at:
ConsumerEditor@hotmail.com