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The Aviation Consumer®

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The Aviation Consumer

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2020 CRYSTAL BALL: TIGHTER REGS ON AUTOMATION

When the calendar turns a new year I'm often asked what I think the future holds for the market, from avionics to new airplane sales and everything in between. And as we turn a new year (and a new decade), my guess may be as good as anyone else's. But looking back on 2019, and at some of our major coverage, could offer at least some clues. I've said it before and I'm sticking with my prediction that the FAA will tighten its hold on new product certifications. It's a good thing we made all that progress last decade—and boy has there been progress, especially when it comes to lower-cost avionics. Let's review.

The party started when the FAA turned a regulatory corner in 2015 when it gave the green light to replace spinning iron gyros and the vacuum systems that drive them with solid-state electronic attitude instruments. Turns out that ultimately birthed new products for the certified airplane market that were reserved for experimentals. First it was Dynon, which partnered with the EAA (Experimental Aircraft Association) and scored an AML-STC to retrofit the D10A EFIS into lower-end Part 23 aircraft. Garmin competitively and swiftly followed with a more extensive AML-STC for the installation of the G5 EFIS, arguably one the most successful retrofit avionics products we've seen since the GNS 430. That easy regulatory momentum (the trend of installing non-TSO'd primary flight instruments under a wide-reaching STC, that is) kept rolling with experimental (and affordable) autopilots. Recall that it was TruTrak and Trio—two big names in experimental autopilots—that earned STCs for installation in certified aircraft. And of course Garmin joined that party, too, and continues to hammer out STCs for its GFC 500 autopilot. That system trickled down from the experimental market. But perhaps the ultimate regulatory break came from Dynon and Garmin, which both earned wide-reaching STCs for experimental integrated flight decks for Part 23 aircraft. Dynon's SkyView Certified is pictured above in our flight trial in a vintage Cessna Skyhawk, as is Garmin's G3X Touch in a Grumman Tiger. I never thought we would see those systems transplanted in the panel of mainstream certified airplanes, did you?

And then there was Garmin's Emergency Autoland—the biggest announcement of the century, and in Garmin's corporate history. As we go to press the system is still pending type certification in Piper's M600 turboprop and in the Cirrus Vision Jet G2. Many ask me why it's taking so long and I suspect we're seeing a glimpse of a new trend in the FAA certification that suggests more caution, especially given the level of automation that exists in Autoland. We all agree it's a real possibility and it's become a cliche, but the Boeing 737 MAX problem could be playing a role in what could be a new regulatory approach to certification. That's really too bad because of course more certification rigor means, you guessed it, higher costs passed along to the buyer. No matter what the right answer is, there's no denying that eliminating the costly old-school TSO process has led to lower costs. We have autopilots priced well south of $10,000 and primary EFIS priced well south of $5000. That was a dream at the beginning of the last century and it's giving old aircraft new leases on life.

Only time will tell if we've seen the end of a more relaxed certification process, and that includes the process for certifying automated airplanes, but I'm hearing more people talking about making the switch to experimental and even LSA models for fear of higher prices. My crystal ball tells me that's something we'll be watching and reporting on moving forward. —*Larry Anglisano*

IS VHF NAV DEAD?

I have some thoughts on Frank Bowlin's interesting article, "Is VHF Nav Dead," in the October 2019 *Aviation Consumer*. I'm not supporting whether or not to have none, one or two ground-based nav systems (VOR receivers), but if the choice is one VHF nav receiver, there could be some challenges.

A 30-day VOR check with a single nav receiver requires VOR receiver checkpoints, since a dual nav system comparison is not an option. The problem is that there are not that many VOTs. However, if the primary (and only) purpose of a VHF nav receiver is for Bowlin's occasional IPC ILS without a VOR-based missed approach, VOR checks are not required and having only one nav receiver would be sufficient.

For instance, look at Florida—a rather large state with many airports. It had only three VOTs (two airborne and seven airports with ground checkpoints). That's not convenient for the majority of the pilots. Interestingly, VOTs are all gone at major Florida airports and I guess airline crews didn't make use of them, even though Part 121 and Part 135 ops do require the checks per the FARs.

Since VOR navigation is the backup to GPS, and with the Minimum Operational Network looming over us, we will have even fewer VOR receiver checkpoints. Separately, with two VHF nav receivers and bearing pointers, the easiest way is to tune the same VOR on both radios and use the bearing pointers—one for Nav 1 and the other for Nav 2. If the needles overlap, you are done. Quick and easy.

Luca Bencini-Tibo
via email

It was somewhat of a struggle, but as a 75-year-old pilot (and retired airline pilot) who has been using VOR and ILS navigation for years and years I decided to lose both of my King KX170B navcomm radios in favor of a single Garmin GNX GPS navigator, which has no ILS or VOR receiver. I'm based in rural Virginia and fly my Bonanza up and down the East Coast and have to say that given the widespread availability of precision GPS approaches, I don't miss ground-based VHF nav in the slightest. I back the Garmin panel GPS up with a Garmin aera 660 portable GPS, plus I use an iPad with the Garmin Pilot app. I did have the shop install a used standalone comm radio since I wasn't comfortable flying IFR with a single VHF comm.

Thanks for the best aviation publication out there, and for the service you provide us old timers who struggle with tough buying decisions.

Richard Barnes
via email

OUTRAGEOUS AIRCRAFT RENTER'S AGREEMENTS

I have worked as an aviation insurance broker since 1960 and one of my clients sent me the most outrageous renter's agreement I have seen.

I would like *Aviation Consumer* to do an article on renter's agreements and non-owned insurance coverage, including what is covered by aircraft policy holders and what is covered by renter's policies.

Larry Rachlin
via email

We're working on it for the next issue of the magazine, actually. You aren't the first who has brought this discussion to the table. We know the aviation insurance market has hardened (we covered it in an insurance update article in the December 2019 issue), and we're looking at renter's policies next.

MISSING THE ADS-B EQUIPAGE DEADLINE

Since my twin is down for two new engines and a major airframe repair, I won't be equipped for the ADS-B Out requirement by the time I fly the airplane to my avionics shop to have a system installed. Any advice for getting the airplane through mandate airspace?

Ted Willis
via email

You can apply for a one-flight exemption via the FAA's ADAPT (ADS-B Deviation Authorization Preflight Tool) online program. Apply for the waiver no more than 24 hours before a flight and no later than one hour before takeoff, then wait for an email response. No guarantees and the FAA says this is an interim measure to get to a shop to have a system installed. Go to tinyurl.com/suxwhrg.

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On The Cover: That's the new Diamond DA40 NG four-place piston single powered by the Austro AE300 Jet-A-burning diesel engine. While diesels have been a tough sell for other manufacturers, overall, Diamond has no trouble finding buyers. It has sold over 500 to date. The flight trial article begins on page 8.

Budget Transponders: Sandia Versus Garmin

With ADS-B, Mode A/C transponder performance is critical. Sandia's STX 165 and Garmin's GTX 325 both pack a modern punch.

by Larry Anglisano

Now that you've equipped for the ADS-B mandate, you'll need to make sure the transponder remains in good working order. Ones that aren't are on the FAA's enforcement list.

There are plenty of aircraft for sale that need transponder (and ADS-B) upgrades, and as we've advised for years, the age and health of the existing unit should be a factor when selecting the right ADS-B Out solution. It's simple—an ADS-B transponder is the best solution for aircraft with vintage models—and that's still the advice moving forward.

But maybe the airplane already has a compliant 978 MHz UAT ADS-B solution (the uAvionix skyBeacon/tailBeacon products come to mind), but you're now faced with replacing a failed transponder. Luckily there are a few modern and budget-friendly options for doing so and in this article we'll look at them. We won't cover 1090ES ADS-B models—we'll hit those in an upcoming ADS-B buyer's guide. Here we'll focus on basic Mode A/C transponder upgrades for those who already have ADS-B, and even for those who don't need to comply with the mandate.

TIME TO UPGRADE?

To know for sure, use FAR 91.413 test standards as a guide. These are the rigors a unit is put through during the two-year transponder inspection. Yes, complying with biennial certification is still required with ADS-B, whether you fly VFR or IFR. Transponder testing and certification itself (not counting pitot static and altimeter certification required by FAR 91.411) might run $150 to $200 without additional bench work. It's worth the labor costs (when done by an experienced tech) because it's an opportunity to gauge the health of the unit, even if you think the unit is healthy. Sure, it's a hassle to drag the aircraft to the shop for this test, but you'd rather the shop spot a problem than the FAA and its resulting enforcement letter.

Now that ADS-B ops are widespread we're hearing reports of ADS-B systems failing (and the FAA sending letters advising of such) because the transponder isn't up to snuff. This includes both Mode A and Mode C altitude reporting functionality. Again, just because you have a functioning ADS-B Out system doesn't mean you're in the clear if the transponder's Mode A

CHECKLIST

- Both the Garmin GTX 325 and Sandia STX 165 have useful features.
- Plus, their all-digital design means longer life and more interface potential.
- If your aircraft already has ADS-B Out via the 978 UAT solutions, why spend the extra money on a transponder with ADS-B?

The Sandia STX 165, top, has a built-in altitude encoder and a small footprint. Garmin's GTX 325, bottom, replaces the reliable GTX 327.

and Mode C (altitude reporting) circuitry has problems.

The testing required per FAR 91.413 ensures the transponder system has sufficient power output (most transponders pulse 250-plus watts of power), the correct pulse framing, SLS (sidelobe suppression), proper Ident function and of course outputs the correct squawk codes. The shop will first test the transponder as installed in the aircraft, which includes the antenna system—critical to overall performance. If there's a problem, or if the unit is on the ragged edge of passing, the shop will remove the unit and put it on the test bench if it has the capability to work with it. Some do, some don't. Ask before showing up especially if you sense there is a problem brewing.

When it comes down to it, a proper bench test (with the correct calibrated test equipment) is perhaps the only real way to determine just how healthy it is. Got an old analog transponder left over from the 1980s or earlier? It's worth the hour or so of bench labor to determine if the unit is a long-term keeper. If the shop is installing a non-transponder ADS-B solution (maybe a uAvionix skyBeacon/tailBeacon or Garmin GDL 82), we wouldn't proceed unless the transponder is in top working order. If it isn't, and long-term functionality is questionable, put the brakes on and look at ADS-B transponders as the ultimate solution.

GARMIN GTX 325

Garmin's all-digital GTX 327 Mode A/C transponder was a huge seller and was often paired with GNS 430/530 navigators. As we describe in the sidebar on page 7, we think the right preowned GTX 327 could be the best solution going. But the GTX 327 has been discontinued and replaced by the GTX 325.

Priced at $2295, Garmin pitches the GTX 325 to buyers who already have an ADS-B Out solution and to those who don't fly in ADS-B mandate airspace.

The GTX 325 is sized 1.68 by 6.30 by 10.07 inches and that makes it easy to replace an existing analog transponder without having to reconfigure the radio stack, although we wish it had a more shallow chassis for saving space behind the panel. For panels where the transponder is displaced away from the fingertips, the unit has a digital databus for onscreen code and Ident selection on Garmin's current GTN-series navigators.

Garmin designed the GTX transponders, including the GTX 325, so that the miniature Garmin altitude encoder, inset, mounts to the transponder's connector plate as show in the main image.

One feature we like about the GTX 325 that trickles down from Garmin's flagship models is how the unit accommodates Garmin's $249 GAE 12 pressure altitude sensor. Think of it as a smart encoder. The GAE 12 is literally the size of a quarter and its static fitting is actually larger than the chassis it sits on. The GAE 12 screws to the back of the transponder tray and the static line connects directly to it. The advantage is that if the transponder has to be removed for repair or replacement, the GAE 12 encoder stays put and the static system remains undisturbed. That avoids the hassle and expense of recertifying the static system. It saves time and money.

From a feature set standpoint, the GTX 325 brings many of the smart functions that are familiar on other units in Garmin's lineup, including a sunlight readable LCD display. It also has useful features including a pressure altitude readout so you always know what the altitude encoder is outputting. When interfaced with an optional temperature sensor, the unit will display density altitude and of course static air temperature.

Carried over from the GTX 327 is a full-featured timer including count up, count down, trip time and flight time. There's also an altitude monitor with aural alerting (for tying into the audio panel) that displays the current deviation from a selected altitude. Wander off the altitude (which has presettable limits) and you'll get an attention-getting "leaving altitude" warning.

Aside from basic push-button code entry there's an automatic VFR button, while the unit holds the previous squawk code in memory. Contact www.garmin.com.

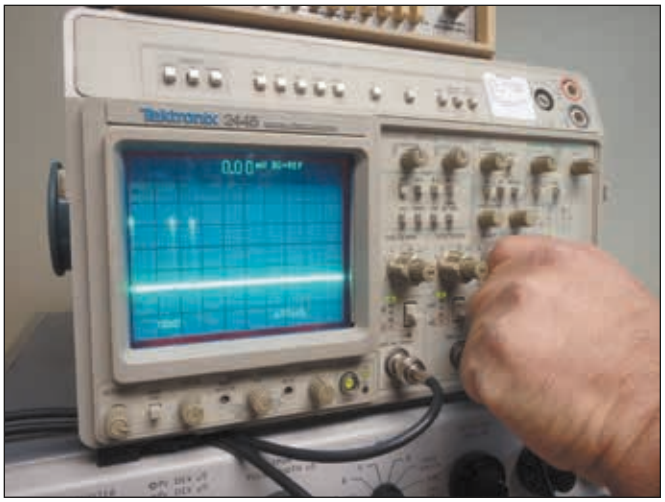
SANDIA AEROSPACE

New Mexico-based Sandia has a variety of products, from cooling fans, altitude encoders and EFIS, and for a couple of years it has been selling the $1950 STX 165 transponder.

It's a space-saver (and weighs 1.3 pounds) with a ½ 3 ATI bezel, and has an OLED display that does well in sun-splashed cabins. The display is small, and it displays a lot of data including pressure altitude and a three-function timer, and has an option for OAT probe input for additional displayed data.

As transponders go, the STX 165 is somewhat untraditional in form factor, but with a simple user control set that's worth a run-through for those only accustomed to using the more common design.

That's an ARC/Cessna RT359A that's tagged inoperative in the top photo. When one fails we say move on to something digital that doesn't have a cavity tube. If there's any doubt about how healthy any unit is, we think it's worth a trip across a test bench. Ask your shop if it has the capabilities, like the oscilloscope shown in the middle. That's the Sandia STX 165 function display at the bottom.



Controls are limited to a power/mode control knob, a VFR key, an Ident push-button and a data knob with a push-button for use as an Enter key. This is a dual concentric knob with push-button action. There's also a photocell for automatic display dimming, plus you can set the minimum and maximum levels for which it will adjust.

The Power button has two additional functions. One is as an Escape mode. If the operator is in a programing mode and wishes to escape to the main page, he can press the Power button momentarily. This will cancel all programming and show the normal display page. This is smart given the need for no-nonsense on-the-fly transponder functions, like changing the code immediately.

The other use for the Power button is controlling the transponder's three timer functions. These include elapsed flight time, count up and count down. To select a timer rotate the Data knob either clockwise or counterclockwise.

The other knob on the lower right of the bezel (Data knob) is used for data entry. The larger Select knob is a momentary switch that is spring loaded. It can be turned clockwise and counterclockwise and will return to center when released. It is used to move the cursor during code selection and to toggle through the display options in the lower left display (PALT for pressure altitude, DALT for density altitude and OAT for static air temperature). The transponder will display temperature in either degrees Fahrenheit or degrees Celsius.

And like the Garmin GTX 325's optional probe, it's worth mentioning that these functions are only available if the optional Sandia STP 78 OAT probe ($350) is installed. For many we think the accessory may be worth the effort to install. Best of all, the STP 78 OAT probe will provide an attention-getting icing alert on the transponder. The icing alert is a snowflake that appears in the upper right corner of the display whenever a user preset temperature is reached. The snowflake symbol will blink for 10 seconds once the icing alert temperature is reached, then remain solid until the temperature goes above the preset temperature. Smart and useful.

The smaller inner knob is the Data knob and is used to select the digit value when programing the squawk code and to select the counter function in the lower right display (when not in the code selection mode).

As for the display, the upper left portion of the screen will show the current transmitter mode. The upper right portion of the display will show the last squawk code that was selected prior to shutdown; the pressure altitude is displayed in the lower left and elapsed flight time in the lower right of the display.

Perhaps what we like the most

GARMIN GTX 327: USED MARKET WINNER

Face it, transponders live tough lives. Their high power out generates lots of heat in the radio stack and ultimately that takes a toll on internal components. So when searching the used market for a sweet deal on a transponder, choose wisely. One slam-dunk winner could be the discontinued Garmin GTX 327.

This is an all-digital Mode A/C model that was a popular pairing with the Garmin GNS navigator and has a good service record because of its solid-state design and rugged control set. Plenty still exist, but many are being removed for a relatively easy transition to Garmin's flagship ADS-B Out GTX 345.

Searching the used avionics market, we found GTX 327 units priced as low as $500 and as high as $1000 after a factory repair. In our view $750-$800 might be a fair price if it includes mounting rack and connectors. Don't forget the antenna and altitude encoder, though, which probably won't be included.

Like any used-market buy it takes a good eye to pick a cherry and it should be obvious which ones lived a hard life. Are the labels on the function keys worn? Is the display and lens healthy? Team with an avionics shop that can put the unit on the test bench to make sure it's a keeper. The right unit could be the best solution, but keep in mind that it may not be the best solution if you need ADS-B Out and a transponder. Garmin charges a flat-rate repair fee of $590 for any unit that comes back to the factory, and it'll be slapped with a one-year warranty after the repair.

Still shopping? We caution against spending anything on an analog transponder. That is, one with a mechanical switch deck and cavity oscillator. Legacy models from King, Narco and Collins all used cavity oscillators to generate their high amounts of power—some as high as 250 watts of output. After a long while these components break down and eventually the transponder might only output half of that power. You know what that means—either you'll hear about it from ATC or from your shop during a transponder check—and it's one reason for upgrading.

Last, we caution against legacy units with fading field support. We're talking King KT76A/C, Narco AT150 and Collins TDR950 to name a few. In our view it just doesn't make sense to spend hundreds of dollars on these old rigs.

—Larry Anglisano

is the integral 35,000-foot TSO-certified altitude encoder. It has a feature where the user can set the transponder to come on in the altitude reporting mode at startup or at a predetermined altitude differential after takeoff. The system also outputs pressure altitude data on an RS232 databus.

Last, there's a remote version of the transponder, the STX 165R. It's priced at $1800, geared toward experimental applications and doesn't have a built-in altitude encoder. It displays on Dynon, Advanced Flight and GRT experimental displays. Contact www.sandia.aero.

SHOULD YOU BUY MODE S?

As you can see, the market for traditional non-ADS-B transponders is stark perhaps because manufacturers assume the majority of buyers would opt for a Mode S ADS-B model. That's what Becker Avionics told us when we questioned why it dropped its line of compact, basic Mode A/C units.

That leaves the interesting question of whether you should you buy an ADS-B Out equipped transponder even if you don't use it for ADS-B, which means not connecting it to a WAAS GPS position source. If you already have ADS-B Out via a 978 UAT system, we don't see the need to spend the extra money for one unless you're still concerned about the Canadian ADS-B requirement for transponder-based systems, which has been put on hold.

As we reported in the October 2019 *Aviation Consumer*, not only did the original spec call for a 1090ES transponder, but it also required Diversity, which means a sizable jump in price. We'll keep an eye on that.

As for choosing between Garmin's GTX 325 and Sandia's STX 165—which we think are two excellent products—how you choose might depend on panel space and what you have for other equipment in the panel.

The Sandia has more flexible mounting options in panels that are space challenged. This includes modern and legacy LSA models where mounting a 6-inch-wide transponder in the radio stack isn't an option.

On the other hand, we like that the Sandia has a built-in 35,000-foot altitude encoder because face it, if you are going through the effort and expense of replacing the transponder, we think you should replace the encoder, too.

Garmin's GTX 325 interfaces with the company's GTN-series touchscreen navigators, which could come in handy if the existing transponder is out of easy reach on the panel and you're looking for more integration.

As an alternative and perhaps the ultimate money saver, we think it's worth shopping for a well-cared-for used GTX 327. They're out there.

Diamond DA40 NG: Buyers Warm to Diesel Singles

While other manufacturers have struggled with diesel singles, Diamond has quietly sold more than 500 DA40s. Low direct costs and automotive-like operation are pluses.

by Paul Bertorelli

AIRCRAFT FLIGHT TRIAL

The final assembly line at Diamond Aircraft's London, Ontario factory has six stations. You can walk the length of it in minute. For at least the past year, the only engines coming down that line are Jet-A fueled diesel powerplants from Austro and many of those have been the DA40 NG four-place single.

Improbable as it seemed in 2002 when the rollout of the diesel-powered DA42 stunned the Berlin Airshow, Diamond has proven unique among major airframe manufacturers for having not only survived with diesel engines, but thrived.

The DA42 made sense as a twin because the training market was starved for aircraft and once the warts were knocked off of it, it proved a popular airplane. But a diesel single? It would be heavier and more expensive than the competing avgas engine, a hard sell to buyers who talk the talk about wanting new engine technology, but get cold feet when the sales contract is to be signed.

The DA42 NG—NG for new generation, the name for the diesel version of Diamond's four seater—has broken the mold. At a high if competitive price of $473,690, the company has found lively demand for the NG in the flight school world, so much so that the Lycoming-powered XLT ($439,800) hasn't seen production since fall of 2018 in London.

When I visited the factory in chilly December 2019, the only gasoline engines in sight were in Lycoming crates in the engine build-up area. A parallel assembly line was building DA62 twins, also with the Austro engines.

TRAINING SWEET SPOT

With demand for airline pilots swelling, the trainer market has suddenly become hot, although the volume isn't huge. The General Aviation Manufacturers Association doesn't delineate sales by type of use, but Cessna appears to dominate the trainer market, with Piper in near second. In 2018, Diamond delivered 45 DA40s, most to the training market and most diesel powered.

The DA40 airframe first ap-

CHECKLIST

- Engine and airframe are exceptionally well sorted. Handling is superb.
- While purchase price is higher than avgas version, operating costs are lower.
- Not as snug as a Cessna 150 but tighter than a Cirrus or a Skyhawk.

The Austro AE300, top right, is well integrated into Garmin's G1000 NXi, middle photo. Front seats, bottom photo, don't adjust fore and aft, but rudder pedals do.

peared in 1997 and entered serial production in 2001 at the company's London factory. It had Lycoming's popular 180-HP IO-360. The timing was right and Diamond enjoyed brisk initial sales.

At the same time, the company's Austria-based skunk works was busy developing a twin based on the same fuselage plan, but powered by a pair of Thielert 1.7-liter turbocharged diesels based on the Mercedes Benz OM640 engine used in the A-Class sedans.

Although twin sales at the time were anemic, Diamond again got the timing right and by 2005, it had a full order book for the DA42, which proved popular for the training market because of its low operating costs.

But by 2007, minor mechanical issues dogged the engine and Thielert proved unable to sustain support under its warranty program. The company went into receivership in 2008 and very nearly took Diamond with it. The severe recession of 2008 didn't help.

Unhappy with Thielert's engine and especially factory support, Christian Dries, then owner of Diamond, started his own engine factory in 2007 adjacent to the company's main plant in Wiener Neustadt, Austria. Thus was born the Austro engine, a four-cylinder turbodiesel based on the very same OM640 that Thielert had used for the Centurion engines it supplied to Diamond.

Again, Diamond proved unique in combining airframe manufacture with engine building, but it at least had some experience at this. When the company evolved from the original Hoffman Flugzeugbau, it acquired and began building a rotary engine for the motorglider market.

TWIN TO SINGLE

Although it got little notice, Diamond installed the Thielert engines in the DA40 as early as 2002, but the so-called DA40-TDI was never certified in the U.S. With its own engine available, Diamond switched new twin production to the Austro powerplants after having re-certified the aircraft in 2009.

A year later, the Austro AE300 engine—officially designated the E4—was certified in the DA40, but Diamond didn't get serious about marketing it in the U.S. until recently because it believed with avgas widely available, North American buyers wouldn't warm to diesels.

That was then, this is now. And now, the only singles coming down the line in London are diesel powered, although Lycoming models will resume this year. The company's Austria factory also builds the diesel single, along with the DA42 NG twin. The London plant also builds the DA62 twin at the pace of a couple per month. Between Austria and London, Diamond has built a respectable 550 diesel singles.

Engines for the airplanes arrive in crates from Austria and are the latest iteration of the E4. In deciding to launch his own engine company, Christian Dries maintained that Thielert made two mistakes in adapting the Mercedes engine. First, to save weight, it used a cast aluminum block and head instead of the original cast iron and its warranty economics were poorly conceived and supported.

He insisted that Austro wouldn't repeat the mistake and would capitalize on the millions of euros Mercedes invested in the engine by messing with it as little as possible. As a result, Austro's production method uniquely received fully

Inflight visibility, left, is excellent. The canopy has a shaded sunshield to improve comfort in hot weather.

dressed automotive engines directly from the Mercedes engine plant and stripped off a handful of components. It then added on the components that transformed the engine into a certified aircraft powerplant.

These include a Bosch-developed electronic engine control unit, a new high-pressure fuel pump, an aviation-specific electrical harness with 28-volt starter and alternator, a redesigned engine sump and a new glow plug controller. Because automotive engines deliver their best torque at about 4000 RPM, the OM640 needs a gearbox to reduce that at 1.6 to 1, plus a prop governor.

On the Thielert engines, the gearbox was a sore spot because it required repetitive inspections at 300 hours and the parts had to be shipped back and forth from Germany. The gearbox also had a life limit and the engine itself had a 1200-hour TBR. Buyers weren't thrilled that it had to be replaced, not overhauled.

The current iteration of the Austro has an 1800-hour TBO that Diamond says may be increased to 2100 hours sometime in 2020. Further, the engine can be overhauled at a price Austro has pegged at about $28,000—rough parity with the Lycoming IO-360. Field overhauls aren't currently an option.

The engines have to be shipped to Austria for overhaul, so replacement/exchange is the maintenance model for the foreseeable future.

Rather than the Thielert's troublesome clutch, the Austro engine has a dynamic torsional vibration damper that protects the prop against the engine's sharp torque spikes. It requires inspection at 600-hour intervals. That's done by removing the gearbox and testing the damper's friction resistance. The gearbox itself is a lifetime part.

Austro's deal with Mercedes Benz anticipated that the advancing automotive product cycle would leave the OM640 behind. In March 2019, it announced that it would begin manufacturing the engine's primary structural components, including cast blocks and cylinder heads, on its own. The engines I saw at London were the last of the MB production.

HIGHER WEIGHT

Because of their higher peak cylinder pressures, diesel engines require more structure—and thus weight—than equivalent spark-ignition engines. For the Austro, the weight Delta is substantial: The Austro weighs 410 pounds against the Lycoming's 279 pounds, a 131-pound difference.

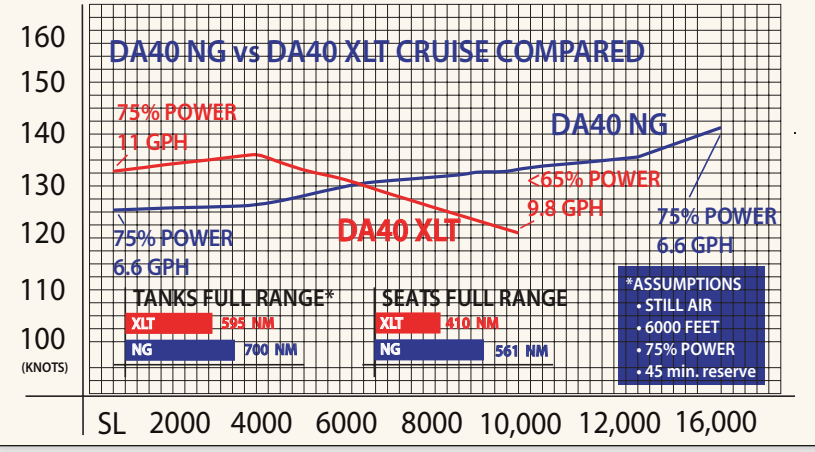
On paper, that should have been a deal killer, but Diamond addressed it by simply certifying the NG at a higher weight: 2888 pounds for the diesel, versus 2535 for the avgas version. Of course, the empty weight is higher for the NG, but the useful loads are identical: 904 pounds for the NG against 900 for the avgas XLT.

The higher weight was approved primarily thanks to beefed-up landing gear. The NG meets stall speed requirements, but has a higher stall speed: 59 knots clean for the NG, 53 for the XLT.

The two airframes are nearly identical, with the exception of a foot shorter wingspan for the NG due to the use of winglets and two inches of additional length because of the Austro's engine mount. With that much additional weight forward, you'd think the NG's CG envelope is different and it is. At gross

TURBO VS. NOT

Over the years, aviation has given us a handful of like models that offered the choice of normal aspiration or turbocharging. The Mooney 201/231, the Cessna 210 and the Bonanza 36 series come immediately to mind. And now the DA40 XLT versus the turbocharged NG. The performance is predictable. At low altitudes, with less cooling drag, the normally aspirated version smokes the turbo. Above some altitude, however, the turbo has the advantage and as the chart shows, for the Diamonds, the curves cross at 6000 feet.

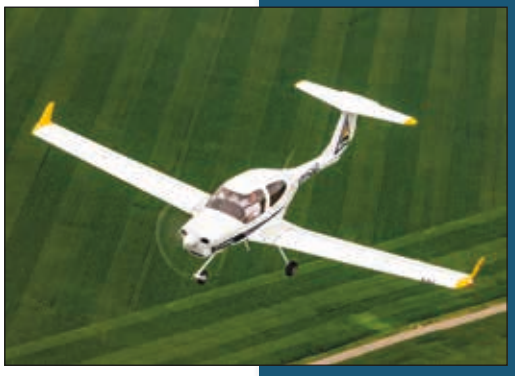


weight, the permissible CG envelope narrows from 5 inches to about 2.2 inches, meaning the NG is more sensitive to forward loading than the XLT is. (The XLT's CG envelope is twice as wide at gross weight.)

Another way Diamond shaved the NG's weight was to limit the fuel capacity to 41 gallons versus 51 for the XLT. The spec sheet lists 41 gallons as the long-range option and 30 as standard, but Diamond says all of the airplanes get the long-range tanks. Even with the lower total fuel, the NG has better range than the XLT because the NG burns less fuel.

FLIGHT IMPRESSIONS

I flew the NG with Diamond test pilot Jarred Curtis on a blustery, snowy day in London. Austro claims the engine is "automotive like" and it can be disconcerting that you can actually coax an engine to life sans incantations with mixture, fuel pumps and throttle position just so.



Just turn on the master and turn the key. The NG is equipped with the latest version of the Garmin G1000 NXi, which integrates power and engine instruments, including an indicator for glow plug heating.

The E4 has a pair of parallel electronic engine control units and it can run on either and actually does, with the engine software automatically alternating between the two. The EECUs operate on battery or ship's power, but there's also a dedicated backup battery that can run the EECUs and excite the alternator field winding, if necessary. A push-to-test switch runs the engine through its paces to check both EECUs and related systems.

According to the POHs, at sea level, the gasoline XLT outperforms the NG slightly in takeoff distances and initial climb, but you'd only notice if the airplanes were side by side. You likely would notice it when the density altitudes are above, say, 6000 feet, where the NG's turbocharger comes into its own.

For training operations, the NG is happy pottering around on 5 GPH and 115 knots. Burn a gallon more and it's doing 120 at 4000 feet. Where the Lycoming will outrun the NG down low, it's finished going fast by 6000 feet while the NG carries on all the way to 16,000 feet, where it will do 154 knots on 8.4 GPH. I'm sure many a curious student will drag it up that high, but with a portable oxygen system, a private owner might plumb the winter winds at that altitude and find 200 knots over the ground. You'll stay comfortable doing it, too, because the NG's heater will melt your sneakers.

As all airplanes should, the NG has a proper center stick perfectly

AUSTRO MAINTENANCE CYCLE

When aerodiesels first appeared nearly two decades ago, their maintenance requirements were eye watering. Gearboxes had to be inspected, pumps and alternators replaced, clutches attended to. Austro (and Diamond) learned from the experience and have reduced scheduled maintenance to a minimum.

Diamond's Ed Hollestelle says the list includes torsional vibration damper inspections at 600 hours, injectors at 900 hours, a high pressure pump at 600 hours, a timing chain at 900 hours and coolant at 600 hours.

Diamond's sales pitch to would-be buyers distills this down to overall operating costs between the Lycoming and the Austro models. Allowing for all the required maintenance, the higher price of avgas and the Lycoming's higher fuel burn, Diamond says direct costs for the IO-360 are about $80 versus about $55 for the Austro-powered NG. That number includes the Austro's ongoing maintenance.

Given the $34,000 price Delta between the two models, the operating costs washes that at about 1360 hours, variable with local fuel prices. Still, at a high-tempo flight school, do those maintenance requirements slow the pace?

To find out, we contacted Lift Academy in Indianapolis, which operates DA40 NGs exclusively. Lift is the creation of Republic Airlines, which decided about 18 months ago that it would address the pilot hiring shortage through its own ab initio training facility. It has about 300 students and 33 NGs, plus some DA42 NGs for multi-engine training.

Lift may be exceptional because it gets a favorable price on fuel because of its association with the airline. But maintenance director Jim Boothe told us the airplanes have lived up to Diamond's claims.

"I've been quite impressed. It's all electronically controlled so we do have some sensor issues. But overall, as far the reliability, it's been really good," Boothe told us. Diamond tells operators that to maintain the engines, they'll need to be comfortable with laptops to plug into the engine's onboard diagnostic port. Boothe says this has proven to be a plus.

"It's very helpful. It's fairly user friendly. What we are struggling with because it's new is understanding what's good and what's bad. Every day we learn something new," Boothe says. Lift is coming up on its first overhaul cycle for the NGs and will exchange the engines. The vibration damper inspections require about a half day for two technicians and Boothe says about four in 10 require replacement.

When we spoke to Boothe in late December, Lift was expecting delivery on two more new NGs.

—Paul Bertorelli

positioned for fingertip control. On the downside, because of the stick and the over-the-front-wing ingress, the DA40 is not as easy to mount as a Cirrus or even a Cessna. And once in, it's a little snugger, but the seats are comfortable and there's an option for electrically adjustable rudder pedal position.

In past reviews, we've commented on how well sorted the DA40 is aerodynamically. This plays out in balanced control forces, a benign, predictable stall and something I had forgotten about: There's hardly any pitch change when flaps are deployed, nor does the airplane seem to require a lot of fussy trimming.

The DA40 has an enviably low accident rate. I find only three fatal accidents among 739 DA40s on the U.S. registry. This is so low as to defy comprehension. No other model is even close. Besides the aforementioned handling traits, one other reason for this may be that Diamond's decision to place the fuel in aluminum tanks between two hell-for-strong spars has resulted in practically zero incidence of post-crash fire. Another design point may also be a factor: Cockpit visibility in the DA40 is superb; the aeronautical equivalent of a fishbowl. Despite widespread use of traffic avoidance gear, you still have to see traffic to avoid it.

Selling diesel has proven to be an uphill fight in the U.S. Cessna gave up on it and conversion projects have similarly sputtered. Piper reports it has sold about 30 Archer DX diesels since it was introduced five years ago, but Diamond has sold twice as many just this year, not to mention another 70 diesel twins. I can't guess whether this has to do with the airplane itself or an exceptionally adept sales force, so I'll concede it's probably both. As noted in the sidebar, U.S. flight schools may be waking up to the fact that the higher the training tempo, the more a diesel engine lowers total operating costs.

Further, good support from Austro may be ridding would-be buyers of the bad taste Thielert left when it entered the market with fanfare and exited in a crater. As the DA40 NG matures and finds buyers, that bad memory slowly recedes. For more, see www.diamondaircraft.com.

Stayin' Alive: Pinch Hitter Courses

Here's what we think should be in a course for flying partners who want to be able to land if the pilot is incapacitated.

by Rick Durden

It's one of the things we macho pilots don't like to talk about—incapacitation. We grouse about taking FAA medical exams or complying with BasicMed. Hey, we're way to cool to worry about keeling over while motoring through the skies with our loved ones aboard.

TRAINING

The good news is that pilot incapacitation shows up as the cause of fewer than 1 percent of general aviation accidents—so the odds are good. The bad news is that incapacitation is generally tied to age and the average age of pilots is increasing—the goods are getting increasingly odd.

The worse news is that, from what we found in our research, those who ride along with their significant other pilots know that there is some risk of incapacitation and it scares them at some level. Those non-pilots are anything but dumb. They are smart people who have stayed alive and healthy because they have successfully navigated what life has thrown at them and they'd like to find a way to reduce the risk that they'll die if their pilot partner passes out or on while they are flying together.

Put yourself in your partner's place: You can't fly the airplane. It goes fast a long way above the ground. All that is between you and minutes of sheer terror prior to violent impact is a guy (yes, guy, 94% of pilots are guys) who isn't in the best of physical condition and gets winded climbing the stairs.

Would you fly with you?

You're right, that woman sitting to your right in the Archer is brave beyond words.

A screenshot of one section of AOPA's online pinch hitter course, which we highly recommend, opposite page. An integral part of pinch hitter training involves learning to fly the airplane from the right seat, above right. Our research indicated that a good pinch hitter instructor reduces the fear factor in students by patiently explaining the "why" of things and makes liberal use of visual aids to supplement ground instruction, below right.

EMERGENCY TRAINING

For reasons lost in the fog of aviation past, courses aimed at teaching spouses/partners/significant others to land an airplane after the pilot became incapacitated acquired the name "pinch hitter." We'll use that name to describe a course that is focused on training a non-pilot to fly an airplane well enough to make a landing that is survivable.

A pinch hitter course is not the more involved "flying companion" course. While we like those courses, they go into more detail and aim to turn a flying companion into an active flight crew member. Such courses are beyond the scope of this article.

WHAT'S OUT THERE

We were interested to note that pinch hitter courses are offered all over the country by seemingly the smallest and the largest flight training organizations.

At the high end, SIMCOM (www.simulator.com) offers a "Pinch Hitter ™ option" at its Orlando and Scottsdale training locations. SIMCOM's website states that: "By attending the same piston or turboprop course with the primary pilot, the non-flying companion will experience the same classroom and simulator training as the primary pilot but at a 75% discount off the regular price."

One of our readers reported that his wife had taken advantage of this offer and attended class and simulator training with him for their family Pilatus PC-12. His wife had been a white-knuckle flyer, but the SIMCOM course changed all that. She went on to acquire a number of pilot ratings, accumulated over 1000 hours of flight time and now flies the family PC-12 as pilot in command.

At a less rarified height, we looked at offerings by national flight schools, local FBOs and flying clubs. We saw prices ranging from $500 (with airplane) to $5000 (in a complex airplane). We were frustrated with how many providers did not publish prices, but were pleased to see that many did publish at least a rudimentary syllabus. The training courses all included ground school, generally from two to five hours, and flight time—two to 10 hours.

FAMILY AIRPLANE

It appeared to us as we worked on this article that most pinch hitter candidates are seeking training in the family airplane. That meant that the cost was simply for the CFI's time. We think that a total of eight hours of dual instruction—split about half and half between ground and inflight instruction—is a good working number for an effective pinch hitter course.

As an aside, we've taught pinch hitter classes and we spoke with other instructors who have done so as we prepared this article. All noted that they enjoyed working with pinch hitter students because they were invariably bright and very motivated to learn. However, they generally made it clear that they were motivated to learn the stuff that was relevant to getting the #%@#& airplane on the ground and nothing else. They were focused and didn't want fluff. That meant that CFIs had to be on top of their game in explaining why something they were teaching was relevant, otherwise they risked being tuned out.

We had a number of CFIs and two flight school managers comment to us that pinch hitter training seemed to be more popular as well as effective when the CFIs were women. The comments we got were that because most of the students are women, there seemed to be more of a peer-to-peer relation that fostered learning, something of value in a course that only lasts a few hours.

After a review of a number of syllabi at different schools and taking the AOPA (www.aopa.org) online Pinch Hitter ™ course, we came to a number of conclusions as to what should be included in a pinch hitter course and syllabus. We'll walk through them below.

PRELIMINARIES

Whether the plan is to attend an organized program through a flight school or contract with a local CFI

Learning to line up with the runway while keeping the speed in the green arc is a basic part of any pinch hitter course, top. Ground instruction includes why and how to do a preflight inspection, middle. A good pinch hitter instructor encourages questions and feedback from students, bottom.

for training there are some preliminaries that need to be taken care of before the student flies the airplane.

Assuming that the machine of choice will be the family airplane the first thing to do is to make sure that the pinch hitter pilot can sit in the right seat and comfortably see over the panel and reach the rudder pedals.

While that seems to be a no-brainer, the reality is that the high panels and lack of adjustment of front right seats in a lot of airplanes means that a lot of women (and men) who are of average height cannot see out of the airplane straight ahead in level flight.

That situation only gets worse as the airplane is pitched up during the landing sequence. As any instructor will tell you, the ability to see forward makes a huge difference in how fast a student learns to land. Even if the airplane involved is a tailwheel bird that is blind forward on the ground, being able to see forward to judge runway lineup on final and then flare height is vitally important when it comes to a newbie pilot pulling off a successful landing.

Find the seat position that is best for the student and then use cushions or pads as necessary to allow the pilot a seating position that generates a good view over the nose and the ability to move the rudders to the stop.

That may mean rudder extensions or some minor modification. Yes, get it done. Without them, you're wasting time with the course. It may also be a good idea to tailor a set of cushions or pads as a number of vertically challenged professional pilots carry. Make sure that whatever is needed is always in the airplane.

INOP?

Fix the broken stuff.

You may be used to and able to deal with your out-of-rig airplane that requires constant right aileron input but it could be a killer if your wife has to step in and fly while dealing with being hit upside the head with the reality of you slumped over your shoulder harness, trying to get help over the radio, figure out where an airport is and—by the way—keep an out-of-rig airplane right side up. You're not fixing the deferred maintenance items for you, you're doing it for the most important person in your life.

PRIOR TO CLASS

Once the airplane is in shape and the student has a good seating position, she should take AOPA's online pinch hitter course. It does an excellent job of introducing the relevant subjects in a fashion that makes sense. We particularly like the fact that it minimizes the use of jargon by using terms that are most likely to be understood by a non-pilot.

Finally, make sure the CFI involved has had a chance to get to know the specific systems and avionics of your airplane. At the most basic level, the CFI should have some flying time in the make and model—your insurance will probably require that—but she may not have dealt with mods you have such as tip tanks, or with the specific avionics suite. Give her some time with the POH. If need be, fly with her in your airplane so she can get a feel for its features.

TRAINING ENVIRONMENT

We recommend paying attention to the space used for the ground portion of the course, recognizing that the students, while motivated, are often quite nervous. In our experience and based on what CFIs and pinch hitter students told us, the ground school space should be comfortable, free of interruptions and free of threatening-looking items. Don't have any post-crash photos lying around or crushed pieces of airplane or pretzeled props.

We're not kidding. What the students seek to do is threatening enough to them, don't add to the problem.

We also strongly recommend that no pilots be allowed in the training sessions—especially spouses. We heard too many stories of pilots adding their two cents to what the instructor was teaching, significantly interfering with the training and intimidating the students. Too often those pilots are doing nothing more than trying to show off their wide aeronautical knowledge. When called on the interruption they piously claim that they are "just trying to help." The reality is that the nonflying spouse has heard it all—many times—from her aviator husband, doesn't want to hear it again and may shut down.

The training atmosphere needs to be comfortable and safe and the CFI teaching needs to be able to go through the course in the manner she planned while sticking to the subjects pertinent to the course. She doesn't need irrelevancies tossed in from spectators.

Based on our experience and research, it is our opinion that the ground training sessions can cover the subject in two two-hour sessions. We've seen flying clubs and FBOs hold the training sessions during evenings, often a week apart, so that it's easier for people juggling work and kids to attend and get in some flying between the two ground sessions.

We also think that about four hours of "flight" time works well, although we recommend that, if possible, the first hour be in a flight simulator that has at least some motion capability. While the sim will not fly exactly like the airplane to be used and will probably have different avionics, it is an excellent nonthreatening environment in which to focus on the basics—control of the aircraft—without the distractions of noise, turbulence, weather and avoiding other aircraft.

GROUND SCHOOL

Have as many visual aids as possible for the ground sessions. The topics that we recommend be addressed are an overview of the airplane so either have an airplane right outside the door or large pictures showing the exterior, cockpit, avionics and autopilot, yoke/stick and rudder pedals and brakes, basic instruments and safety equipment such as fire extinguishers, restraint systems, door locks and, if installed, the ballistic recovery system.

The next step is basics of flight, which calls for explaining the flight and engine controls and what they do. There is not much emphasis on the theory of flight—this is practical application. If I want to fly level, how do I do it? This section ties in

PINCH HITTER CHECKLIST

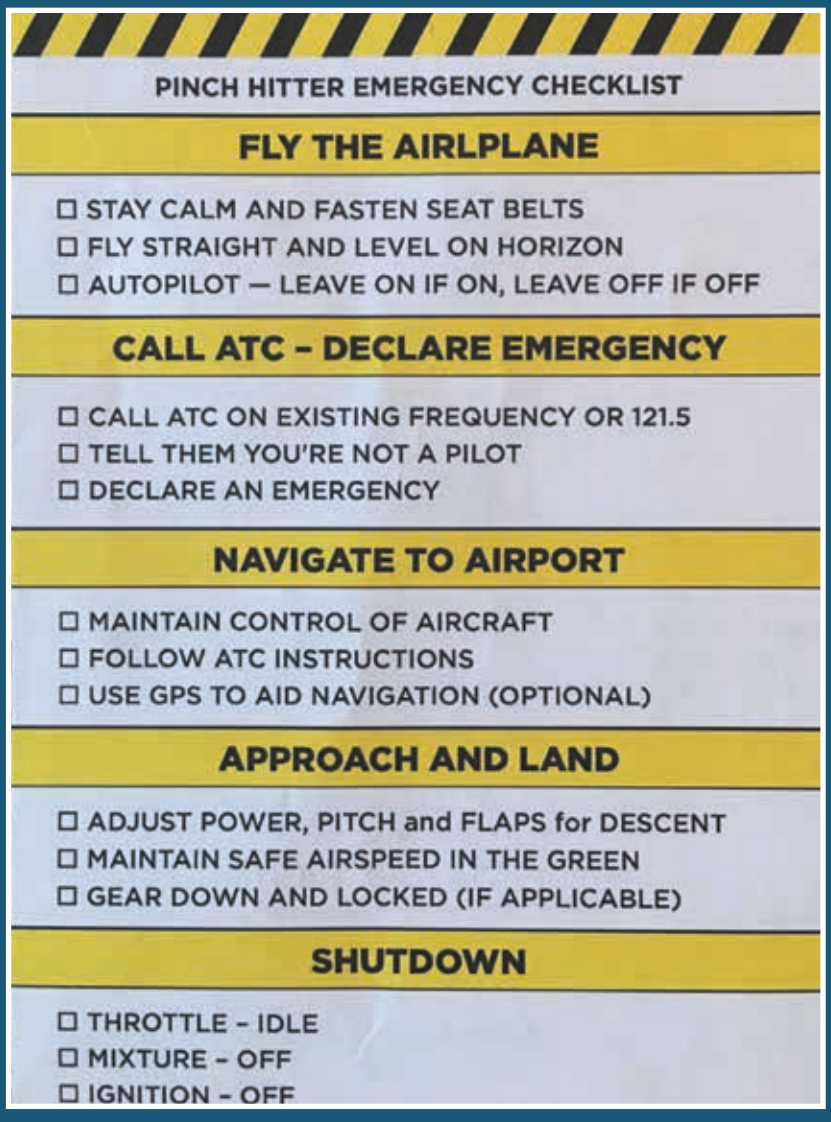
During a good pinch hitter course, we recommend that the instructor and student work together to develop an emergency checklist that is designed for the specific airplane the "suddenly a pilot" will be operating.

In our opinion the checklist should function as a memory aid for an intelligent person who has completed a pinch hitter course and demonstrated the ability to land the airplane.

We think that it should be short enough that the user doesn't risk losing control of the airplane because her head is down reading a complex list of instructions.

Once the instructor and pinch hitter pilot have developed a checklist that works for them, we strongly recommend that it be printed, laminated and added to the existing airplane checklist.

As a starting point, we like the checklist that AOPA developed in its pinch hitter course. It's reproduced below.



PINCH HITTER EMERGENCY CHECKLIST

FLY THE AIRLPLANE

- ☐ STAY CALM AND FASTEN SEAT BELTS
- ☐ FLY STRAIGHT AND LEVEL ON HORIZON
- ☐ AUTOPILOT — LEAVE ON IF ON, LEAVE OFF IF OFF

CALL ATC – DECLARE EMERGENCY

- ☐ CALL ATC ON EXISTING FREQUENCY OR 121.5
- ☐ TELL THEM YOU'RE NOT A PILOT
- ☐ DECLARE AN EMERGENCY

NAVIGATE TO AIRPORT

- ☐ MAINTAIN CONTROL OF AIRCRAFT
- ☐ FOLLOW ATC INSTRUCTIONS
- ☐ USE GPS TO AID NAVIGATION (OPTIONAL)

APPROACH AND LAND

- ☐ ADJUST POWER, PITCH and FLAPS for DESCENT
- ☐ MAINTAIN SAFE AIRSPEED IN THE GREEN
- ☐ GEAR DOWN AND LOCKED (IF APPLICABLE)

SHUTDOWN

- ☐ THROTTLE – IDLE
- ☐ MIXTURE – OFF
- ☐ IGNITION – OFF

THIS IS THE AUTOPILOT

It's unrealistic to think every non-pilot flying companion can master the autopilot, especially under the stress of dealing with a slumped-over pilot. But it sure is worth a try. Whether your autopilot is highly integrated (Garmin's GFC 700 comes to mind) or is a simple wing leveler with heading hold, show them how to use it and keep reviewing it on every flight. Got a model with a Level button? Stress that this might be the first button they'll push while they sort things out. Put the airplane into a bank and demonstrate what it does to correct. Then work into basic coupling commands.

Start as every pilot new to an autopilot should and give your companion the pilot's guide. It's filled with jargon, but by reviewing it with them you can likely dumb it down enough where anyone can understand it. Continue to reinforce the button-pushing on every trip you fly, even if your companion is paying attention to nothing else. Simply put, show them how you're making the airplane go to the destination. If the autopilot is interfaced to a GPS navigator as many are, that's more to cover. Again, simplify it and start with the navigator's Direct button and simply concentrate on teaching how to make the autopilot fly to an airport. Baby steps. As they become more comfortable, show them how to make the autopilot join an approach. The problem, of course, is that with autopilot programming comes the prerequisite of understanding navigation. Still, with good help from ATC (make sure the companion knows the model of the autopilot) they might be able to line the airplane up on a runway.

Last, show them how to disconnect the autopilot. If you had it engaged before your incapacitation, they should know how to take command of the airplane or cancel their own botched input. I would also make an abbreviated ops guide and have the companion use it to make the autopilot work while you coach. A good reference for constructing this is found in the Pilot Workshops (www.pilotsorkshops.com) *Flying Companion* book, which also has 50 tasks a non-pilot can take on. Some of those include commanding the autopilot.

—Larry Anglisano

the flight and engine controls with the concept of making the airplane go where the student wants it to go.

Next comes communications—who to call, how to speak on the radio and how to clearly declare that you have an emergency and need help—this is a time to be assertive and here's how to do it.

Finally, there's an explanation on how to find an airport and land on it (and how to shut off the engine).

Following that comes scenario training beginning with prevention: The pilot doesn't seem to feel good, so encourage that Type A goal-achiever to divert and land. If prevention doesn't work and the pilot becomes incapacitated, show how to secure the pilot away from the controls, how to keep calm and handle needed communications, including coding 7700 on the transponder. Then it's time to work on use of installed automation, navigating to an airport, setting the airplane up to make a successful landing and getting stopped.

FLIGHT

The flight lessons mimic initial flight training but with an emphasis on the basics. Preflight and takeoff is taught, because the information is of value to the student (and she may detect a problem with the pilot before takeoff and can prevent an inflight incapacitation). More emphasis is placed on straight and level flight, climbs, descents and turns to a heading.

Radio communications are added, often with the instructor playing the role of controller. Use of installed automation is explained and practiced. Finally, the focus is on approaching an airport, configuring the airplane for landing and making the landing.

During ground and flight training we recommend that the instructor continually emphasize the student's priorities when they suddenly become the pilot: 1. Fly the airplane. 2. Communicate. 3. Navigate. 4. Set up the approach. 5. Land the airplane and get it stopped.

CONCLUSION

We think that an effective pinch hitter course can be completed in eight hours, four on the ground and four in flight. The cost should be the cost of eight hours of CFI time and four hours of airplane (we prefer one hour in a motion-capable sim and three in an airplane) time.

Because aviation skills that are not practiced extinguish themselves, we also recommend that someone who has taken a pinch hitter course take recurrent training every year. We believe that can be accomplished in about half the time as the initial course. We think that setting aside a half a day with a trusted instructor to review the pinch hitter basics and make some landings will go a long way to allowing a safe ending to the unthinkable—inflight incapacitation of a pilot.

Having been involved in such classes, we encourage flight schools and flying clubs to organize and advertise pinch hitter courses on a regular basis. Our experience has been that it increases aircraft use as it increases spousal comfort with flying and it increases the overall safety level of operations at the organization. And, it has led to new student starts.

That's the under-the-headset Aithre Illyrian pulse ox sensor with a Bose headset, and the Aithre Connect app on an iPhone and Apple Watch, main photo.

Aithre Illyrian: Smart Pulse Oximeter

The Illyrian pulse oximeter measures SpO2 under the earlobe or on the forehead. Intrusive, but full-time monitoring is worth it for some.

by Larry Anglisano

In the Innovations building at last year's AirVenture, Idaho-based Aithre was showing what we think are the most innovative pilot-focused biometric devices we've seen. Aithre is an attention getter because surprisingly, there's been a slow progression of gadgets for minding pilot and passenger health in the cabin.

For measuring blood-oxygen saturation, or SpO2, some finger pulse oximeters have Bluetooth and tablet app integration, and Garmin's D2 Titanium aviator's watch has a sensor for reading SpO2 and heart rate on the wrist, with some limitations.

And now Aithre takes an entirely different approach to full-time SpO2 monitoring via an under-headset earlobe sensor with the Illyrian smart oximeter. Here's a field report.

DEVELOPED BY ATHLETES

Aithre was founded by Vans RV-10 builder, patent attorney and endurance athlete Jim Ruttler, who also studied neurobiology, and almost died from running out of oxygen in his RV while cruising the flight levels.

"In my airplane I have so many advanced avionics including synthetic vision, I can precisely measure parameters down to the exhaust temperature in a cylinder and I have multiple ways to look at fuel flow, but on that one passenger-carrying trip I couldn't effectively monitor the O2 supply and everyone's blood-oxygen levels," Ruttler said. And it was that trip that sparked the idea to build a company focused on products that will. One is the Illyrian smart oximeter.

Priced at $169 and now distributed by Sporty's, Aircraft Spruce and Pilot Mall, to name a few, the Illyrian is a departure from the familiar finger pulse-ox devices, which require cabin occupants to monitor on their own. Ruttler makes a good point that this is fine as long as they aren't hypoxic. With the Illyrian you're always connected to the Aithre Connect iOS-based interactive smartphone app. More on that in a minute.

STICK IT UNDER THE EAR

The Illyrian system's main hardware consists of the SpO2 sensor, designed to sit under the earlobe or on the forehead using a supplied sport headband. It has a built-in BLE (Bluetooth Low Energy) wireless transmitter, and the Bluetooth antenna sits in a small junction box on the bottom of the sensor's cable, keeping the transmitting antenna away from the head. The sensor automatically pairs and streams the measured data to the smartphone without any user action. This style of pulse oximeter is obviously boldly different than the familiar finger pulse ox device most of us use in the cabin. Never used one? Here's brief review of SpO2 measuring.

With any pulse oximeter, a sensor shines a visible red and an infrared beam of light (through the finger or toe, to name two bodily locations) to detect the changes in color of the arterial blood. Once the device computes, it displays the measured blood oxygen saturation level on a display. In terms of aviating in an unpressurized cabin, clinicians make a good point that if you fly

CHECKLIST

- ⊕ Full-time SpO2 monitoring offers another layer of safety for high-altitude ops.
- ⊕ At $169, the Illyrian and the accompanying smartphone app is a good value.
- ~ You'll have to manage a cable that connects the SpO2 sensor with the battery pack.

The Illyrian sensor tucks under the lower portion of a headset earcup as shown in our bench test shot. That's the pulse oximetry data page on the Aithre Connect smartphone app, lower left. We got SpO2 and pulse readings that were mostly consistent with the Masimo MightySat finger pulse oximeter, lower right.

much above 6000 feet, you'll be less oxygenated than you would be at sea level. In turn, pilots are taught to self-diagnose their own level of hypoxic symptoms, which of course includes carrying a pulse oximeter.

As recently as a decade ago, medical-grade oximeters sold for nearly $700, but you could bargain hunt and find some finger pulse ox devices for as little as $13.

The Illyrian sensor needs power, so the other component in the system is the supplied portable USB power bank. It has a power button, five battery life indicators and a handy flashlight function. It's charged via Micro-USB input.

We fought with the power bank's mode button the entire evaluation. While the bank stays on all the time and has good endurance, we found it difficult to simply turn the device off when trying to conserve power when it's not in use. The problem is that the switch also turns the flashlight on or off, and at times that's all we could get it to do without repeated button presses. It's a bit quirky. The Bluetooth connection was flawless.

The company advises in the user's manual that you need to use this specific power bank because since the measuring sensor draws so little power, some smart power banks will automatically shut off as they sense there's nothing connected. While we didn't try one, a panel USB port might be another choice for powering the sensor, but only if it's in close proximity to the user. There's roughly 38 inches of cable length to work with, from the base of the sensor to the base of the USB connector on the other end. On the other hand, the portable power bank will help streamline the sensor to the body—maybe stuff it in a shirt pocket to keep the sensor's cable from dangling loose on the body. Last, included is a coil cable wrap for keeping the sensor's interface cable ruly and intertwined with the headset's downcable. The interface is about as good as any wired one can be, which isn't great.

USING IT

We tried the device with a Bose A20 headset, and also tried the sensor on the forehead with the sport headband. You'll need to experiment. Aithre says that different individuals will find the best readings in different places of the body, and that the best performance is achieved under the earlobe or on the forehead—an area that worked well for us, but it requires wearing the headband to keep the sensor in place and directly on the skin's surface. It's awkward, for obvious reasons, and also because the darned power cord has to be looped behind the ear. Add an oxygen cannula, shoulder restraint, headset, sunglasses and maybe a ballcap to the mix ... you get the point.

The majority of users will likely tuck the sensor pad under the headset earcup. But you have to get it right and it's worth mentioning that the sensor does not read on the earlobe, but underneath it. Moreover, Aithre says that women

and children often get inconsistent readings in this location, something we couldn't substantiate in our evaluation. But what we did find, male or female, is that this location isn't ideal if there is excessive head movement or even movement associated with typical cabin conversation.

We like that the Aithre Connect app notes the sampling quality of the SpO2 and blood pressure readings below the displayed values. That means if you get a reading that doesn't quite look right, you can dismiss it as a bum sample—and then adjust the sensor. But in our trials it worked well more than it didn't. When the head was still and the sensor was placed in what we call the "sweet spot" under the earlobe, we consistently saw a "high" sampling quality. We compared the Illyrian's measurements with the Masimo MightySat multifunction finger pulse oximeter—an accurate and high-quality device we've learned to rely on for flying and endurance sports training.

We also threw Garmin's D2 Delta Titanium aviator's watch in the mix. It has a wrist-based SpO2 and heart rate sensor built into the watch's chassis. What we've learned to like about it is its basic data display in the Garmin Pilot smartphone app, but we've also learned to accept its measuring limitations. The heart rate data lags, and the SpO2 measuring is finicky at best (but accurate when it gets a clean sample).

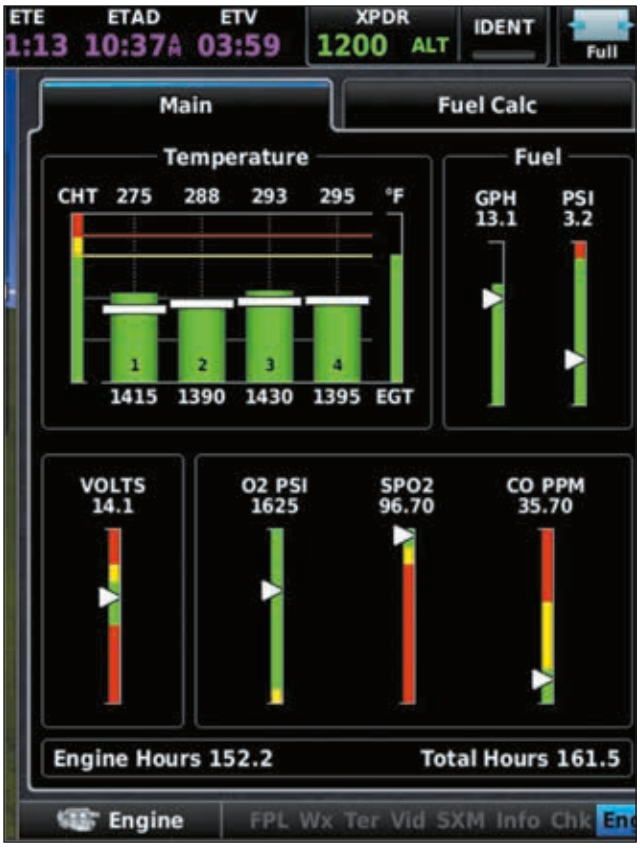
SIMPLE, USEFUL APP

Where plenty of cockpit apps have grown multiple layers deep, the Aithre Connect app is refreshingly shallow and straightforward. Its main purpose is full-time monitoring of your biometrics, and you start by turning the Apple Siri/popup notifications on in the app. For alerting, the default warnings trigger when the SpO2 drops below 92 percent and then again below 85 percent—which is indeed hypoxic. But you can also specify custom SpO2 warning levels within the Settings tab of the app.

But the app falls short in that the warnings are provided only once, "so as to avoid them being a nuisance,"

YouTube See a field report video of the Illyrian at http://tinyurl.com/j95ht2a.

That's the data from the Aithre full suite of sensors interfaced with the experimental Garmin G3X Touch in the top photo. Garmin's D2 Titanium aviator's watch has full-time SpO2 and heart rate monitoring with a wrist sensor, bottom.



the manual says. We think this should be user controlled, and Aithre is working on it. The app has an easy to decipher time-trend (up to 12 hours) graph for SpO2 and heart rate that's overlaid against pressure altitude. The app is also interactive, offering regular hypoxia risk testing with custom interval quizzes.

The Aithre Connect iOS app includes a companion WatchOS app that tags along with the free download. It's installed automatically on the Apple Watch once the iOS device downloads the Connect app. In turn the WatchOS app will display the SpO2 and blood pressure automatically when the Illyrian is paired with the main iOS device. For many that will be more convenient than keeping the Aithre Connect app open all the time, although the app does work in the background. We'd like to see future interfaces with popular third-party apps for simplicity.

ROOM TO GROW

Aithre's Jim Ruttler feels strongly that passengers are often neglected when it comes to being monitored for hypoxia. As a result, the Aithre Connect app can simultaneously connect with up to six Illyrian oximeters, and at press time the company was offering a 50 percent discount for a second oximeter.

Additionally, the Illyrian can display biometric data on the Garmin G3X Touch, Dynon SkyView and the

Advanced Flight Systems experimental avionics suites through the Aithre Shield EX 3.0. This device is integral to the company's carbon monoxide and oxygen tank pressure measuring systems, which also display on the Aithre Connect app. We'll look at these devices and their interfaces in a separate field report.

Minor warts aside, we think the Illyrian device is a good value for $169, and a solid utility for high-flying pilots who are serious about full-time hypoxia monitoring and alerting.

Visit www.aithreaviation.com.

CiES Fuel Senders: Fixed For Early Cirruses

The stock fuel gauge in early-gen Cirrus models has less than stellar accuracy, but CiES says it finally found the cure owners have been waiting on.

by Larry Anglisano

If you fly a G1 or G2 Cirrus you might have considered upgrading the OEM mechanical fuel quantity gauge with the Aerospace Logic FL202G digital "smart gauge" control head, along with the CiES digital magnetoresistive fuel senders. That's just what we did back in 2014 for an *Aviation Consumer* field report.

But as we described in the November 2014 issue of the magazine, the upgrade in our 2002 SR22 G1 testbed yielded disappointing results—so much so that we ultimately removed the digital setup and had the OEM system reinstalled. The installation cost $5200 (CiES ultimately refunded the investment) and the plane was down for approximately one week. CiES stopped shipping the kit for G1/G2 models while it worked on a fix. Apparently persistence pays off because CiES says it found the problem and has a fix.

PROBLEMATIC BY DESIGN

Worth mentioning is that CiES digital senders have been widely successful in other aftermarket and OEM applications, including G3 and newer Cirrus models. What's the difference in the old SR22?

The early Cirrus models are unique because they have two fuel senders in each wing, including one that's installed in a small collector tank. That collector tank is a walled semi-section of the tank on the far inboard section of the wing. It holds approximately 3 gallons of fuel. The collector is supposed to keep fuel from unporting in maneuvering flight, including critical phases like during climbout and landing.

According to CiES President Scott Philiben, this small tank, combined with the small lines to feed it—and the manner in which Cirrus chose to vent the tank—caused a series of issues, which unfortunately a more accurate (digital) sensor revealed. One issue is suction depression in the collector tank, due to the small feeder lines that originate in the main tanks. This was rectified in the G3 models and beyond.

The other issue CiES found is that the design of the vent system tended to trap an air pocket in the collector tank. This pocket of air expanded at altitude as the vent system didn't allow the slightly pressurized air to escape the vent system. "To say that this combination caused an active and dynamic effect on the inboard sender would be an understatement," Philiben told us.

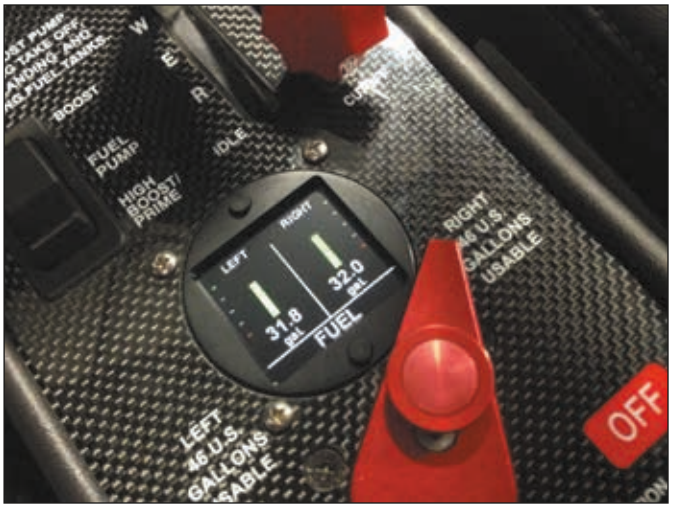
THE FIX

Over the course of several years CiES tried a variety of fixes, including software patches, revising fuel line fittings and relocating fuel vents. These bandages did stem the flow (which ultimately included relocating the inboard sender into the main tank), but only addressed some of the issues found with the retrofit. Philiben wouldn't settle for performance that's any less than what you get in new Cirrus models. If you've flown one you appreciate the accuracy.

Since the design of the early Cirrus aircraft included a hard point on the inner fuel tank rib, moving the sender to the main tank is relatively straightforward and apparently solved the issue.

A huge part of the digital retrofit is a tedious system calibration

Perhaps the best time to make the upgrade to a digital fuel quantity system is when the aircraft is opened for a detailed inspection. That's the Aerospace Logic FL202G electronic "smart gauge" in the lower right photo.



process. Philiben shared with us the calibration curve results, which show a highly uniform pattern across the fuel quantity measuring spectrum. Flight testing revealed better results.

"One obvious characteristic that showed a fix was the immediate drop in fuel level when switching tanks, caused by the suction depressing in the tank or conversely in the prior tank being relieved," Philiben reported. The net result is highly accurate fuel indications in these early Cirrus models, finally.

A BETTER SYSTEM

As we've suggested in the past, there's good reason to consider replacing non-digital fuel senders with digital ones, and early Cirrus models are candidates. To appreciate the accuracy that a digital fuel sender can provide is to understand the shortcomings of the average mechanical float-style sender, which in many applications were born from typical automotive senders. Automotive resistance-type ceramic sensors that are reconfigured for use in aircraft often fall short in performance due to the large quantity of fuel that's stored in an aircraft fuel tank.

A signature trait is the fluctuation in displayed fuel quantity as the sender's resistance wiper moves. And yes, the old saw that says these analog fuel measuring systems are the most accurate when the tanks are completely full and completely empty is true because many are calibrated for the full and empty positions.

The CiES digital sensor is magnetoresistive or specifically, AMR (for anisotropic magnetoresistive). This magnetic fuel sensor is proven to work well in a variety of temperatures and conditions that aircraft fuel tanks are exposed to, including the extreme sloshing of fuel within the tank (especially in turbulence). It's compatible with alternative fuels.

The AMR sensor operates on the scientific theory that the electrical resistance of ferromagnetic alloys are influenced by external magnetic fields. The best and simplest explanation is that the fuel sensor acts like a compass, always pointing to the measuring float no matter how you move. There are no wires or traces of resistance inside of the fuel tank. Instead, the CiES sensor utilizes a magnetic pickoff located on the float arm, which is detected by the non-contact sensor on the outside of the tank.

A tech gains access to the Cirrus fuel tank through an access plate under the fuselage, top photo. Notice the modified position and configuration of the sender in the bottom photo.

And like most things with a digital databus, the digital fuel sensors (which convert the changes in fuel quantity to a digital signal) have multiple interfacing advantages. Computed fuel level is transmitted through a simple digital databus, cleanly transferring multiple pieces of fuel level data to a multifunction display. In this interface, the display is the Aerospace Logics FL202G—a gauge that fits in place of the mechanical gauge in the center console of the Cirrus.

The FL202G display is STC-approved as a primary gauge, and has a 65,535-color LCD display that works well when splashed with sun and has a wide viewing angle. There are two buttons on the bezel. The top button advances between display screens, selects an action from a menu and is used for programming. The bottom button is used to select the measured quantity in the left or right fuel tank. The default screen displays the quantity level for each tank in a color vertical bar format, plus a numerical value below the bar.

We like the fuel imbalance warning, which is a flashing yellow bar on either tank designation indicating a fuel imbalance condition. The flashing tank indication will be that of the tank with the most fuel. In the SR22, a 10-gallon imbalance will trigger the alert.

CiES is currently updating its STC list to include the early Cirrus models, and some other models too, including a variety of amphibs.

A CiES/Aerospace Logic upgrade won't be insignificant, but we think the latest fix for early-gen Cirrus models will be worth it for some.

Contact www.ciescorp.net for more tech data.

Battery Box Upkeep: Bogert Replacement

The battery box is a major system that's often overlooked by owners and mechanics. Bogert's STC'd replacements better most OEM boxes.

Staff report

In the typical car or truck the battery box may be nothing more than a tray to support the battery. But there's more going on in the battery box in most aircraft—and it might not be good. Neglect can lead to unnoticed airframe corrosion, engine starting problems, audio system noise and other electrical system problems.

Part of the problem is that 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. And when it's time to replace one, hold on to your wallet. The good news is that modern battery boxes are much improved over older ones.

WHAT THEY DO

More than you think, actually. 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 that, 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.

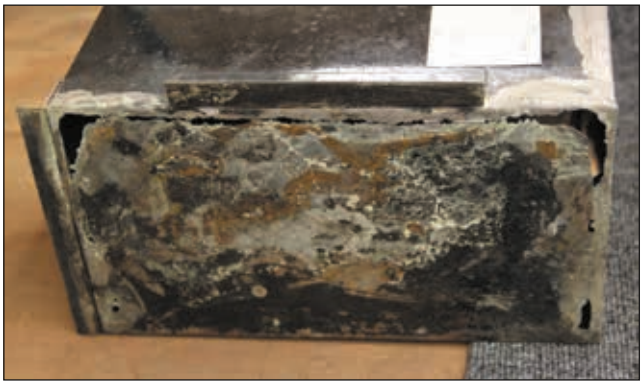
Some boxes (including those on Piper models) have external vent tubes to catch the slipstream from the belly of the aircraft and push fresh air into the box, while an exit line sends the vented air back overboard.

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 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. We've seen the resulting corrosion so bad that it required a skin repair on more than one airframe. This generated an invoice north of $5000, not including the cost of the new battery box.

TIME TO GO SHOPPING

Before you do, realize that battery



That's a modern battery enclosure made by Bogert Aviation in the lower left. What's left of the one in the lower right was original equipment in a Piper Comanche—and the reason you want to keep an eye on these things.

boxes have to be FAA approved, unless your application is an experimental aircraft. We thumbed through catalogs of several mail-order parts suppliers and found plenty of replacement boxes, but few that were approved for certified aircraft. As one example, mail order supplier Aircraft Spruce sells a fiberglass box for around $110 and an aluminum box for around $190, but these are for experimental aircraft only.

You could, of course, 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 share the same design.

Some don't even utilize an actual 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 appropriate FAA-approved replacement that meets or exceeds the original spec.

We talked with a couple mechanics who 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 boxes 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.

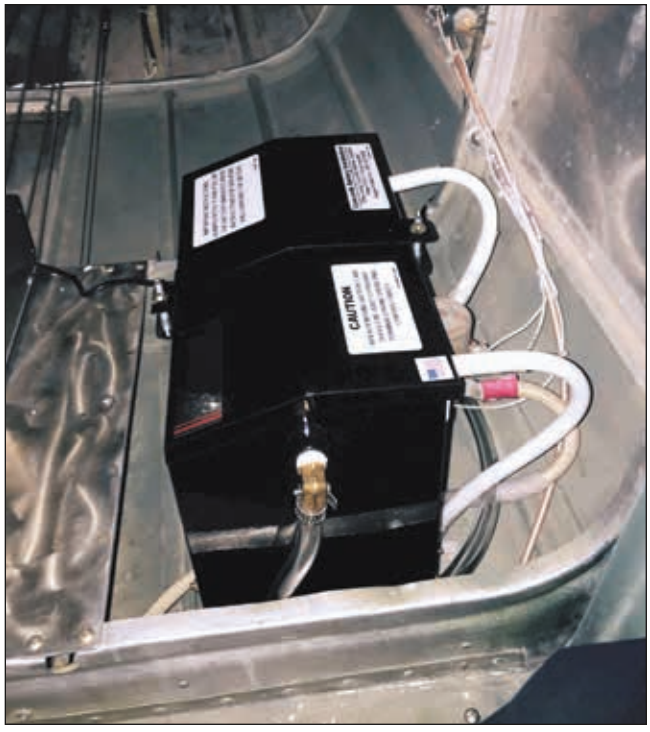
On Cessna 150-and 172-series aircraft (where the battery boxes are mounted on the firewall), the installation process is slightly different. The retrofit requires drilling a single hole in the rear pressurized air inlet baffle of the engine. This is to accommodate a small air pickup tube that mounts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

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.



As you can see in the image above, some battery boxes have built-in battery terminals, airflow venting and drainage tubes. This one is an FAA-approved model (it has an STC) for a Cessna 182 and is priced at a whopping $1175.

Given the cost of a new Bogert box, which can range from around $800 to over $1800, depending on the application, rebuilding an existing box could be a better option if the housing isn't broken or corroded.

The STC'd Bogert replacement for a Piper Warrior (PA-28-161) is $1819, while a model for a PA-24-260 Comanche is $1286. Given the quality, it's probably the last battery box you'll ever have to replace. Our advice is to ask your shop or mechanic to put a close eye on the existing box during the next annual. In many cases, proactive replacement is cheaper than dealing with the damage a failed one can cause. It might even solve other issues.

Visit www.bogertaviation.com, 509-736-1513.

Beech Bonanza 36:

Buyers flock to the big-cabin 36-series Bonanza for its solid handling, comfort and reliability. Newer ones carry a hefty price premium and none are cheap to maintain.

CHECKLIST

- The Bonanza 36 series has sturdy, solid handling, making it an easy step-up single.
- There are plenty of well-cared-for models at various price points.
- Upkeep won't be cheap, and it's unforgiving for the untrained pilot.

For as long as we can remember there has always been a certain prestige that tags along with owning a Bonanza. We suppose that's good and bad. On one hand, the Bonanza 36's earned reputation as arguably one of the flagship GA complex singles (in good company with Piper's PA46 Malibu, perhaps) might after all these years still boost the airplane's retail value.

But when you roll onto the maintenance ramp with one don't expect any sympathy. Moreover, service parts for Bonanzas and its multi-engine sibling (the Baron, of course) aren't exactly priced for shoestring budgets. Keep all of the above in mind when considering stepping up to a Bonanza.

With that out of the way, we think the right used 36 Bonanza will likely be one of the most satisfying singles to own and fly. Load it heavy, fly it far and install some performance-boosting aftermarket mods.

HISTORY

In one form or another, the Bonanza has been in continuous production since 1947, when the first V-tail was built—an astounding fact in itself. The 35 Bonanza was the first high-performance postwar single and was markedly different from the average light airplane of the day. Base price of the first models was $7975 ($58,943 in 2020 dollars).

By 1967, Beech had a gaping hole in its model lineup. Archrival Cessna had been selling its six-place retractable single, the 210, since 1960 and by the end of the 1967 model year had rolled 936 through the factory doors. Cessna also had the 206 for the utility market.

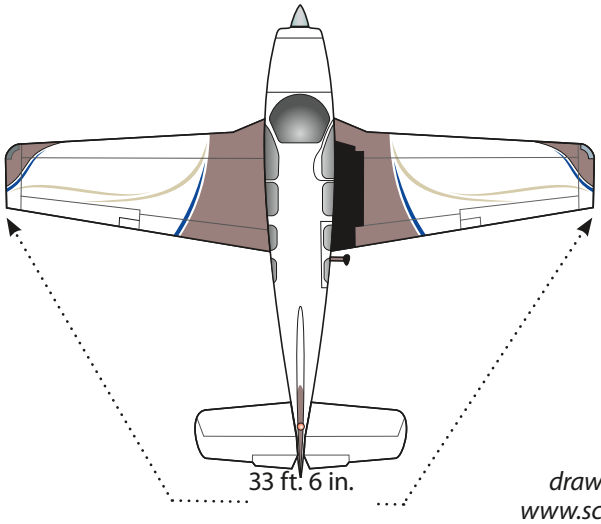
The handling for its intended mission is just about as good as it gets.

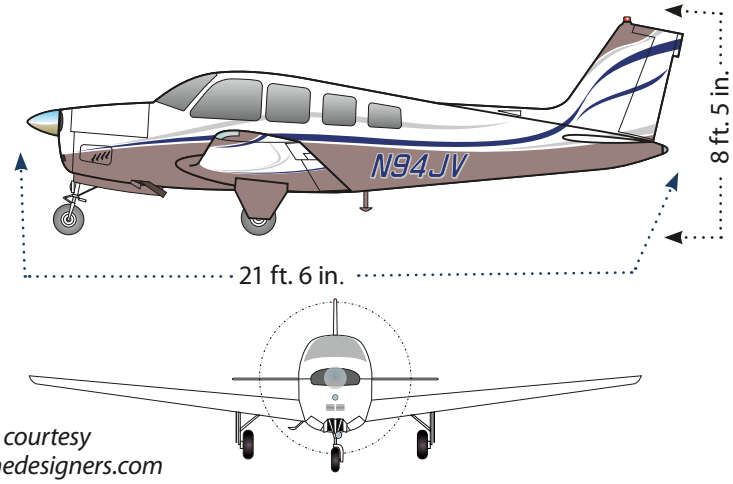
Beech didn't have a truly comparable airplane. The V-tail, S35 Bonanza, introduced in 1964, received a 19-inch cabin stretch that permitted the installation of a fifth and sixth seat. These were called "family" seats, and they really weren't suitable for adults. The company kept working on a true six-place airplane.

For the 1968 model year, Beech introduced a stretched version of the Bonanza, with six seats, a conventional tail like that on the eight-year-old Debonair (redubbed 33 Bonanza that same year) and an aft set of doors. Base price of

That's one of several A36 Bonanzas for sale by Carolina Aircraft Sales in the lead photo. The company says demand for well-cared-for and well-modded models is high.

BEECHCRAFT BONANZA 36 SERIES



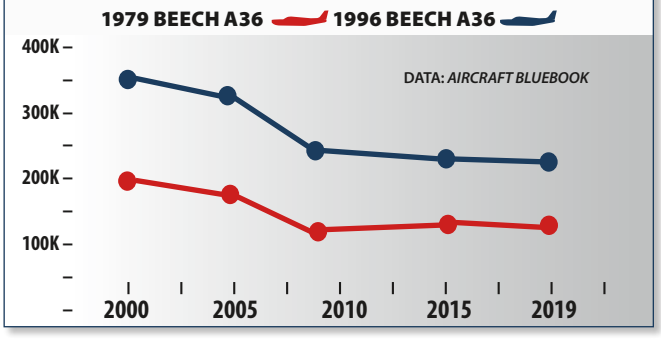


drawings courtesy
www.schemedesigners.com

BEECHCRAFT BONANZA 36-SERIES SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1968 BONANZA 36	285-HP CONTINENTAL IO-520-B	1700	$30,000	50	1620 LBS	170 KTS	±$90,000
1979 BONANZA A36	285-HP CONTINENTAL IO-520-BB	1700	$30,000	74	1405 LBS	168 KTS	±$145,000
1979 BONANZA A36TC	300-HP CONTINENTAL TSIO-520-UB	1600	$35,000	74	1381 LBS	190 KTS	±$140,000
1982 BONANZA A36	285-HP CONTINENTAL IO-520-BB	1700	$30,000	74	1405 LBS	168 KTS	±$165,000
1982 BONANZA B36TC	300-HP CONTINENTAL TSIO-520-UB	1600	$35,000	102	1512 LBS	190 KTS	±$175,000
1996 BONANZA A36	300-HP CONTINENTAL IO-550-B	1700	$33,000	74	1384 LBS	168 KTS	± $260,000
2002 BONANZA B36TC	300-HP CONTINENTAL TSIO-520-UB	1600	$35,000	102	1512 LBS	190 KTS	±$350,000
2006-08 BONANZA G36	300-HP CONTINENTAL IO-550-B	1700	$33,000	74	1300 LBS	168 KTS	±$430,000
2012-16 BONANZA G36	300-HP CONTINENTAL IO-550-B	1700	$33,000	74	1300 LBS	168 KTS	±$625,000

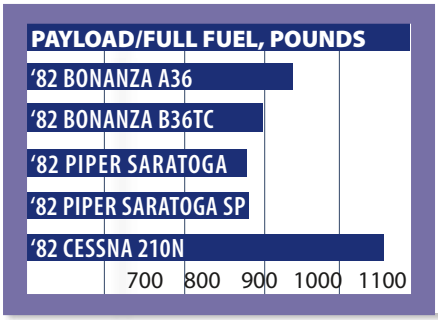
RESALE VALUES

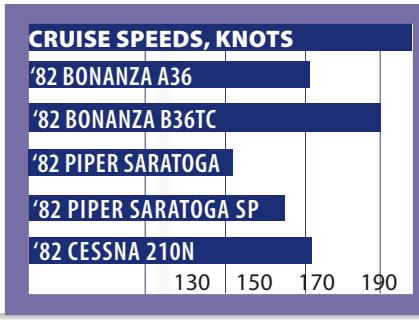


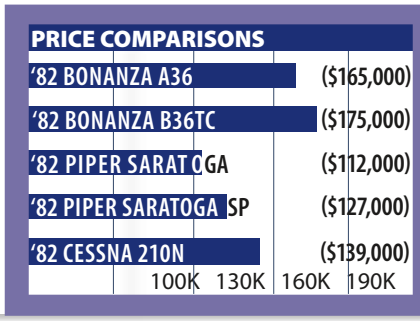
SELECT RECENT ADs

AD 2007-08-08	GEAR UPLOCK ROLLER INSPECTION, REPLACEMENT
AD 2000-08-08	INSPECTION OF V-BAND EXHAUST CLAMPS
AD 97-14-15	INSPECTION OF CABIN DOOR LOCKING HANDLE
AD 97-04-03	INSPECTION OF WING SPAR FOR CRACKING
AD 2019-21-08	INSPECTION FOR FRACTURED AILERON CONTROL CABLES

SELECT MODEL COMPARISONS







You'll find a variety of instrument panels and retrofit avionics across the Bonanza line. The top one here is a 1987 B36TC. Compare it to the A36 in the middle, which has the displaced radio stack. The bottom image is an all-electric 2016 Garmin G1000-equipped G36, still in production today.

this first 36 Bonanza was $40,650, which rose to an average of $47,050 equipped ($347,748 in 2020 dollars). That same airplane is now worth an average of $90,000.

The original 36 was equipped with a six-cylinder Continental IO-520-B engine producing 285 HP and swinging a two-blade prop. It had some limitations compared to the later models: Club seating was not yet available and the standard fuel capacity was only 50 gallons, with 80 optional.

The stretch was accomplished by adding 10 inches to the fuselage of a 33 Bonanza; the 36 was not an all-new airplane. The length was added in such a way that the cabin moved forward, relative to the wing. Empty weight rose only 31 pounds.

The 36 was aimed at the utility and charter market dominated by Cessna, as a good choice for air taxi and cargo hauling. This was in contrast to the V-tail Bonanza, which was sold as an upscale business airplane. The 36 Bonanza could even be flown with the rear doors removed. Of course, the original 36 could be outfitted with options like a more plush interior. In 1970, the A36 debuted with the popular club seating option. The marketing focus changed, positioning the A36 more as a larger version of the other Bonanzas rather than as a utility airplane. Many of the "luxury" options became standard equipment.

In 1973, the fuel system was changed. Standard capacity actually went down to only 44 gallons, with a 74-gallon extended range system available. We believe it's highly unlikely that there are any standard-capacity A36s in the fleet. An 80-gallon system was made standard in 1980.

As the years passed, the basic A36 remained largely unchanged, though in keeping with its real-world mission—a personal user's IFR platform—more and more equipment was made standard. By 1976, an autopilot was standard, along with what is now a basic IFR suite.

Responding to the call for turbocharging, Beech introduced the A36TC in 1979. With a 300-HP Continental TSIO-520-UB, equipped with a variable absolute pressure controller that automatically maintained manifold pressure during altitude and temperature changes, the airplane showed a lot of potential. Only 272 were sold in three years, as pilots complained about having only 74 gallons of fuel aboard when the engine wasn't exactly fuel efficient.

In 1982 Beech released the B36TC, which used the Baron 58 wing. It was longer, for better performance at altitude, and carried 102 gallons of avgas. The changes punched up range by 50 percent.

The biggest change to the normally aspirated airplane came in 1984, when a 300-HP Continental IO-550 replaced the IO-520. There was an all-new (and very well laid out) instrument panel. Gone was the trademark Bonanza "throwover" control wheel with its massive central column in favor of a pair of ordinary control yokes. With the introduction of this airplane, the base price had roughly quadrupled over the original 36: $160,700 ($397,818 in 2020 dollars) with a current aver-

Passengers appreciate the rear cabin doors for getting in and out. Most have club seating and a tray table, which gives the roomy cabin a big-airplane feel. The bottom photo is a cockpit shot of a G36.

age value of $155,000.

The bigger engine can be retrofitted to older aircraft; a popular mod, judging by our reader feedback. TBO on all of the engines that have gone into the "straight" (non-turbo) 36 Bonanzas is 1700 hours, with the estimated overhaul cost on the 520 currently at $30,000 or so and $33,000 for the 550. An owner opting to switch rather than overhaul not only gets the extra power (for not a lot more fuel burn), but better service reliability as well.

The current G36 (G for Garmin 1000 glass panel) Bonanzas are the only Beech singles still in production; the last F33As were built in 1994.

PERFORMANCE AND HANDLING

This is why pilots love Bonanzas. The handling for its intended mission is just about as good as it gets, although the 36 is regarded as more ponderous than the sports-car-like V-tail 35. This is due mostly to the stretched fuselage, although that has its advantages over the 35 when it comes to weight and balance.

The somewhat higher control forces are also a safety feature in that they translate directly to rock-solid stability—desirable in an IFR platform. An airplane with relatively high stick-force-per-G control forces is less likely to depart into a spiral if the pilot has to divert attention for a moment or two from the task of keeping the airplane upright and on course. That's very important in slick, fast singles, as loss of control in IMC causes a significant number of accidents.

Landing is much easier than in some airplanes, although at extreme forward CG loadings (common when flying solo), it requires some determination to raise the nose in the flare and make a smooth landing. Use the electric pitch trim. Still, unlike earlier research we did on the airplane's accident record, we were impressed to find few runway loss of control incidents on landing. But keep your guard up—too much speed on touchdown can be a setup for an overrun or loss of control on rollout.

One characteristic of the classic V-tail that is blessedly reduced in the 36 models is the notorious tendency to Dutch roll in turbulence. The extra length makes for a more comfortable ride and many straight-tail Bonanzas have a yaw damper system, which makes it even more steady.

In keeping with its mission as a serious cross-country machine, performance is respectable. Cruise for the normally aspirated 36 and A36 is about 165 knots, with a 1000 FPM-plus initial climb rate. The A36TC and B36TC will keep up with a Mooney 231 and Cessna T210N, running in the 170- to 180-knot range in the middle altitudes. Once over 20,000 feet, the longer wing of the B36TC shows itself, making the airplane a few knots faster than the A36TC, with cruise speeds in the area of 190 knots. That's not bad, but there's a price to pay.

Fuel burn for the turbos is high, at least 17-18 GPH, to keep head temps under control.

CABIN AND PAYLOAD

The 36 has excellent visibility and is quite comfortable, although head-

A36 BONANZA ACCIDENTS: OTHER

In looking at the 100 most recent Beech A36 Bonanza accidents we came away impressed by the low number of runway loss of control (RLOC) events—two; landing gear mechanical issues—two; and general landing-related mishaps—six. The good manners of the long Bonanza around a runway meant we didn't see any of the things we're used to seeing with other airplanes such as botched landings where the pilot got sideways, went around and hit something or stuck a wing in the ground trying to deal with a crosswind.

On the bad news side of the equation, while the engine/mechanical count of 22 was not out of line, at least a quarter of the events involved maintenance malpractice. Not torquing through-bolts correctly after cylinder replacement destroyed three engines and reusing what turned out to be a corroded exhaust valve spring from a cylinder that was lying around led to a fatigue failure of the spring and an airplane sliding to a stop in the dirt.

We think that the rate of fuel-related engine stoppages—17—is high and that there may be an issue with pilots understanding the fuel system. Fewer than half of the power losses were due to fuel exhaustion; the rest were pilots running a tank dry and not getting a restart after changing tanks.

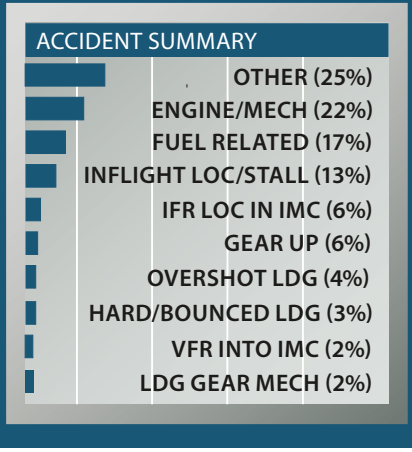
In at least some of those accidents, it appeared to us that the pilot "riched-out" the engine by turning on the aux fuel pump. That may have been because the pilot didn't get a good checkout in the specifics of the Bonanza fuel system and how its two fuel pumps work. If the engine-driven fuel pump is working and the pilot turns on the aux pump, the engine isn't going to run unless the pilot either leans the mixture or shuts off the aux pump.

An A36 is a slippery, high-performance machine, yet there were fewer than 10 spiral-dive type inflight loss of control accidents, a rate consistent with good handling and good pilot checkouts, we think. Nevertheless, two pilots new to the type and the avionics suite, with checkouts in VFR, lost control in their first IFR flights in IMC.

Of the 13 VFR loss of control accidents, nine involved the pilot stalling the airplane. Two were on approach while dealing with a problem such as an open door. The rest were on climbout shortly after takeoff due to such things as short fields, downwind, heavy and/or into a thunderstorm.

Two pilots died in otherwise survivable accidents because of head injuries. One didn't wear his shoulder harness; the other hadn't replaced a badly worn shoulder harness and it broke.

An A36 flies just fine with the cabin door or emergency exit window open. Not all pilots are aware of that fact. Some get in trouble trying to deal with the side issue rather than flying the airplane. A pilot who used paper towels to stuff a gap under his emergency exit window had the window pop open after takeoff. Thinking the autopilot was on as he wrestled with the window, he noticed his mistake when he saw a windshield full of ground. He pulled out successfully but then realized that he was about to hit power lines. Closing the throttle, he put the airplane into a field under them. He survived.



room and legroom is cramped for taller pilots and passengers. With four aboard, it's a luxury liner, but adding a fifth and sixth person makes things tight. There is a noticeable shortage of baggage space. Some room aft of the third row of seats (watch that CG envelope) was created with the 1979 model. Before that, the only place to stow things was the modest slot between the front seats and the rear-facing center row. There is not enough room to fit six people and six bags on board, a problem for a family that has kids and needs space for stuff.

Up front, the panel is generally well organized, although at the time the earlier 36 Bonanzas were made, Beech was still using the "backward" or "airline" positioning of the gear and flap switches with gear on the right and flaps on the left. It wasn't right or wrong, but just different. But it has led to many inadvertent gear retractions. We do this: When clearing the runway and cleaning up the airplane, don't touch the handle until you verify (verbally call it) it's the flaps you're about to raise. Later models have the switches placed as they are in other airplanes.

When loading the 36, figure on about 950 pounds in the cabin with full fuel in an A36, but watch the aft CG limit when carrying passengers. The A36TC is not a great load hauler; full fuel cabin load is 700-800 pounds. With six 170-pounders in the cabin, each with 20 pounds of luggage, it is not possible to put any fuel in the tanks and be under gross weight.

The B36TC had a higher empty weight than the A36TC, but gross weight went up by 200 pounds, a net improvement of about one 170-pound passenger. Plan on being able to carry 900 pounds in the cabin with full fuel.

CRASHWORTHINESS

Beech paid attention to crashworthiness and survivability, providing a strong "keel" arrangement from the aft end of the cabin to the nose. It's tied into a sturdy rollover structure that provides anchor points for shoulder harnesses for all occupants (four-point style for the front seats). There are openable side windows that function as emergency exits.

Garmin has a Bonanza STC for the GFC 600 autopilot, which is a flawless performer based on our evaluations.

There is no separate door or exit for the pilot. The fuel tanks are in front of the main spar, which lessens their protection in a crash and means that the center of gravity moves aft as fuel is burned.

The gear is massive. It's the same landing gear used for the Baron, where it has to support far more weight. The military T-34 trainer is basically a Bonanza, and as a result the gear had to be subjected to severe drop tests to satisfy the Pentagon. All that structure underneath the cabin also helps to absorb impact forces in a crash.

Another nice thing about the gear is that it's electromechanical and, if correctly maintained, has proven reliable. Emergency extension is through a simple hand crank located behind the front seats.

The 36 Bonanza also has a simple feature lacking in many aircraft: an easy-to-open "barn door" cowl, making preflight of the engine easy. This is really a safety feature, in our opinion. A popular mod is seatbelt airbags from AmSafe.

The 36 Bonanzas have a much longer CG range than the Model 35 series, although not as long as its competitor, the Cessna 210. Both fore and especially aft loading have to be carefully watched. A pilot flying solo with a full fuel load might have difficulty getting the CG aft of the forward limit. Trying to carry six passengers (reduced fuel is necessary) and any baggage aft of the rear seats may not be possible.

MODS AND CLUBS

Unlike the V-tail, the 36 Bonanzas (G36, for the Garmin G1000 integrated avionics) being built today are very similar to the first ones off the line: The biggest difference is the engine. As a result, there aren't quite as many mods as for the smaller airplane, though the list is still a healthy one. Too many to list, but here are a few popular ones.

As noted above, upgrading the IO-520 to the IO-550 is a popular option when it comes time to overhaul. The STC is available from a wide variety of sources. We have been particularly impressed with Tornado Alley Turbo's (www.taturbo.com) turbonormalization mod for the A36 that adds 400 pounds to the gross weight and makes the airplane capable of carrying four people 1000 miles at 200 knots.

Owners of two-blade props can

D'Shannon Aviation has popular and worthy mods for the 36-series Bonanza (and others), including extended-range tanks, top, and the 300-HP IO-550B engine conversion and baffling kit, middle. AmSafe makes airbag seatbelts, bottom.

upgrade to the three-blade airscrew from Hartzell at (www.hartzellprop.com). Also available are various speed mods and even vortex generators.

But hang around a Bonanza hangar and you'll hear the name D'Shannon Aviation. Its Raw Power engine conversion kits gives the airplane a serious shot in the arm. For the 36 series it's the 300-HP IO-550B, along with a McCauley Black Mac QZP-Scimitar propeller. The company also owns gross weight increase (GWI) STCs to bring the 36-series airplanes to 3850 pounds. All 1983 and previous models need to have the IO-550 STC and baffle cooling kit to qualify for the 3850-pound GWI. All 1984 and later A36 and G36 models don't need any upgrades for the GWI. D'Shannon's tip fuel tanks increase the gross to 4010. The company also has a high-performance exhaust kit for IO-550, IO-520 and IO-470N Bonanzas. There are also gap seals, vortex generators and new instrument panels. Visit www.d-shannon-aviation.com for a wealth of available mods and their performance gains.

Arizona-based AmSafe has STCs for seatbelt airbag systems for the Bonanza and you can find more information at www.amsafe.com. We looked at them in the June 2017 *Aviation Consumer*.

Approach Aviation (www.approachaviation.com) markets its SmartSpace baggage conversions for pre-1979 airplanes. It gives a much-needed eight cubic feet of baggage area behind the rear seats, with a 70-pound capacity, while retaining the rear hat shelf. Installation is reported to take only a day.

The best source of current information about mods is the American Bonanza Society. It offers service clinics, training clinics, fly-ins and a good magazine. The ABS is located in Wichita, Kansas (where else?). Find them at www.bonanza.org. In our opinion, we would not own a Bonanza without being a member of the ABS, and neither should you.

MARKET REALITIES

Scanning the current used market for the 36-series Bonanza, we found prices all over the place depending on mods—especially engine mods. Our go-to starting point reference, *Aircraft Bluebook*, says a 1994 A36, as one example, might retail for around $245,000. Backstopping that with the popular used aircraft website www.controller.com, we found that $300,000-plus asking prices are more realistic in the current market. Ones with the latest and greatest retrofit avionics, plus posh interior and nice paint, fetch even more money.

We found a good number of turbine Bonanzas on the market. These are the ones modified (by Tradewind Turbine Conversions) with the 450-HP Rolls-Royce Allison jet prop engine. We found a 1994 model with 2300 hours total time and 1795 hours (since new) on the engine priced at $500,000. Another with 143 hours since a hot section was priced over $600,000.

The latest Bonanza from Textron Aviation is the G36 and you'll pay dearly for a new one and even an earlier one. For example, a 2007 60th Anniversary Edition G36 with 1100 hours total time (airframe and engine), WAAS G1000 avionics, no damage, factory oxygen, ADS-B Out and a Tornado Alley turbonormalized mod is priced at $519,000.

That's Ralph Scargall's 1977 A36 with 20-gallon tip tanks and the IO-550 engine mod, which boosts the gross weight to 4000 pounds.

No matter which Bonanza suits you, do a thorough prepurchase evaluation and pay particular attention to the performance of the autopilot, especially earlier King KFC150/200 and Century-equipped models. Look for pitch oscillations and pay close attention to approach coupling. The autopilot is an important system in a Bonanza and maintenance to these older systems can be pricey and time consuming. Garmin recently earned an STC for its GFC 600 retrofit autopilot. We flew it last year in the company's A36 flight test airplane and it flew the airplane like it was on rails. But you'll pay a hefty price for such performance and integration. For the right Bonanza we think it's worth it and a better long-term solution than paying to maintain an old King or Century system.

OWNER COMMENTS

I have a 1988 B36TC and I think it fits the high-performance piston single spot well. I live at 8000 feet in Colorado and often cross the mountains at 13,500 or 14,500 feet, or above, so the turbo engine is useful. It will climb 1000 FPM, even in the teens, and the ceiling is 24,000 feet. Cruise is 170 knots true at a modest power of 28 inches and 2300 RPM at 18 GPH, at 11,500 feet. More power, up to 31 inches at 2400 RPM, gives more speed and probably 200 knots true at 20,000 feet.

Pros: interior room and a feel of quality overall. Holds 108 gallons fuel, so range is longer than I can sit. Nice handling in cruise, stronger than some planes, rated utility category.

Cons: the Continental engine, problems with exhaust valves mainly—once had zero compression since the valve face was missing a pie-shaped piece, and had a cracked case.

Two points to know on the B36TC: If not properly rigged and closed, the door can pop open just at liftoff. No problem, but the noise is like a firecracker and can scare the pilot into doing something dumb. Do it on purpose on the initial checkout and learn.

It comes new with six seats. If you don't want two people to have to ride backward, you can turn the middle seats around to face forward. It is easy if you read the pilot manual on how to do it. I removed my rear seats and use that area for baggage room.

Bill Greenwood
via email

I bought a 1977 A36 (N214RS) this last spring after owning a V35A for a number of years. My new airplane has D'Shannon 20-gallon tip tanks, an IO-550 engine upgrade and other mods that allow a gross weight increase to 4000 pounds.

I can highly recommend the American Bonanza Society to other

The Aviation Consumer

Used Bonanza

(continued from page 31)

Bonanza/Baron owners. The ABS is an extremely valuable source of information for everything Bonanza.

Ralph Scargall
Santa Fe, New Mexico

We acquired our A36 after selling our previous bird, an A35 Bonanza, due to our family having outgrown it. Both aircraft are from the same lineage, and because of that they share the same wonderful flying qualities for which the Bonanza is so well known. But, there is an extra 1000 pounds on the wing in the 36 and you feel it in the controls. In short, flying the A36 is like flying a truck when compared to the A35.

While the controls are heavier, they aren't objectionable, and the extra weight also makes for a much more stable platform. I found that to be the only issue in transitioning from our old Bo.

We routinely true out at 155-160 knots at 10,000 to 11,000 feet. Fuel burn with a stock IO-520 engine at our normal cruise of 20 inches and 2300 RPM averages about 12 GPH. We installed GAMIjectors, and that reduced cruise fuel flow to about 10.5 GPH. Speaking of GAMIjectors, that, in my opinion, is the single best mod any Bonanza owner can do to their aircraft.

The airplanes are solid, reliable machines. For family travel they really have no competition; they are in a class by themselves. They're great to fly, have no nasty handling quirks and are super comfortable for long flights.

Chris Nichols
via email

The Bonanza's cowling halves open wide for easy access to the engine bay. That's not to say the turbocharged Continental isn't packed tightly. It is, but serviceability isn't that bad, either.

CESSNA CONQUEST

It's time to take a look at the used Cessna 425 Conquest market for the *Aviation Consumer* Used Aircraft Guide. We want to know what it's like to own these twin turboprops, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Conquest to appear in the magazine, send us any photographs (full-size, **high-resolution**) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on the Conquest by April 10, 2020, to:

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e-mail at:
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