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FIRST WORD

XM WEATHER: STILL A PROPRIETARY PROTOCOL

Subscription-based satellite broadcast weather data still beats ADS-B FIS-B data for tactically threading the needle through real weather. SiriusXM delivers more data, it works on the ground and has tighter image resolution. But when ADS-B got rolling, the budget-driven market generally favored subscription-free FIS-B, accepting its limitations rather than forking over \$1000-plus per year on an XM subscription. Still, that didn't stop recent letters and phone calls from readers complaining that Garmin's GDL69 SiriusXM weather system won't work with the popular ForeFlight tablet app, but it does with Garmin's own Pilot app.

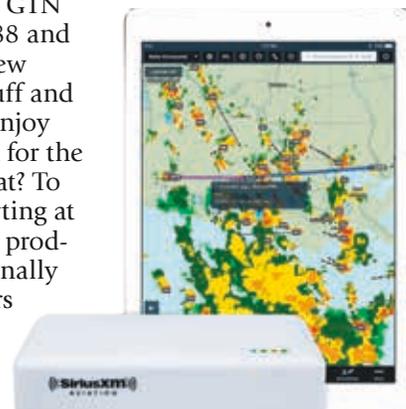
A selling point for Garmin's new capable Flight Stream 510 wireless system is its ability to stream data from various panel-mounted systems and LRUs. This includes two-way flightplan data from a GTN navigator, weather and traffic from the GDL88 and GDL39 ADS-B systems and even Garmin's new wireless ADS-B transponders. Got all that stuff and a ForeFlight Mobile subscription and you'll enjoy crossbrand compatibility at its finest—except for the missing XM weather data. What's up with that? To find out, I started asking some questions starting at the source with Bill Stone, Garmin's aviation product manager, and asked if Garmin is intentionally maintaining a closed interface as some buyers suggest. You know, sort of like Apple.

"That's absolute horse pucky. Going back to early products, including the first-gen GNS navigators, we realized that it's in Garmin's best interest to interface with as many products as possible. That comes at a sizable expense," he said. Having been involved in a whole lot of those early retrofits, I can attest that Garmin did play well with other third-party autopilots, EFIS, traffic, weather and terrain interfaces. Stone explained why the XM interface (through the GDL69-series LRU) is different, pointing out that many trickle-down standardized RTCA and other interfaces originate in the transport-category market. Since the XM interface isn't a standardized one (the transport market hasn't adopted wired XM interfaces on a large scale), Garmin and others—including HeadsUp Technologies, with its XMD76 receiver—developed their own interfaces. "Since there is no public standard in place, XM is a proprietary interface," Stone said. All right, but why not open the interface?

Garmin maintains that sharing a proprietary interface with third-party vendors takes consumer demand, engineering effort, time and ultimately, money. "If a third party (in this case, app developers) wants to display our product, we have standards for usability, integrity and the overall user experience. We have to protect our brand and reputation," Stone said when asked about sharing the protocol. Let's acknowledge the obvious. While Garmin sets a very high standard with its UI, there's a business side to sharing protocols, and while Garmin and ForeFlight have partnered on a sizable portion of the Flight Stream wireless interface, they remain competitors in a small industry.

ForeFlight's Tyson Weihs acknowledged that while this partnership has helped sell a boatload of Garmin products and ForeFlight subscriptions, it's unrealistic to expect a totally open architecture for all products, with Garmin's GDL69 closed protocol as an example. ForeFlight did precisely what I would expect and found a different partner for interfacing SXM weather on its app, working directly with SiriusXM Aviation with an interface that includes the SXAR-1 portable SXM receiver, pictured above, plus new subscription and hardware pricing. Introduced a couple of years ago, the SXAR-1 only worked with WSI's PilotBrief app, but I suspect the ForeFlight interface will give it a new lease on life. I'm currently evaluating the interface and we'll have a full report on it in our next issue.

Garmin left satellite weather out of its Bluetooth-enabled aera 660 portable GPS, but hinted that a new SXM receiver is imminent. New receivers might take satellite weather off life support, but in a market dominated by subscription-free ADS-B, cheaper fees and an open protocol are key to survival.—Larry Anglisano



CONTROL RIGGING SCARE

In his article about aircraft flight controls rigging (October 2016 issue of *Aviation Consumer*), Kim Santerre may not have emphasized strongly enough the danger of improper control cable tensions as it relates to aircraft damage. I once experienced rudder flutter that should have cost me the airplane, but somehow did not.

Years ago, I was flying a friend's P-51 Mustang and was flying low-level at roughly 400 knots (at the time there was no speed restriction below 10,000 feet) when the rudder flutter began. I flew vertical and reduced to idle power to slow the airplane down, where the flutter stopped at about 170 knots.

The violence of the flutter was unbelievable and destroyed nearly every instrument in the cockpit, leaving gauge needles lying at the bottom of their instruments. We tiptoed back to the airport in Van Nuys, California, for an immediate and uneventful landing because the airframe had a vibration that made me nervous.

Turns out the incident was caused by the aircraft being painted a few weeks earlier without having the rudder balanced before returning it to service. Since the rudder is fabric covered, proper balancing is extremely critical. During an inspection, the rudder cable tension was found to be low, but that could have been the result of the 20-second wildly violent flutter. I wouldn't expect a lesser airframe to survive. On this Mustang, the only airframe damage was popped rivets on the area ahead of the horizontal stabilizer and some stains on the pilot's parachute. Control cable tension and surface balancing matters!

Jeff Cannon
via email

A lot of airplanes rely on correct cable



tension as part of their flutter margin, although most of it is done by balancing the control surfaces. Lots of pilots (and mechanics) underestimate the importance of proper control cable tensions.

There are a number of different kinds of flutter, with divergence usually causing catastrophic failure very quickly.

XM WEATHER AND TFR DATA

During my summer flying experience, I encountered three incidents where TFRs reported via XM WX Aviation Weather were either missing or reported in error.

On my way to AirVenture at Oshkosh, Wisconsin, there were two TFRs near Jackson Hole, Wyoming, that were not displayed on my XM-equipped Garmin GPS696 system, but luckily I was alerted by ATC that I was about to enter TFR-restricted airspace. Returning from AirVenture, XM was showing a TFR over Sunriver, Oregon, but upon contacting ATC, I was informed that the TFR over Sunriver had been lifted. Then, while preflighting a month later, DUATS indicated there was no TFR west of Sunriver, but the XM system showed it as being hot.

I corresponded with XM WX Aviation Weather detailing my problem and suggested that more diligence should be taken in reporting TFRs. I received a timely reply, but was told that I should not rely upon XM Weather as a primary source of data.

My advice to fellow pilots is if you rely on satellite broadcast weather, do so at your own risk. For me, the data I receive from XM is critical, not just for entertainment.

Cheryl Cooney
via email

While we certainly rely on both XM broadcast and FIS-B ADS-B data, this reinforces that the information they provide really is for supplemental use because the data isn't precisely in real time.

FOREFLIGHT 8 UPGRADES

Having received the October 2016 issue of *Aviation Consumer*, I was interested in exploring the new mapping capabilities for my recently updated ForeFlight app subscription to version 8.1. In my app, when I got to the Maps tab the Aeronautical tab is grayed out, or inaccessible.

The first time I touched that tab a pop-up appeared that said I had to purchase a separate subscription. You neglected to mention, among the platitudes describing the new aeronautical layer, that this feature requires yet another separate subscription to ForeFlight. I subscribe to the ForeFlight Pro version and that is expensive enough. Please inform your readers that this new feature is not without an additional cost over and above the regular ForeFlight subscription price.

James Torley
Colorado Springs, Colorado

We did mention that a fresh subscription is required and that ForeFlight issues a credit for the time remaining on the old subscription. However, we didn't make it clear that the aeronautical mapping feature is bundled into the Basic Plus or Pro Plus subscription packages.

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CHECKLIST

-  Multifunction ADS-B transponders simplify installation effort.
-  Wireless capability means you can skip a panel display and play traffic and weather on a tablet.
-  First-gen models require a certified external WAAS input and don't have integral ADS-B In.

ADS-B Transponders: L-3, Garmin Top Picks

But there are scalable, cheaper solutions. Appareo's new Stratus ESGi ADS-B In/Out system has a price and installation that fits the market's lower end.

by Larry Anglisano

With roughly three years until the ADS-B mandate hits, a new breed of multifunction transponders is making equipping easier than ever. But with a market flooded with choices (including lesser equipped first-generation models), the buying decision can be overwhelming.

Moreover, tablet app compatibility and cockpit wireless networking add to the delirium. In this article, we answer your call for an overview of ADS-B-compliant transponders and tips for selecting the right one for your mission and avionics suite.

LOGICAL TREND

It's easy to see why shops are reporting a surge in ADS-B transponder installations and a sharp decline in remote ADS-B systems, known as Universal Access Transceivers or UATs. Transponders are winning the race because of new self-contained features and overall simplicity.

Second-gen models fit a wide variety of applications and their curtailed installation effort reduces downtime and labor costs. Face it, the major

teardown that's required to install a remote ADS-B box and associated wiring can cost as much if not more than the equipment, with some exceptions.

Got a lesser-equipped aircraft without a WAAS GPS or a panel display? Those worries are gone. The latest ADS-B transponders are WAAS equipped (or have options for such), plus they have ADS-B In receivers and have wireless capability for displaying weather and traffic on a tablet. But don't dive in without planning.

The first step is assessing your mission and the existing avionics in the aircraft. A brief review of the equipment requirements is in order, and you've heard it all before. The rules haven't changed. If you plan to fly above 18,000 feet—where 1090ES extended squitter is a requirement—you're already qualified for an ADS-B transponder because 978 MHz (or UAT) Out solutions aren't an option.

If the aircraft has an aging Mode A/C transponder, the decision to upgrade to an ADS-B model is made even easier, since you'll still need reliable Mode A and Mode C functionality, in addition to ADS-B Out.

But, if you've recently upgraded to a modern non-ADS-B transponder, the decision is more difficult and it could make sense to move forward with a UAT system, unless your shop is willing to offer a trade-in allowance for the existing transponder. You could, of course, retain it as a secondary backup—a common scenario. One owner told us that his more discrete non-ADS-B secondary unit is handy for VFR flights when he doesn't want his whereabouts to appear on internet tracking sites.

Although we're seeing more cross-brand compatibility thanks to more liberal architectures, mixing brands could sell short an otherwise capable interface. For example, if you're accustomed to automatic mode and flight timer operation with your current Garmin transponder/navigator setup, installing a non-Garmin ADS-B transponder will likely kill that capability. Consider the possibility that future software upgrades can limit functionality.

Let's scan the market by manufacturer. We've combined some manufacturers, since rebranding is common.

APPAREO

Yes, this is the same company that makes the popular Stratus portable ADS-B receivers sold by Sporty's. It

Dual touch displays make the L-3 NGT-9000 transponder, top, a small but capable weather and traffic display, while an external Wi-Fi adapter sends the data to a handful of tablet apps.

That's the Appareo ESGi package to the right. It includes the 1090ES Stratus ESG transponder, plus the remote 2i receiver, which has Wi-Fi for interfacing with ForeFlight.

earned certification for its Stratus ESG ADS-B transponder this summer. When Appareo began developing the ESG, it predicted (based on FAA stats) that NextGen equipage trends would favor 1090ES transponder solutions, especially considering an easier installation and an aging fleet of Mode A/C transponders. But there was another strategy.

From the beginning, Appareo engineers were sharply focused on federated avionics interfaces, which are radio stacks that might have a variety of avionics brands, both old and new. It also focused on the price-sensitive, lower end of the retrofit market. Many of these targeted buyers likely have Stratus portables, which could boost brand recognition.

The 1090ES-based ESG transponder doesn't have an internal ADS-B receiver, but it does have internal WAAS GPS, eliminating the need for an external GPS input. Also recognizing that buyers would want a seamless ADS-B In solution, it designed the transponder to interface with a new hard-wired, remote version of the Stratus portable, called the 2i.

Unlike the models in the original Stratus line, the 2i isn't portable and requires a connection to the electrical bus. The benefit is a cleaner installation—no wires strung across the glareshield, and no windshield mounts to deal with. Mount it behind the panel or anyplace that's convenient. Connecting the 2i (and also the portable 2S, with an optional interface wiring kit) with the ESG provides auxiliary power, GPS signal and also the ADS-B reception from external antennas.

As with the portable Stratus receivers, the 2i displays traffic, weather and AHARS on the ForeFlight app through a Wi-Fi connection.

Of course, if you want to move the Stratus portable receiver between aircraft, you'll want the 2S. If not, we favor the 2i's cleaner interface.

Appareo has two packages: The standalone ESG transponder with



installation kit is \$2995, and the ESGi (with the 2i receiver) is \$3495. You won't lose any features if you go with 2i over the 2S—just portability. Contact www.appareo.com.

AVIDYNE

Avidyne's full-stack retrofit avionics line includes the AXP340 transponder, which can be connected with the company's IFD550/540/440 navigators for a WAAS position source. It's also approved for use with Garmin's GNS430W/530W WAAS navigators, plus the newer GTN navigators. The AXP340 has no built-in ADS-B receiver; you have to buy the company's \$2500 MLB100 receiver for that, which will display weather and traffic on the IFD navigators. It will also display on a wide variety of tablet apps, using the IFD's built-in wireless transceiver.

The AXP340 is designed as a slide-in replacement for the Mode A and

Mode C functions of the King KT76A transponder, while also using the King's mounting rack.

We wish the AXP340 was compatible with Garmin's GTX327 transponder wiring—which was standard in Avidyne Entegra-equipped Cirrus models. With many of these Cirrus owners upgrading from the original equipment GNS430W navigators to the slide-in IFD440, it sure would be convenient to also slide in the AXP340 in place of a GTX327, but that requires a new mounting tray and a wiring change—essentially a new installation.

Avidyne has a remote version

The Avidyne AXP340 transponder and IFD440 navigator, shown below, is a complete ADS-B Out solution, but requires a separate ADS-B In receiver.



L-3 VERSUS GARMIN BY THE NUMBERS



At first blush, the buying decision for two flagship ADS-B transponders—L-3's NGT-9000 and Garmin's GTX345—seems straightforward. One has a built-in display and the other doesn't, right? Well, yeah, but there's more to it than that. Go knee-deep into the interface potential as we did for this article and you'll be reaching for your preferred painkiller. Here's one common upgrade scenario that requires some number crunching and ultimately, some tough decision making.

As an example, consider a simple application like a Piper Archer (although it could just as well be a Cessna, Beech or other non-pressurized single or twin). The avionics in the aircraft are aging, but it has a functional Garmin GNS430W and a King transponder that's been hiccupping. Since the WAAS receiver in the GNS430W is an approved ADS-B position source, your plan is to simplify the installation and use it for input to the ADS-B transponder.

The entry-level version of the L-3 NGT-9000 has a current list price of \$5490, which includes the installation kit, the PIM-9000 Wi-Fi module and an external GPS/WAAS antenna. L-3 told us the NGT-9000 can only use its own internal WAAS GPS, so using the GNS430W for a position source is off limits. But, it's possible to split the WAAS signal from the existing Garmin WAAS antenna, eliminating the need to install a dedicated WAAS antenna. While the end equipment cost might be a wash after subtracting the \$240 WAAS antenna and adding a signal splitter, you'll save some labor by avoiding a GPS antenna installation.

The NGT-9000 kit doesn't include a required L-Band transponder antenna, which also serves double duty for ADS-B reception. A new Comant CI-105 fiberglass L-Band

antenna with new cabling and connectors is roughly \$200, boosting the total equipment cost to roughly \$5700.

Based on consultation with two experienced shops, a typical, no-surprises installation in a basic airframe should take roughly 15 hours, including testing, certification and sign-off paperwork. At the average \$110 per-hour shop rate, that's \$1650, for a total installed price of \$7350, without dealer discounts or manufacturer's promotions.

The list price of Garmin's GTX345 without internal WAAS/GPS receiver is \$4995. Add an L-Band blade antenna for a total equipment cost of around \$5200. While the shop won't have to install a WAAS antenna, it will have to access the GNS430W wiring to input the WAAS GPS signal. But unlike the NGT-9000, which has an external wired Wi-Fi dongle, the GTX345 has built-in Bluetooth, saving a couple hours of total labor. We'll say 13 hours, for a fly-away price of \$6630.

While this \$720 difference isn't insignificant, it's not the only consideration. Think in terms of ADS-B weather and traffic presentation. With the NGT-9000, data is limited to a relatively small screen (it won't play on the GNS430W), although with Wi-Fi, you can also play the data on a tablet. The GTX345 has no display at all, so you'll be streaming the data to Garmin's Pilot app or to ForeFlight. You can also overlay the data on the Garmin GNSW screen, but you'll only see traffic targets in TIS-A symbology, while FIS-B weather is limited to NEXRAD, METARs and TAFs.

If you have a late-model Garmin portable GPS, you can play the data on it. That, along with the price savings, could be convincing enough to go with the Garmin.

of the AXP340 called the AXP322. Priced at \$5450, the 1090ES AXP322 is controlled through the IFD navigators—a feature that does target Entegra/Garmin-equipped Cirrus models—because eliminating the transponder from the radio stack frees up space for the larger IFD550/540. Visit www.avidyne.com.

BENDIXKING/TRIG/ FREEFLIGHT

We grouped these brands together because there's lots of rebranding going on. First BendixKing, which has advanced the KT74 1090ES ADS-B transponder interface to include compatibility with Garmin WAAS navigators (it doesn't have internal GPS or an ADS-B In receiver), plus it connects with the BendixKing

KSN770 retrofit navigator for use as an approved position source.

For ADS-B In, BendixKing sells the KGX series UAT transceivers, which are repurposed FreeFlight RANGR systems. As we go to press, the BendixKing KSN770 navigator still won't display ADS-B weather and traffic, although BendixKing's Roger Dykeman said the company is still working through the FAA approval process.

It is Trig Avionics that designed and builds the KT74 for BendixKing, and still offers the rack-mounted TT31 and two-piece TT22/21 1090ES transponders. FreeFlight Systems sells the Trig TT22 as the RANGR FDL 1090 TX.

The BendixKing KT74 and Trig TT31 were designed as slide-in replacements for the King KT76A, KT76C and KT78 transponders, but

all require the additional wiring for external GPS input. While we've always been fond of Trig's quality and design, we think its current line of first-generation transponders are at a disadvantage without internal GPS, especially with newer-generation models from Garmin, Appareo and L-3, which substantially streamline the interface.

Instead, Trig offers the NexNav remote WAAS GPS receiver, plus external GPS antenna, which is a mandate compliant system priced at \$1100. It weighs less than 1 pound and can be mounted pretty much anywhere in the airframe.

FreeFlight has the \$3995 model 1201 dedicated external WAAS/GPS sensor for use with the RANGR. The sensor is certified to TSO-C145A as

an approved ADS-B position source and connects with the transponder via RS-232. The receiver comes with an antenna and can work in other applications needing WAAS. Visit www.bendixking.com, www.freeflightsystems.com and www.trig-avionics.com.

GARMIN

Garmin's latest GTX transponder product line may seem confusing at first, but that's actually a good thing because there are a wide variety of configurations to choose from, depending on desired functions.

Worth mentioning is that Garmin's first ADS-B Out transponder—the GTX330ES—has been discontinued. It was replaced by the \$2995 GTX335, an entry-level ADS-B Out model with optional internal WAAS receiver (\$3795), not including GPS antenna. Garmin says it will continue to support the GTX330ES and still performs "ES" upgrades to plain-vanilla GTX330 transponders for ADS-B Out. This is a factory modification with a flat-rate cost of \$1200.

Like the GTX330ES, the GTX335 doesn't have an ADS-B In receiver. You'll need to step up to the GTX345 for that—an upgrade we think makes sense for a lot of applications, especially for future growth.

Starting at \$4995, the GTX345 has a built-in Bluetooth receiver for displaying ADS-B weather and traffic on the aera 660/GPS696/796 portable navigators, Garmin's Pilot tablet app for Apple and Android devices, plus it works on ForeFlight Mobile. A version with internal WAAS GPS is available for \$5795, not including antenna, which is priced at \$350. These ADS-B transponders are also available in remote versions, for interfacing with the GTN750 retrofit navigator and with select G1000 systems

ADS-B TRANSPONDERS COMPARED			
MODEL	STARTING LIST PRICE	CONFIGURATION	COMMENTS
Appareo ESG	\$2995	1090ES Out, external In	Integral WAAS, \$3495 with Stratus ESGi wired ADS-B receiver (Wi-Fi connection with ForeFlight).
Avidyne AXP340	\$3995	1090ES Out	Partial plug-and-play with KT76A, compatible with Avidyne IFD, Garmin GNSW/GTN navigators.
BendixKing KT74	\$3500	1090ES Out	Partial plug-and-play with KT76A, compatible with BendixKing, Garmin and FreeFlight GPS.
FreeFlight RANGR FDL-1090-TX	\$5195	1090ES Out	Two-piece design compatible with FreeFlight 1201/1203C and Garmin WAAS navigators.
Garmin GTX345	\$5795	1090ES Out, dual band In	Integral WAAS, Bluetooth connectivity with Garmin Pilot for iOS and Android, ForeFlight, and select Garmin portable GPS. Version without internal WAAS is \$4995.
Garmin GTX335	\$3795	1090ES Out	No ADS-B In, available without WAAS for \$2995. Replaces the GTX330ES.
Garmin GTX345R	\$4995	1090ES Out, dual band In	Remote version, works with GTN750 navigator and select G1000 suites.
L-3 Lynx NGT-9000	\$5490	1090ES Out, dual band In	True multifunction transponder with color touch display. Available with diversity, with active TAS and with eTAWs terrain capability.
Trig TT22	\$2200	1090ES Out	Two-piece design with 2-inch compact control head. TT21 lower power for LSA applications.

when approved by the aircraft OEM.

The GTX345 with internal ADS-B In (these are dual-band receivers) interface with the GTN750/650. You get traffic and weather display, including Garmin's Trend Vector traffic mapping technology. You'll get basic traffic display (no ADS-B symbology), plus NEXRAD images, MET-ARs and TAFs on GNS530W/430W navigators. The transponders won't display on legacy (non-WAAS) GNS navigators. These are simply out of horsepower. Visit www.garmin.com.

L-3 NGT-9000

L-3 doesn't like to call the Lynx NGT-9000 a transponder, even though it is technically a Mode S Class A1/A1S transponder. Perhaps "multifunction ADS-B system" is a more accurate description. Regardless, the NGT-9000 was the first transponder of its kind with a built-in WAAS GPS receiver, dual-band

ADS-B receiver and 1090ES ADS-B output. What is unique about the NGT-9000 is its dual multifunction touchscreens for displaying ADS-B weather and traffic. It also has a Wi-Fi module for playing the data on ForeFlight, Wing X Pro, FlyQ EFB, SkyRadar, FltPlan Go and AvPlan EFB.

The NGT-9000, which originally had a starting price of around \$7000 (and nearly \$12,000 for flagship versions), initially seemed more appropriate for higher-end twins and turboprops. However, recent price reductions have made it a worthy player for the market's lower end, too. Shops tell us the NGT-9000 isn't as popular as Garmin's new GTX series models, but it has gained sizable traction due to the lower price.

The Lynx comes in several mod-

Scotland-based Trig avionics makes the KT74 transponder for BendixKing, lower left, and also the two-piece TT22. Tight on panel space? That's the TT22's miniature control head in the lower right.





Garmin's GTX345 and remote GTX345R transponders, shown in the photos at the lower left, connect with Bluetooth-equipped Garmin portable GPS units. That's the new aera 660 displaying TIS-B traffic in the top photo.



els, including the base NGT-9000, NGT-9000D (dual-antenna, diversity-enabled model) and the flagship NGT-9000D+, which adds an internal active TAS processor. L-3 sold off its SKY497 Skywatch traffic system, but TAS-equipped NGT-9000s can connect to existing Skywatch antennas for both TAS and ADS-B use.

The NGT-9000 fits in a standard 6-inch-wide radio stack and measures just under 2 inches high. Despite its multifunction status, it's packaged in a similar footprint as most other rack-mounted transponders. And there's the rub.

Given the limitations of a bezel that measures under 2 inches tall, the device may not be the best way to view traffic and weather data, although the system does have tablet computer connectivity with a Wi-Fi

module that L-3 is now including in its package price. Still, for panels that lack an MFD, we think the NGT-9000 offers plenty of utility. We also like the easy feature set and crisp color display.

The data is divided into left and right screens, which L-3 calls applications. You select each screen application using both drag and swipe actions, while basic screen position identifiers (hollow or empty circles) at the bottom of the screen show which page is active. Onscreen scroll bars navigate through lists or blocks of text, while slider bars are used for editing data and for increasing and decreasing numerical values. It's really a shallow feature set.

Since the NGT-9000 serves as a primary transponder, there is a dedicated transponder application that shares the left screen with traffic alerting. It contains transponder squawk code, IDENT-reply, pressure altitude readout, transponder mode control, plus a MSG key that flashes when a new message is received. The ON-GND indicator advises that the

transponder is operating in ground mode and isn't replying to all interrogations.

In addition to traffic and ADS-B weather, the NGT-9000 has TSO authorization for use as a Class B embedded terrain awareness system (eTAWs). The terrain option—for a whopping \$4000—is enabled through a field software upgrade.

Using both graphical and aural warnings, the color-coded terrain screen provides a surveillance range of 24 nautical miles and will alert when flight into terrain is imminent by automatically switching to the eTAWs screen when a terrain warning is issued. You'll also hear an aural warning when the system is connected to an audio panel. The eTAWs page shows land-based obstacles, plus the system provides alerting for negative climb rates. Visit www.l-3avionics.com

TOP PICKS

Clearly, there isn't a one-size-fits-all ADS-B solution and we'll stop short of saying a smart ADS-B transponder is the hands-down best option. We still think a remote UAT system will make sense for some and we'll scan that market in an upcoming article.

For all-in-one ADS-B transponders, we equally favor the L-3 NGT-9000 and Garmin's GTX345 for their rich feature sets and growth potential. But as complete as these systems are, what's missing is an integrated altitude encoder, so you might need to consider this added cost in your planning.

If price and an easy installation are the only considerations, we think the Stratus ESGi system is a near perfect fit for basic federated panels, but it only works with ForeFlight. Save \$500 by wiring in your existing Stratus portable receiver, plus collect the FAA's \$500 rebate (it's up and running) and you'll have the cheapest transponder-based ADS-B In/Out system available.

Mag Compass Upkeep: More Than Fluid Fills

You might save money by helping with time-consuming calibrations, but a new replacement makes better sense than attempting major bench repairs.

Staff report

Among the minimum equipment required for VFR and IFR flying, FAR 91.205 still lists the magnetic direction indicator as a must-have item. Don't confuse this with the gyroscopic (or equivalent) directional indicator. That's required for IFR, in addition to a compass.

Given the primitive nature of a magnetic compass, owners are often shocked at the impressive invoices it can generate when it fails. And compasses do fail. Ever have one that leaked its fluid down the front of the instrument panel? The idea is to address the health of a compass before it comes to that. Even calibration—which should be done regularly—can be a time-consuming project.

In this article, we'll address compass maintenance and replacement options, plus the procedure for calibrating one.

ROUTINE UPKEEP

Do you remember the last time your compass was checked for accuracy on a compass rose or with a calibrated site compass? Any changes in avionics (or even adding metallic objects to the glove box and around the panel) may affect the magnetic compass.

Maintenance work can also cause sizable amounts of compass error, resulting from the placement of magnetic metals (ferrous screws/bolts) near the compass. Even the routing of

The gasket peeking through the glass of the compass in the photo could offer a clue that the instrument hasn't been serviced in a while. Notice the absence of a required correction card.

wires under a cowl-mounted compass can cause magnetic interference, as can the installation and removal of equipment. Good shops include it in the final stages of an avionics upgrade, but you should ask if your installation includes a compass calibration.

As simple as a mag compass may seem, its maintenance is considered specialty work. According to FAR 65.81, any repair or alteration of instruments on certificated aircraft (a compass is one of those instruments) may only be performed by a certified instrument repairman. That also means if you calibrate one on your own, technically it should be supervised and signed off by an A&P.

More than one IA told us the only task they can legally perform on a compass is removing, replacing and calibrating it—no rebuilding. One

noted that even topping a compass off with fluid is off limits, although the fluid is a necessary part of maintaining the instrument's accuracy.

A partially drained compass will also contribute to the oxidation of the upper pivot bearing, which can make it stick or cause erratic readings. Some compasses are field-refillable, but save the Jack Daniel's for your own consumption.

Alcohol (hence the whiskey compass designation) was used at one time, but now kerosene or aliphatic naphtha is used. The correct fluid is MIL-C-5020A.

ALIGNMENT

Busy shops put compass alignment, often referred to as compass swings, in the same category as pitot/static system certification. Both tasks are equally disruptive to the schedule given the time-consuming process. But, it's a necessary job.

The specific requirements to swing a compass may come as a surprise and are outlined in AC 43.13-1B. The advisory circular says the instrument should be swung anytime inaccuracy is suspected (off more than 10 degrees), after any cockpit mod involving ferrous metal and whenever the compass has been subjected to shock, such as a hard landing or severe turbulence.

The compass needs to be checked if the aircraft has passed through a severe electrical storm, after a light-





a change is made to the electrical system.

Even storing the aircraft can require calibration. This includes changing its permanent position to a different geographical location that results in a major change in magnetic variation.

Some shops charge a higher hourly rate for compass swings because it can require

two technicians. It's worth asking if you can assist, but understand that experience is required to get it right the first time—which even the pros sometimes don't.

If you want to attempt it yourself, you can find an official compass rose. This is an interference-free painted area on the field for positioning the aircraft and making the adjustments. The rose is oriented to magnetic north, while cardinal points are normally painted 30 degrees apart.

The compass must be swung with the plane in a flight configuration, meaning a tailwheel airplane will need to be raised to a level flight attitude. The engine(s) should be running and all typical avionics and lighting used in flight turned on. That makes a big difference. Watch your compass swing to a new heading the next time you start or stop the engine and turn stuff on and off.

AC 43.13 recommends that the thorough procedure is done both with all electronics on—simulating basic flight condition—and with the avionics off. A compass card should be made to reflect both conditions.

Other than the sight compass, there really aren't specialty tools required, although you will need to make adjustments with a brass or other non-magnetic screwdriver, and often a narrow tip is required.

What you adjust are the compensating magnets in the compass that are designed to compensate for electrical and magnetic influences of the aircraft. (They affect deviation, as opposed to the magnetic influences of the earth, or variation.)

There are two screws on the face of the instrument (sometimes covered by a removable plate), which move the compensating magnets. The two screws are labeled N/S and E/W. Be sure to remove any material from the

glove box and surrounding areas.

Put the aircraft exactly on magnetic north and adjust the N/S compensator screw until the compass reads 0 degrees. Turn the aircraft and put it on east and adjust the E/W compensator until the compass reads 090 degrees. Continue by placing the aircraft on 180 degrees and with the N/S screw, remove half of the south heading correction. Obviously this will throw off the north correction, but the error will now be divided equally between the two headings. Last, go back to west and adjust the E/W screw to remove half of the west error.

Once the compass has been swung successfully, the results are recorded on a compass correction card, which is mounted next to the compass. Errors up to 10 degrees between the compass heading and a magnetic heading are acceptable. If the errors are greater than 10 degrees, there could be strong influences in the cockpit that the compensating magnets can't cope with, or you were sloppy during your lineup. Start the correction card with a west heading with and without the radios on. Work your way around the rose, making correction notes every 30 degrees.

REPAIR OR REPLACE?

These things don't last forever. The baking 200-degree temperatures on top of a glareshield mean you'll likely be faced with a repair or replacement. Generally, the main part that fails (ultimately leaking) is the rear rubber expansion/contraction diaphragm. Since the fluid in the compass needs room to expand and contract with temperature changes, a sealing membrane keeps the fluid inside. These simple devices aren't packed with components. Typically, it takes just four small screws to expose the diaphragm on the rear compass housing.

For the simplest of repairs, Aircraft Spruce and Specialty (www.aircraftspruce.com) sells a repair kit for the popular Airpath compass. For \$11.50, it comes with a diaphragm, fluid and a glass gasket. But it doesn't have a compensator, glass and other components that an instrument shop would use for a real overhaul. The kit availability makes one wonder about the strict rule about adding fluid being the domain of the certified instrument repairman.



A typical fluid diaphragm chamber and rubber diaphragm—responsible for leakage—is shown in the top photo. That's a Precision PAI-700 vertical card compass, middle, and a SIRS Navigator, bottom.

ning strike (this also may cause ferrous components in the structure to become magnetized) and whenever

COMPASS CALIBRATION 101



Clockwise from upper left: Professionals have a calibrated sight compass used specifically for compass adjustments. This makes it a two-person task; one manning the sight compass (to line up the aircraft) and the other operating the aircraft while making the adjustments to the compass, plus making note of compass error. Even with calibrated equipment, you still need to bring the aircraft to an interference-free area. Some airfields like Meriden Markham Airport in Connecticut have a designated compass rose.



Still, more than one shop told us it doesn't deal with bench repairs for compasses that need more than fluid top-offs, since it's usually more economical to purchase a new replacement. Julie Lowrance at Kansas-based Mid-Continent Instruments and Avionics pointed out that proper compass repairs utilize a pressure chamber for removing the air from the instrument's capsule as it's filled with fluid. That's something the average shop might not have. MCI's busy instrument division doesn't repair compasses, but instead offers new replacements, which range from \$100 to \$400, depending on the model.

We priced TSO's replacements from multiple sources and found that a common Airpath C2300 starts at around \$150—that's almost as much as one hour of bench labor. Prices will vary depending on the mounting. For example, an Airpath C2400—which has an overhead mounting configuration—is \$250.

We caution against ordering one and carrying it in to your shop without knowing exactly what's required. If the shop has to change the mount, it could substantially increase the labor effort. They also come in specific lighting voltages and in northern- and southern-hemisphere configurations.

MODERN REPLACEMENTS

If faced with a replacement and you want to abandon a whiskey compass for something more modern, it won't be an inexpensive upgrade. One alternative is the SIRS Navigator, which is made in the U.K., but has TSO certification. The Navigator is a traditional design, but has modern features including blue LED backlighting and a fluorescent yellow legend.

We like its silicon damping design that all but eliminates the annoying bobbling found in other wet compasses. We don't like the specialized adjustment tool that's required to calibrate it.

The Navigator—which starts at around \$260—comes in panel-top, overhead and pedestal mounting configurations. The Pegasus model is designed for in-panel mounting. While the SIRS products come with a 3-year warranty, distributor Aircraft Spruce said repair can only be accomplished at the factory in England.

Precision Aviation (www.PAI700.com) has close to 90,000 of its PAI-700 vertical card compasses in service. With a presentation that mimics a directional gyro, it's easier to reference than a traditional mag compass. If you already have one and it needs repair, the factory in Houston, Texas, charges a flat-rate fee of \$199 for complete rebuild, with a few days of downtime. Aircraft Spruce sells new ones, starting at around \$375, but mounting hardware could increase the price.

Last, don't underestimate the required installation effort. With calibration, you could be looking at an invoice that's well north of \$600.

Action Cam Trials: VIRB Ultra Crushes It

All the cams produce comparable imagery, but ease of operability drives it. For aviation use, Garmin's new VIRB Ultra 30 walks away with this comparison.

by Paul Bertorelli

If it's every pilot's sacred duty to upload aviation videos to YouTube to offset a criminal surplus of cat coverage, Garmin and GoPro are ready to deal. Just as we go to press this month, both companies have introduced new action cameras suitable for in-cockpit shooting and outside shots of aircraft in flight. The good news? Usability is up and prices are down and the accessory market is soon to go into frenzied

overdrive on the off chance that you can't find just the right gadget for the shot you want.

For this article, we're reviewing four cameras: the new GoPro Hero 5, Garmin's just-released VIRB Ultra 30, plus the previous VIRB XE and the 360fly, a specialty wide-view camera that's getting traction in the action cam market and being sold by Sporty's.

To be fair, these aren't the only action cams out there. GoPro has the Session model and several other manufacturers offer sports cams, but to contain the topic to a sensible few, we're examining the top contenders suitable for aviation use.

WHADDAYAWANT?

If you're otherwise not into surfing, mountain biking or skydiving, why would you even want an action cam? For one thing, they beat con-

Both VIRB Ultra 30, left, and GoPro Hero 5, right, are touchscreen-menu driven and both use GoPro-style mounts.

CHECKLIST



Garmin's VIRB Ultra is vastly improved over previous models.



The GoPro Hero is improved too; they fixed the quirky menus and buttons.



Against a \$399 base price for top models, we don't feel the love for cheaper cams.



double as a sports cam and given such features as slow motion and time-lapse photography, these cameras are a credible option over a cellphone. What we want in an action cam is versatile mounting options, good image quality with plenty of shooting options, accessories such as ND filters and mics and, above all, an easy- and quick-to-use operating logic. Remote controls are a nice plus, but all of these cameras work well with smartphone apps. 4K resolution is also a plus, but not a must unless you have a monitor or TV to view it at full resolution or you need pixel density for cropping. Garmin and GoPro's newest models have voice controls for various commands and while this is a nice touch, it's of dubious value for aviation use.

GARMIN VIRB ULTRA 30

The \$399 VIRB Ultra 30 (\$499 with an aviation bundle) is Garmin's fifth camera, with the VIRB, Elite and XE/X models preceding it. Although it's not specifically a camera company, Garmin has been more aggressive in new model introduction than GoPro has, which explains why GoPro's sales have all but tanked.

The new Ultra represents an interesting confluence with GoPro. Heretofore, Garmin's cameras were slightly larger than the GoPro, but waterproof without need for the GoPro-style case. Now, the two companies have switched. The GoPro Hero 5 is waterproof *without* the case and the VIRB Ultra is smaller, but not waterproof. It requires a GoPro-style case and, conveniently, it mates up to standard GoPro mounting hardware.

The Ultra represents a substantial improvement over the XE, in our view. It has more shooting resolu-



CAMERA	BASE PRICE	IMAGE OPTIONS	MOUNT	EXTERNAL MIC	ACCESSORIES
GARMIN VIRB X	\$299	1080P30 960P30 720P60 12MP STILL/BURST	GOPRO	YES	Aviation bundle includes ND filter, audio cable. Remote an option.
GARMIN VIRB XE	\$399	1440P30 1080P60 960P100 720P120 12MP STILL/BURST	GOPRO	YES	Aviation bundle includes ND filter, audio cable. Remote an option.
GARMIN VIRB ULTRA 30	\$399	4K30 2.7K60 1080P120 720P240 12MP STILL/BURST	GOPRO	YES	Aviation bundle includes ND filter, audio cable. Remote an option.
360FLY 4K	\$499	2880X2880/24/30 1728X1728/60 2560X1440/30	1/4-20 INSERT	NO	Charging cradle, cable, case, camera mount adapter, sports mounts.
GOPRO HERO 5	\$399	4K30 2.7K 1440P80 1080P120 720P240 12MP STILL/BURST	GOPRO	YES	Remote with voice control, mic adapter, sports mounts, charger.
GOPRO HERO 5 SESSION	\$299	4K30 2.7K 1440P60 1080P90 10 MP STILL/BURST	GOPRO	YES	Remote with voice control, mic adapter, sports mounts, charger, dive housing.
GOPRO SESSION	\$199	4K 2.7K 1440P30 1080P90 8 MP STILL/BURST	GOPRO	NO	Sports mounts, charger, dive housing.

tion and frame-rate options than the XE—including 4K—and the operating menu has been revised to make it simpler and more reliable. Where the XE had no viewer and the previous VIRBs a rudimentary screen, the Ultra has a color touchscreen that's suitable for viewing shots and works well for navigating the control menus.

Previous models of both GoPro and Garmin cameras had control logic best described as quirky, although the VIRBs were better than the GoPro, in our opinion. In the Ultra, the most-

VIRB XE, right, is a competent camera and waterproof without additional housing. But the dedicated charging and audio cable, left, is awkward. 360fly, upper right, is an enigmatic faceted ball that produced the image on the facing page.





a can't-miss single touch. As noted, the Ultra has its own waterproof case, but there's also a skeleton case so you can pipe audio into the camera or get at the HDMI port. Here another big

X which, at \$299, has fewer video shooting options than the XE. The X might be a good basic camera if you don't want to spend more, but the VIRB Ultra, for the additional \$100, is just a lot better camera, in our view. The only plus for the XE/X, in our opinion, is that they're waterproof right out of the case. That reduces the accessory count when traveling.



VIRB versions record GPS data that can be layered onto the video to show speed, position and other aviation data, top. Lower photos show what a 360-degree camera sees when tail mounted, facing forward.

plus. The XE uses a dedicated cable for both charging and audio access and we absolutely hate it. It's heavy, awkward and requires carrying around a cable good for nothing else. The Ultra also has a dedicated cable, but it's less awkward than the XE version and for charging, a standard mini USB cable will do it.

For shooting, all the VIRBs have had a unique slider or toggle that starts the camera shooting whether it's turned on or not. The Ultra continues this with a top-mounted toggle switch to record and a pushbutton to shoot a still. Additionally, it now has voice control. Say "OK, Garmin" and the camera beeps, readying itself for a command such as start recording or take a picture. It can bookmark a point in the footage if you say, "remember that."

Useful? Maybe, but hardly must have. Far more practical is the wireless capability, which allows controlling the camera from a phone or tablet app, including playback of videos. That's handy capability if you've got the camera stuck to the belly of the airplane and you want to switch it on and off or frame the next shot. We think the Ultra's wireless works more reliably than previous iterations and the camera also has Bluetooth to link to Garmin's various fitness gadgets. It also has GPS so position and navigation data can be overlaid on the footage using Garmin's free VIRB Edit app.

360FLY

Action cams are all about the most dramatic shots imaginable and thus we have so-called 360-degree cameras. These attempt to capture an essentially spherical image with the camera in the center and some actually do this. But the 360fly, technically, isn't one of them. In the horizontal plane, it does capture 360 degrees, but vertically, it's limited to 240 degrees. Nonetheless, the 360fly yields a dramatically inclusive image that's sharp and with infinite depth of field.

As indicated in the chart, 360fly calls this 4K imagery, but we think that's a stretch. 4K is technically 3840 by 2160 pixels; the best the 360fly can do is 2880 by 2880, a square image that's a function of the super wide lens. It can also be configured to shoot a standard rectangular 16:9 frame, but the resolution is limited to 1440p. The fly has but a single button, which serves as an on-off switch and the record control. Like the other cameras, it has wireless and a decent app to control image size, exposure settings and still shots.

After some initial hitches getting the app to work correctly, resetting the camera yielded a robust wireless link that permitted controlling the camera mounted externally on the tail of the airplane. The imagery is impressive, but radically distorted, so the fly would be a good choice as a second camera, but not a primary. It's waterproof, but has no external mic capability. The standard HD version sells for \$299, the 4K version for \$499.

GOPRO HERO 5

GoPro essentially invented the action cam market but it hasn't exactly remained dominant. The Hero 4 Black was introduced two years ago, during which time Garmin rolled out two models. GoPro has been struggling to reinvigorate its own market and the Hero 5, long awaited and probably delayed, is supposed to do that. It's not a

used menu is the default and gives ready access to video, photo, playback and wireless settings. Higher level and system settings are accessible via a gear icon. Easy peasy.

Some of the settings are controlled with sliders, which the GoPro Hero 4 also had. These were almost impossible to slide with a finger on the small screen. Garmin must have noticed, because its sliders activate with

CONTACTS...

Garmin International
800-800-1020
www.garmin.com

GoPro
855-635 3578
www.gopro.com

Sporty's Pilot Shop
800-776-7897
www.sportys.com

VIRB XE

We're mentioning the XE here as an also ran. Although it's an excellent camera with similar performance as the Ultra, the XE lacks 4K capability, it uses Garmin's old-style menu structure, it lacks a screen viewer and it has those bothersome cables to mess with. Furthermore, it costs the same as the Ultra, at \$399 or \$499 with an aviation bundle that includes an ND filter and an audio adapter cable.

Garmin's bargain model is the VIRB

bad start. The obtuse menu system of the previous models has been streamlined and, like the Hero 4 Silver, the 5 has a color touchscreen but it's much improved over the previous version. In addition to simpler operating logic, the app has been improved and the wireless connection with the camera is more reliable. Following Garmin's lead, GoPro added a GPS chip and an operating button that allows grabbing a quick photo or video on the fly without turning the camera on first.

Mechanically, the Hero 5 is a mixed bag. It's slightly larger than the Hero 4, but it's waterproof to 10 meters. That's good; not so good is that it still needs a skeleton case for mounting and we found it difficult to extract from the case. Also, to access the charging port and HDMI jack, you have to crack open a door on the side of the camera. But the door has to be removed entirely to fit into the case so...what's the point? It seems certain to get lost sooner rather than later.

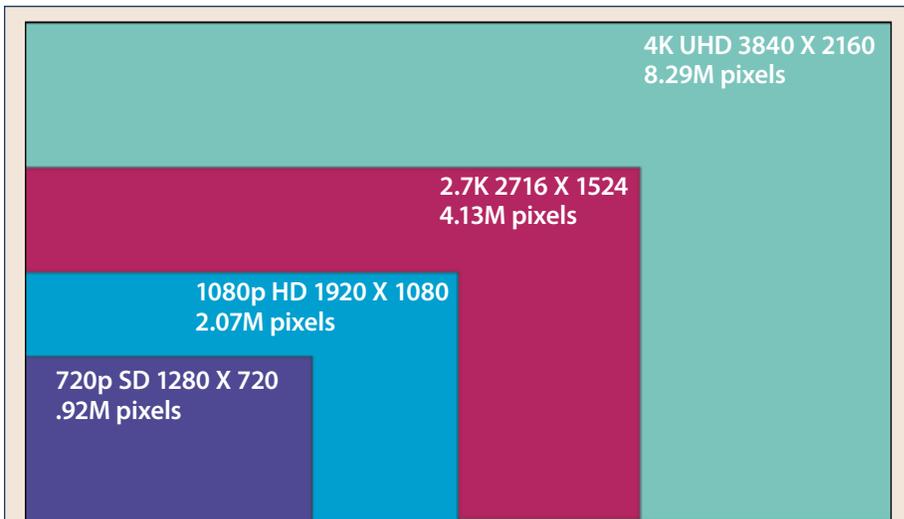
The Hero 5 uses the same sensor as the 4, but it has more resolution and frame options than most of us will ever need, plus the ProTune feature to sweeten things like color temperature and exposure value. Professional shooters will appreciate this. (The VIRB Ultra has similar capability called Pro Settings.)

The Hero 5's footage is gorgeous, especially the high-frame rate (up to 120 fps in 1080p) HD and 4K. The color is saturated and there's a lot to work with in editing software. Head to head, we would give GoPro the edge on imagery over the Garmin.

Also new to the Hero 5 is the ability to offload the footage wirelessly via cloud server so it's available for viewing and editing on any device. Nice idea if you simply must post something on social media from a hot spot at Starbucks, but it'll cost you \$5 a month for the service.

One annoyance is that the Hero 5 doesn't work as a mass storage device, so to move the footage conventionally, pop the card into a reader (ugh) or use GoPro's dedicated capture and editing software. It works, but it's not our fave.

If you want to input audio through an external mic, you'll need GoPro's \$50 powered mic adapter. While we're at it, we'll mention GoPro uses the oddball (but emerging) USB-C cable standard. Already carrying too many



4K EXPLAINED (WE HOPE)

The 4K image resolution standard is all of these things: flexible, confusing and over-hyped. First, image resolution is given in pixel dimensions, with the vertical dimension as the accepted label. Thus, a 1920 by 1080 pixel so-called high-definition image is called 1080p while a standard definition or SD image (1280 by 720) is 720p.

4K gets its name because it's four times the pixel density of 1080, so it should be 4320 vertically. Except it's not. True cinema 4K is 4320, but video cameras shoot a lesser variant called ultra high definition whose image is 3840 by 2160 pixels. So really, shouldn't 4K be 2160p, in keeping with using the vertical pixel dimension? Logically, yes, but for some reason, for UHD, the industry applies the horizontal

dimension, just to confuse the hell out of everything.

To confuse things further, there's 2.7K, a resolution between 1080p HD and 4K UHD at a dimension of 2716 by 1524 pixels. Again, against the standard, 2.7K refers to the horizontal dimension, not the vertical.

So does it make sense to have 4K and use it? It depends. To get the most out of 4K, you'll need a 4K monitor or TV. Prices of these have declined recently, but if you don't have one, 4K will look little better than 1080p. 4K files are much larger than 1080p (or 2.7K) and will take longer to transfer and process in a video editor. Because they have the highest pixel density, 4K files do offer more cropping options during editing.

odd cables? Add one more; life is not getting simpler.

WHICH TO BUY?

If you already have a GoPro Hero 3 or 4, we would say the 5 doesn't represent enough of an upgrade to spend \$400. It's better, but not that much better. Similarly, if you have an older VIRB, the image sensor is good and the new Ultra won't blow it away. It's a better camera, but again, maybe not worth \$400 on a whim.

For new buyers, our recommendation is easier. In our view, for aviation use, the VIRB Ultra crushes the Hero 5. It's got more aviation stuff like GPS, filters and audio adapter cables.

Plus, with the Garmin's .gpx files and VIRB edit, you can put aviation speed, altitude, course and other graphical gauges on your videos. Cool stuff. Although it has GPS, the GoPro can't do this yet; it will probably get there. Doubling as a sports camera, the VIRB will hold its own against the GoPro and has the benefit of Garmin's full suite of ANT+ sensors for various sports such as cycling or skiing. Not to suggest the Hero 5 would be a bad choice, just that the VIRB Ultra is a better one for aviation.

 See video reviews of cameras at <http://tinyurl.com/j95ht2a>

Speed Mods: Bucks for Knots

Face it, speed costs money. Nevertheless, we surveyed the speed mod world and found some that will make your airplane faster without costing a fortune.

by Rick Durden

While experience has taught us that there's no free lunch in aviation, especially when speed is involved, we wanted to know if there were any ways to make our airplanes faster without having to spend cubic bucks. We surveyed the speed mod market—it's vast—and found that while there are some high-dollar mods out there, it may be possible to up the cruise speed and climb rate of your airplane by 5 to 10 percent without going broke. Here's what we found.

REALISTIC EXPECTATIONS

Any attempt to make an airplane go faster comes up against the cruel laws of squared functions as applied to aerodynamic drag—to make an airplane go twice as fast, you have to have eight times as much power. That's the bad news. The good news

is that general aviation manufacturers didn't always optimize their designs for speed. At some point during development diminishing returns set in and they said, "That's good enough," froze the design, went through certification and put it on the market. For a number of legacy airplanes from Piper, Beech, Cessna, Mooney and Grumman American, that means for under \$5000 it may be possible to improve your airplane's performance enough that you notice it. Most of the aftermarket mods are designed to reduce drag—airframe and/or cooling—but two are exhaust system mods that increase engine power output.

Virtually all of the mods we looked at required Supplemental Type Certificate testing. That does not mean they meet their advertising claims for improved performance;

it just means the FAA found that the aircraft's overall level of safety, structural integrity and its stability and control were not degraded by the mod. We also noted that virtually all of the mod shops advertised cruise speed increases in miles per hour rather than knots because the numbers look bigger. We keep waiting for them to switch to kilometers. We recommend an appropriately jaundiced eye when looking at advertising claims. We also note that if one mod for your airplane is said to increase its speed by 3 MPH and another by 4 MPH, putting both of them on probably won't bump the speed by 7 MPH—speed increases per mod are based on just that mod on the stock airplane.

KNOTS 2U

Jim Bradshaw, the late founder of Knots 2U (www.knots2u.net), made the Piper Twin Comanche some 20 MPH faster with speed mods he designed. The company eventually expanded into making speed mods for a wide variety of singles and twins and acquired Met-Co Aire, maker of the Hoerner wingtips that have demonstrated performance benefits.

The Hoerner wingtip was developed by Dr. Sighard Hoerner for military aircraft. It was applied to civilian aircraft by Met-Co Aire and is designed to reduce the strength of wingtip vortices generated by high-pressure air under the wing moving outboard over the wingtip. The tip vortices create turbulence and drag. The shape of the Hoerner wingtip reduces tip vortices in a manner not unlike a winglet, although not as effectively.

Knots 2U advertises benefits of the Hoerner wingtip that include—depending on aircraft model—3-5 MPH cruise speed increase, 60 FPM rate of climb increase, 1-2 percent greater range, 4-5 MPH reduction of stall speed and reduced takeoff distance. We note that some manufacturers have made Hoerner wingtips standard equipment on their airplanes.

Knots 2U offers Hoerner wingtips for numerous models of the Bonanza and Baron, Piper singles and twins

LoPresti Aviation's cowling mod for the Piper Arrow includes a cowl flap, improves cooling air flow and increases speed.



SpeedPants from Laminar Flow Systems, above right, are low-drag strut and wheel fairings advertised to up cruise speeds as much as 11 MPH. Knots 2U landing gear strut fairings, lower right, are advertised to increase cruise speeds by 3-5 MPH.

and Cessna singles. Prices start at \$640, with the most expensive we saw being for the Bonanza and Baron at \$944.

One of the most effective mods developed by Knots 2U was more streamlined gear strut fairings for fixed-gear airplanes. As Cirrus and Columbia showed the world, an airplane with properly faired landing gear can be smoking fast. For the Piper Cherokee line, Knots 2U offers its main-gear wheel fairings for \$1095 and advertises a 3-5 MPH speed increase. Installation time is 8-9 hours.

For fixed-gear Cessnas, Knots 2U sells fairings for the mains (\$2048 a set) and nosegear (\$1276). It advertises a 2-4 MPH speed bump for the nosegear and 2-3 for the mains. Installation time for all three is about 10 hours.

There's also a cleanup for the Piper Arrow gear—a \$634 gear lobe fairing attached to the underside of the wing behind the main landing gear that cleans up the airflow and reduces drag. Installation time is 3.5 hours and is advertised to boost cruise speed by 3-5 MPH.

Finally, for Piper flap hinges there's a \$297.60 set of fairings that only take an hour to install and add 1-2 MPH to cruising speeds.

LOPRESTI AVIATION

Known as "Mr. Fast" in general aviation, the late Roy LoPresti was largely responsible for cleaning up and speeding up the Grumman American singles and the aerodynamics of the Mooney 201 when he worked for those companies. Going on to form his own company, he created numerous speed mods for Pipers, Mooneys and Grumman Americans that continue to be offered by LoPresti Aviation.

Much of LoPresti's aerodynamic cleanup work involved cowlings—



outside and in—reducing cooling drag and the aerodynamic drag of the cowling itself.

LoPresti Aviation offers cowling mods for most Piper singles, the Grumman American Cheetah and Tiger and Mooney M20E, F and J. Speed increases advertised range from 5 MPH on the Cheetah to 15 MPH on the Comanche 260. However, cowling mods aren't something we consider to be a budget speed mod—we were quoted \$16,995 plus a 55-hour installation for a 5 MPH speed bump on a Cherokee Arrow. The new cowling is made of carbon fiber, has a hinged access door and a cowl flap for better cooling airflow. According to Curt LoPresti, one of the major selling points is that it looks great.

Looking at the more modestly priced LoPresti mods, we note that its best performer is its more aerodynamic wheel pants for fixed-gear Pipers. It advertises up to 10 knots extra speed for a Cherokee 180. The main gear fairings are \$4995 for the set and a nosegear fairing goes for \$2495.

Piper flap hinge fairings are \$1495 and give as much as 3 MPH more speed. For the Piper Arrow series, LoPresti offers a wheel well fairing that is advertised to give an extra 4 MPH for \$899.

LAMINAR FLOW SYSTEMS

Advertising up to a 15 MPH cruise speed increase, Laminar Flow Systems (www.laminarflowsystems.com) sells speed mods for the Piper Cherokee, Lance, Saratoga and Seneca lines.



The main players in terms of speed per mod from Laminar Flow Systems are two types of main gear strut fairings for fixed-gear Pipers. Priced at \$1100 for the pair, Fancy Pants are main gear fairings that enclose the exposed gear struts and brakes and are more aerodynamic than Piper wheel pants. They fit over the existing Piper wheel pants, are riveted into place and have an access and service door so that they do not have to be removed for inspections and service. Installation takes 4-6 hours and speed gains of up to 10 MPH are advertised. We appreciate that Laminar Flow Systems warns potential buyers up front about shipping costs—wheel pants are bulky, making for shipping that can run as high as \$300.

TWIN CESSNA SPEED COVERS: IMPROVED CLIMB AND SAFETY

Premiere Aviation (www.premiere-aviation.net) claims that its Speed Covers for the main landing gear of several models of 400-series Cessnas reduce fuel burn 5-10 percent, increase single-engine rate of climb 25 percent and should increase cruise speeds. We recently took Premiere's Peter Danto up on his offer to flight test the Speed Cover mod. We came away of the opinion that for only \$2000 plus two hours installation to get better rates of climb—especially single-engine—the mod's a slam dunk. We'll tell you about our flight test after some background.

With over 7000 hours and 30 years flying Cessna 421s, Peter Danto knows the airplanes cold. He used his knowledge to develop a product that could inexpensively reduce a major area of drag on the airplane—the exposed main landing gear wheels. When Cessna had changed from an electro-mechanical to hydraulic landing gear with the development of the models 402C, 414A and 421C, it simplified the system by omitting gear doors for the main landing gear wheels. When it developed the 425 and 441 turboprops it used the same gear design, leaving the main wheels exposed in flight.

The upper photo shows the left main landing gear wheel of a Cessna 421C. The stock wheel has no hubcap. When the gear is retracted each main gear wheel sticks out of the well into the energized slipstream right behind its respective propeller. Danto tufted the entire underside of a 421C wing, flew it and filmed the behavior of the yarn tufts in various flight regimes. The images showed that the main landing gear wheels generated significant turbulence.

Danto's solution was to develop slightly convex fiberglass wheel covers to see if they would restore at least some of the laminar flow along the underside of the wing. The lower photo at right shows a Series I Speed Cover on a Cessna 421C with the gear retracted. The view is looking forward.

Flight testing revealed that the Speed Covers reduced drag and resulted in increased rates of climb and higher cruise speeds. Upon completion of the required testing, Danto's company, Premiere Aviation, applied for and received Supplemental Type Certificates for Speed Covers for the Cessna 402C, 414A and 421C.

The Series I Speed Covers must be removed to add air to the tires. While that only involves three screws, it still takes time, so Danto created the Series II Speed Cover that has an opening for the valve stem and does not have

to be removed to service the tire pressure.

Most recently, Premiere Aviation has certified the Series III Speed Cover. It is also certified for the Cessna 425 and 441. It too has an opening for the valve stem, is slightly more convex than the other models and has a greater diameter so that it covers a portion of the tire in addition to the wheel. A Series III Speed Cover is shown in the upper photo at left.

The flight test took place at Parkland Estates Airpark, Erie, Colorado, which has a field elevation of 5050 feet. The airplane was a Cessna 421C owned by Vern Randel. Peter Danto brought a new set of Series III covers to be installed after we had done a baseline test without the covers. The flight profile was for a climb to FL250, level flight for at least five minutes to let the speed stabilize, then a descent to FL200 and level flight for at least five minutes before a descent to landing. The airplane would be flown at the same climb speeds, power settings and fuel flows on both flights. Takeoff weight would be the same. As it happened, OATs at FL250 were within one degree C of each other on the flights.

Time to climb to FL250 for the unmodified airplane was 31:50. Cruise speed at FL250 was 213 KTAS; at FL200 it was 201 KTAS.

The installation of the Speed Covers took 30 minutes. The paperwork included with the kit was, in our opinion, clear and straightforward.

Time to climb to FL250 with Speed Covers installed was 27:45—4:05 faster, a nearly 13 percent improvement. As the airplane climbed, the delta in rates of climb between the flights increased—a 421 tends to run out of puff above FL210—and the modified airplane's rate of climb was nearly double that of the unmodified airplane above FL200. Speeds at FL250 and FL200 were 214 and 207 KTAS, respectively—nearly identical at FL250 and 6 knots faster at FL200.

We did not shut down an engine for climb comparisons, relying on the video of tests Danto ran earlier and available on the company website.

The price for a set of Series I Speed Covers is \$1500; for Series II and III it's \$2000. For an airplane worth well north of \$100,000 and the fuel burn of a 400-series Cessna, we think the improved rate of climb and a possible cruise speed increase make the Speed Covers worthwhile. Further tipping the scales, we think a mod that improves the anemic single-engine rate of climb of a piston twin improves its safety.



SELECT SPEED MODS			
MANUFACTURER	MOD	CLAIMED SPEED GAIN	PRICE
Knots 2U	Hoerner wingtip - Bonanza, Baron, Piper singles, Cessna singles	3-5 MPH	\$640-\$944
	Main gear wheel fairings - Piper Cherokee line	3-5 MPH	\$1095
	Main gear wheel fairings - Cessna fixed-gear singles	2-3 MPH	\$2048
	Nosegear fairing - Cessna fixed-gear singles	2-4 MPH	\$1276
	Gear lobe fairing - Piper Arrow	3-5 MPH	\$634
	Flap hinge fairing - Piper	1-2 MPH	\$297.60
	Flap and aileron gap seals - Piper	2-3 MPH	\$474 and up
LoPresti Aviation	Engine cowling - Piper singles, Grumman American Cheetah, Mooney M20	5-15 MPH	\$16,995 and up
	Main landing gear fairings - Piper fixed-gear	Up to 10 knots for mains and nose	\$4995
	Nosegear fairing - Piper fixed-gear	Up to 3 MPH	\$2495
	Piper wing flap hinge fairings Wheel well fairing - Piper Arrow	4 MPH	\$1495 \$899
Laminar Flow Systems	Fancy Pants main gear strut fairings - fixed-gear Pipers	Up to 10 MPH	\$1100
	SpeedPants main gear wheel pants - fixed-gear Pipers	10.5-11 MPH	\$3670-\$4270
	Nosegear strut fairing - fixed-gear Pipers	Up to 3 MPH	\$287
	Piper flap hinge fairings	Up to 2.5 MPH	\$450
	Piper Cherokee fuel tank fairing and smoothing kit	Up to 4 MPH	\$832
	Wheel well fairing - Piper Arrow, Lance, Saratoga SP and Seneca	Up to 4 MPH	\$598
Maple Leaf Aviation	Cowling cover - 1968 and 1969 Cessna 177	8-12 MPH	\$379
	Fancy Pants nose landing gear strut - Cessna 172, 177 and 182	3-8 MPH	\$659
	Main landing gear strut fairings - Cessna 177	3-4 MPH	\$919
	Brake fairings - Cessna 177 and 182	2-3 MPH	\$329
Power Flow Systems	Custom exhaust system - Aviat Husky, Cessna 170, 172, 175, 177 and 177RG, Diamond Star, Grumman American Traveler, Cheetah and Tiger, Beechcraft 19 and 23, most four-cylinder Piper Cherokees, most four-cylinder Mooneys and most four-cylinder Maules	5-10 MPH	Starting at \$5000
Leading Edge Exhaust Systems	Custom exhaust system - Cessna 180 and 200 series and Piper PA18 and 20/22	Not specified	Starting at \$4395

The second type of main gear fairings offered by Laminar Flow Systems is referred to as SpeedPants. SpeedPants are built to order, so there is an eight-week lead time.

The price is dependent as to whether the airplane has strut fairings—\$4270 a pair for airplanes with strut fairings and \$3670 for those without. Laminar Flow Systems says that its tests showed a 10.5 MPH speed gain over bare wheels and 8 MPH over original Piper wheel pants on pre-1978 airplanes and 11 MPH over bare wheels and up to 6 MPH over Piper wheel pants on later-model airplanes.

The nosegear fairing sold by Laminar Flow Systems is priced at \$287, although a \$50 discount is offered if purchased with a pair of main gear fairings. The nosegear fairing covers the lower nosegear strut, reducing drag, according to the company, and increases speed up to 3 MPH. It is not a nosegear wheel pant, just a fairing around the strut.

For \$450, Laminar Flow also offers flap hinge fairings and advertises a speed increase of up to 2.5 MPH.

The exposed rivets and screws along the fuel tanks of PA28s and PA32s have long been a source of complaint for pilots wanting more speed. Laminar Flow Systems sells

a kit to fair and smooth the area. Priced at \$832, it is advertised to increase speed by up to 4 MPH.

For \$598, owners of Piper Arrows, Lances, Senecas and gear-up Saratogas can buy a wheel well fairing kit that can increase cruise speed as much as 4 MPH.

MAPLE LEAF AVIATION

Targeting the Cessna 172, 177, 177RG, 180, 182 and 185, Maple Leaf Aviation (www.aircraftspeedmods.ca) offers a line of speed mods for those fixed-gear Cessnas although its emphasis is on the Cessna Cardinal and Cardinal RG. We spoke with Paul Millner, head of Cardinal Flyers Online (www.cardinalflyers.com), who told us that many of the mods created by Maple Leaf Aviation's principal, Roy Sobchuk, were made specifically for the Cessna Cardinal line and that members of the organization spoke of the effectiveness of the speed mods.

The big dog of Maple Leaf's Cardinal mods is a cowling cover for the 1968 and 1969 Cardinal. It corrects a high drag area of the airplane to more closely match the design of the 1970 and later Cardinals, improving airflow, rate of climb and cruise speed. Cruise speed is advertised to increase by 8-12 MPH and, according

to Millner, CFO members who have bought the \$379 kit say that on short airstrips they no longer worry about hitting the trees on takeoff.

To combat the high-drag nosegear strut on the 172, 177 and 182, Maple Leaf Aviation offers what it calls Fancy Pants, a fairing that fits between the top of late-model wheel pants and the underside of the cowling.

For the 177 and 182 a 6-8 MPH speed gain is advertised; for the 172 it's a 3-5 MPH gain. The price is \$659. On the Cardinal, Cessna had three different wheel pant designs—Fancy Pants is only compatible with the most recent—which were the lowest drag.

Maple Leaf Aviation also sells a duplicate of the late-model Cessna wheel pants for use with the Fancy Pants mod. The price is \$275.

Even though Cessna faired in the main landing gear legs of the Cardinal, the way it was done turned out to create a high drag area on the airplane. Maple Leaf Aviation offers a kit that includes low-drag, extended chord gear leg fairings that are oriented at a better angle of attack, brake fairings and fuselage fairings. For \$919, the kit is advertised to increase cruise speed by 3-4 MPH.

Maple Leaf also offers brake fairings for the 177 and 182 that, in

GAP SEALS: MANEUVERABILITY GAINS

A long-targeted area for aerodynamic cleanup has been the gap between the wing trailing edge and the flaps and ailerons. Engineers thought that by blocking high-pressure air from escaping through the gap to the low-pressure area above the wing overall lift would be increased and the wing could operate at a lower angle of attack, making it faster. Testing showed it to be generally true.

Involved testing by N.A.C.A. (the predecessor to NASA) in 1937—we weren't kidding about this being a long-targeted area—found the more significant benefit of aileron gap seals: The roll rate increased dramatically.

During research for our March 2014 *Aviation Consumer* article on gap seals, we were told by Laminar Flow's Darren Tilman that his testing of aileron gap seals on a Cherokee 140 increased cruise speed by 2-3 MPH; however, they increased the rate of roll by 80 percent at 100 MPH IAS. That's a huge benefit, in our opinion.

The photo above shows Laminar Flow's aileron and flap gap seals on a Cherokee. The airplane also has the company's flap hinge cover and wheel pant speed mods. Prices start at \$474 for the seals for a Cherokee at www.laminarflowsystems.com.

The roll rate improvement was also noted by Horton (www.horton-stolcraft.com), maker of aileron and flap gap speed mods for Cessnas and Pipers. The Horton representative we spoke with emphasized the improvement in roll rate and handling at low speeds. He said that users reported an increase of at least 2 MPH in cruise speed. For a 172 the price is \$349. Installation time is 8-10 hours plus painting.

When it comes to flap gap seals,

owners expressed concern about an increase in stall speeds because the seal would interfere with airflow between the wing trailing edge and the flap—especially with Fowler flaps, which move aft and down. All of the companies offering flap seal mods told us that their testing disclosed no change in stall speed.

Curt LoPresti, of LoPresti Aviation (www.loprestiaiviation.com), said that its testing showed a 2-3 MPH speed increase for Pipers with flap gap seals and an insignificant gain with aileron gap seals, so it does not even sell aileron gap seals. LoPresti told us to visualize an airplane head-on and noted that the lift distribution on the wing is such that most is generated inboard of the

ailerons. Consequently, according to LoPresti, stopping the flow of high-pressure air through the gap has more benefit inboard—which the company's testing on Pipers confirmed. The flap gap seal kit

for a Cherokee 180 is \$1495 plus a five-hour installation.

Lasar Aero Styling (www.lasar.com) offers flap and aileron gap seals for a number of Mooneys and advertises a 3.5 MPH speed increase. The price is \$505 and installation is said to take 14 hours.

Knots2U (www.knots2u.net) offers gap seals for a large variety of the Piper, Beech and Cessna lines and claims speed increases of as much as 5 MPH and rate of climb increases of as much as 75 FPM. Prices start at \$500 for a set of flap and aileron gap seals.

D'Shannon (www.d-shannon-aviation.com) offers gap seals for Debonairs, Bonanzas and Barons. Prices start at \$600 for a set.

We like aileron gap seals because they improve handling—any incidental speed increase is a bonus.



conjunction with late-model main gear wheel pants, are advertised to increase speed by 2-3 MPH. They are priced at \$329. They are included in the Cardinal main landing gear leg kit.

POWER FLOW SYSTEMS

While most speed mod shops get additional performance via drag reduction, two that we surveyed do so by modifying the engine exhaust system to allow the engine to develop more power. The length of each exhaust tube is customized to cause the low pressure traveling down the tube behind an "exhaust puff" to reach the collector where the tubes join in time to suck out the exhaust from the next cylinder.

Power Flow Systems (www.powerflowsystems.com) offers its exhaust mod for the Aviat Husky, Cessna 170, 172, 175, 177 and 177RG, Diamond Star, Beech 19 and 23 series, Grumman Americans and four-cylinder Maules, among others. Prices vary with engine size, but start at around \$5000 plus installation. Speed gains are reported to be from 5-10 MPH.

LEADING EDGE EXHAUST

Originally a company that did exhaust system repairs, Leading Edge Exhaust Systems (www.wemakeyoufly.com) of Anchorage, Alaska, wanted to design systems that were more robust than OEM equipment and allow the engine to develop more power. It has developed its systems to maintain a laminar flow and reduced back pressure, facilitating scavenging the products of combustion, improving volumetric efficiency and horsepower.

The systems are available for the Cessna 180 and 200 series and the Piper PA12, 18 and 20/22. Power increase is approximately 10 percent. While Leading Edge advertises cruise speed gains, it does not make specific number claims. Prices start at \$4395 for the 150-HP engine in the Piper PA12.

CONCLUSION

We like that there is a strong market and competition for most types of airplanes. We think the most bang for the buck lies with landing gear drag reduction on fixed-gear airplanes. We also like the mods for twins that increase single-engine rate of climb.

Ferry Permits: FAA Paperwork, Smarts

Don't take unnecessary risks by flying an unairworthy aircraft on the sly. Getting a special flight permit is easier than you think if you follow the regs.

by Larry Anglisano

At some point, you could be faced with having to fly an aircraft that's technically unairworthy. To legally do that, there are several steps you must take before even thinking about climbing in and launching. This includes getting an FAA-issued special flight permit.

For many folks, the process may seem complicated and intimidating, but the FAA has reasonable rules in place that can make it straightforward. Here's how it works.

SPECIAL FLIGHT PERMIT

This is the official FAA terminology for what the industry generally calls ferry permits. The guidance is found in FAR 21.197, subchapter C, which deals with certification procedures. In part, the regulation says that a special flight permit may be issued for an aircraft that may not, currently, meet applicable airworthiness requirements, but (and this is important) is capable of safe flight.

That means the FAA (generally the FSDO governing the location where the aircraft is based) will make the final call as to whether the aircraft is indeed safe to fly. A DAR (designated airworthiness representative) can also approve a ferry permit, which is valid for one single flight—with fuel stops—for a variety of purposes.

The most common reason for soliciting a ferry permit is to relocate an aircraft that has an expired annual inspection, but there are other reasons, which I'll get to in a minute. Remember that operating an aircraft that's out of annual is in violation of its U.S. standard-category type certificate, which says it must be maintained per the FARs (which require the annual) and it must be in a condition for safe operation. Worth noting is that the FAA, in general, doesn't specifically define airworthiness, other than requiring that the aircraft conforms to its type certificate and approved modifications.

However, the FAA does say in FAR 91.7 that you can't fly an unairworthy aircraft. That's where the special flight permit comes in, which requires the involvement of either an A&P mechanic, an IA or an FAA repair station. You'll need them to provide an aircraft logbook endorsement that says the aircraft is safe (not airworthy—otherwise you wouldn't need the permit) for a one-time flight. In reality, getting the endorsement can be more difficult than dealing with the FAA. It helps to be realistic about flying an unairworthy aircraft.

Unforgettable is the owner of a Cessna 210 who challenged the shop doing the annual inspection (which was expired when it arrived) when it wouldn't sign off on a sizable crack in the turbocharger. Convinced that he was going to fly his airplane home, rather than deal with the repair, he brought in several mechanics until he found one who would sign off an endorsement for the ferry permit application. I suggest not playing that game.

The other suggestion I might make is to avoid bringing the FAA in to inspect the airplane. While an FAA airworthiness inspector can do an inspection and make the endorsement to support the permit, an inspector who wished not to be named said you really don't want to go down that road. I get it.

EASY PAPERWORK

The aircraft owner is the one who applies for the permit, using FAA form 8130-6, which is actually an application for a U.S. airworthiness certificate. A mechanic can be the one to solicit the ferry permit on the owner's behalf if the owner supplies a signed letter of authorization.

This PDF application is downloadable from the FAA's website and you don't have to fill out all of the sections—only I, IV and VII. Section VII is for listing the special flight purposes. This section is specific for the one-time flight that you're ap-

You're not going anywhere with those propellers. You could replace them for a ferry flight, but TCM says disassembly and inspection of all rotating engine components is mandatory prior to further flight.



FERRY PERMIT CHECKLIST

- ✓ Find an A&P, IA or repair station to inspect the aircraft.
- ✓ Realize this is a rough inspection, not an annual.
- ✓ Download and complete FAA Form 8130-6.
- ✓ Ensure the safe-to-ferry endorsement gets in the logbooks.
- ✓ Email, fax or bring the 8130-6 and endorsement to the FSDO.
- ✓ Limit onboard souls to essential crewmembers.
- ✓ Ferry flight is limited to daytime VFR.
- ✓ All outstanding ADs must be complied with.
- ✓ Avoid flying over congested areas.
- ✓ Advise your aircraft insurance agent of the ferry flight.
- ✓ When possible, limit the flight to a short distance.

plying for and requires a description of the flight. You'll state a departure and destination, any anticipated fuel stops, the departure date (the permit is generally valid for 10 days), plus the duration of the flight. You'll state the specific reason why the aircraft is unairworthy.

As for the timing, you'll need to keep your eye on weather windows because ferry permits, unless negotiated otherwise, must be made during daytime VFR conditions.

Keep in mind that maintenance ferry flights are usually short in duration—which is a pretty good idea if there's a known discrepancy, even if a mechanic believes the aircraft is safe to fly. Remember, his or her inspection isn't going to be to the level of an annual, but instead to determine if it's safe for one short flight. Also understand that ferry flights are limited to essential crewmembers. The FSDO probably isn't going to sign off on you carrying your kids, wife and mother-in-law on the flight.

You might help convince the FSDO by stating (in section E) any restrictions that are in place for safe operation. For instance, if the aircraft had a landing gear incident and the purpose of the ferry flight is to bring it to a shop for repair, you might state that the flight will be made with the landing gear in the down position.

Once you have the 8130-6 and the safe-to-fly endorsement, bring

it, email it or fax it to the FSDO. My experience is that FSDOs generally jump on the approval process pretty quickly. If you don't hear anything after a day or so, follow up. The approval paperwork I've seen was in the form of FAA 8130-7—a special airworthiness certificate—but you might get a letter approving the ferry flight stating its operating limitations. Regardless, it will be used in lieu of the standard airworthiness certificate and it must be in the aircraft during the flight.

Remember, the permit can't be used for multiple flights. If you get the aircraft to a shop and decide to bring it elsewhere, you'll have to go through the entire process again.

FAR 21.197 lists other reasons for special flight permits, including evacuating the aircraft from areas of impending danger (hurricanes come to mind), delivering or exporting the aircraft and production flight testing of new or modified aircraft. You can also get a permit for flying in excess of the maximum certified takeoff weight. This includes carrying extra fuel tanks for a long delivery flight, for example.

OTHER CONSIDERATIONS

An important consideration for ferry flights is aircraft insurance. Remember, most insurance policies require that the aircraft is flown in an airworthy condition. The subject air-

craft is not. Just because you have the FAA's permission for a one-time repositioning flight doesn't mean your insurance carrier will honor a claim if you auger during the process.

I talked with a couple of aircraft insurance professionals about the rules of flying on a ferry permit. All suggested you contact your agent or underwriter before making the ferry flight. Most companies don't have a problem with the flight if they know what's going on beforehand and that you're following the rules—which are there to ensure at least some level of safety.

One issue that might put the lid on the ferry flight is outstanding airworthiness directives. A propeller strike on many Lycoming engines actually invokes AD 2004-10, requiring tear-down inspection before flight. As one example, Lycoming defines a propeller strike as any incident, whether or not the engine is operating, that requires repair to the propeller other than minor blade dressing. Like any AD, if it requires compliance before the next flight, that's precisely what the FAA might require to issue a ferry permit.

Will the FAA sign off on the ferry permit with outstanding ADs? It's possible, but FSDOs are known to be, rightfully, more stringent when it comes to sudden engine stoppage during a prop strike. Many airworthiness inspectors are A&Ps and IAs and they've seen their share of catastrophic engine failure. Ask yourself if you really want to be flying it without doing a teardown inspection—I don't.

The rules for Part 135 for-hire operations are different than they are for Part 91. If you have an airplane that's on a 135 certificate, your ops specs might have specific requirements for dealing with any prop damage, no matter how minor.

Under Part 91, a mechanic might feel comfortable doing a visual inspection and engine runup after a minor prop ding before signing it off as safe for a one-time flight. Many techs will play it safe and stick with the engine manufacturer's recommendations.

While the FAA doesn't charge for the permit, don't expect a mechanic to work for free. He or she is also taking on a fair amount of liability when endorsing the aircraft for flight.

Last, if you aren't comfortable flying it on your own, consider hiring someone who's qualified to fly it for you.

Faro G3 Carbon ANR: Good Noise Reduction

But the drawback is slightly tighter clamping pressure on the head. A generous feature set gives it plenty of credibility in a crowded market.

by Larry Anglisano

The midpriced headset market is a crowded space, and coexisting with veteran brands like Lightspeed, David Clark and Flightcom, to name a few, is no easy task. Adding to the challenge is the competition and superior performance of headsets in the market's high end.

On paper, Faro Aviation's \$689 flagship G3 ANR headset hits all of the required high points to go the distance. It's lightweight, loaded with features and has a good warranty. We flew with the G3 Carbon for a few months to see how it compared with the rest of the models in our long-term evaluation pool of ANR models. Here's a summary.

CARBON FIBER DESIGN

Weighing in at 9 ounces, the G3 has carbon fiber earcups and carbon fiber suspension hardware. For comparison to higher-end flagship models, the Bose A20 weighs 12 ounces and the Lightspeed PFX is 13.9 ounces. But weight doesn't matter as much as clamping pressure, in our view.

You can tweak the G3's fit (and resulting clamping force) with two thumb knobs, which move the earcups up and down the headband, which has a padded head cushion. The boom for the electret microphone can be rotated 360 degrees and placed on either side of the headset.

When properly adjusted, we rate the G3's clamping force as moderate. While far from painful, we think the benchmark—Bose's A20—wins by a sizable margin. Still, it's nearly \$600 more than the flagship Faro.

Backseaters with heads of all sizes never complained about the G3's comfort, although one experienced slight discomfort with metal-templed sun-

glasses. The G3's active noise reduction is rated at 52 dB and we found that the ANR circuitry performed well in our two evaluation aircraft: a Cessna 210 and a Cirrus. We never experienced ANR rumble or other imperfections we half expect when trying new models. When passive (with the ANR circuitry off), the G3 is a good performer and we attribute that to the tighter clamping force. Lose the batteries and the set outperforms a passive Bose A20, in our estimation.

The set uses two AA batteries and Faro discourages using rechargeables because they can provide uneven voltage, which can flaw the ANR circuitry. Depending on the cockpit noise level, Faro says you can expect up to 40 hours of battery life, but we didn't log that much time with the headset. We immediately appreciated the automatic shutoff, which powers down the ANR circuitry after an hour if it isn't connected to audio jacks.

Additionally, we applaud Faro for including battery power status annunciators, which flash green when power is strong, flash amber when low and flash red when the batteries are about to quit. The annunciator is perfectly positioned above the on/off power button on the face of the control module.

The module is simple and logically designed, but it's a bit too fat for our liking (it seems heavier than the headset), plus we struggled with the removable battery compartment door

The stereo G3 has good build quality, but we wish the control module had less bulk.

on its backside. The left and right volume controls are strategically placed on the upper corners of the module's case and adjustment is linear, offering plenty of gain for aircraft radio/intercom and Bluetooth audio input. There's also a 3.5-mm wired aux input. A Bluetooth status annunciator is located directly above the Bluetooth control button. There's also a dedicated Bluetooth audio volume control, which eliminates having to reach for your smartphone or tablet to tweak the volume of the tunes. We had no trouble pairing to an iPhone 5, 6 and current-gen iPad.

Similar to high-end audio panels and intercoms, an auxiliary audio priority slide switch controls which audio gets switched through—either A, B or C. The "A" selection is intercom priority, which mutes the Bluetooth and aux input when there's intercom chatter. The "B" selection mixes all audio sources together and "C" isolates the intercom, muting all audio sources, which is useful for passengers.

Like all of the headsets in the Faro line, the set has a 3-year warranty, a 30-day return policy and comes with a decent soft storage bag.

Contact Faro at 855-359-3276 in North Las Vegas, Nevada, and at www.faroaviation.com.





Beechcraft Sierra

Slower and cheaper than a Bonanza, the Sierra impresses with a comfy cabin, good reliability and sturdy build quality.

The Beech Sierra's entry into the normally aspirated 200-HP piston single market was—like its competitors' offerings—a growth airplane derived from an earlier model with less horsepower and less complexity. That was the Model 23 Musketeer, of course. Like Piper's Arrow and Cessna's Cardinal RG, the Sierra sports four seats, a constant-speed prop and retractable landing gear, making it a logical step-up for newer pilots and owners looking for something a bit more than a trainer-category aircraft. While it's no speed demon, there's a lot to like about Sierra ownership.

Like the Musketeer—and most any product from Beech, for that matter—the Sierra is well-known for quality components and construction, as well as comfort. Owners admit that the Model 24R Sierra isn't the sleekest of the 200-HP crowd and it certainly isn't the fastest. It might be the most comfortable, however, and perhaps the most reliable.

HISTORY

Beech's Musketeer was the company's answer to the Cherokees and

Skyhawks of the world. The first of that line, the Model 23, came to market in 1963. Three years later, the Model A23-24 Super III debuted. With 200 HP and fixed gear, it wasn't nearly as fast as the same-power Mooneys of its day (the Arrow and Cardinal RG hadn't been

Like most of the Beech line, the Sierra is considered an absolute delight in the air.

introduced yet). In 1970, Beech made the decision to fold the A23-24's landing gear, resulting in the Model A24R, or Super R.

The Sierra name came with the B24R in 1973. Also, Beech one-upped Cessna, Mooney and Piper by making the A23-24 and the 24R models nominal six-seaters, if so ordered from Beech; they cannot practically be retrofitted with the aft seat, due to structural differences.

It gained some speed, but still lacked some of the better, more utilitarian features that would make

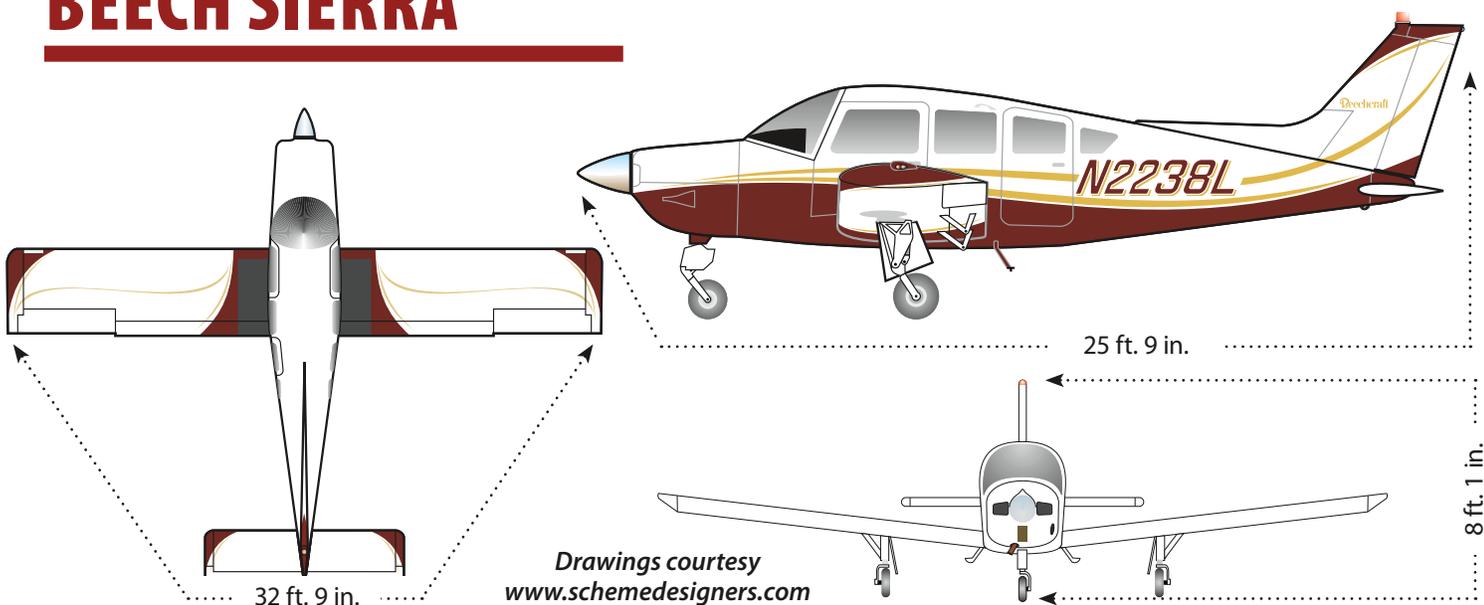
its successors much more likeable. It did, however, have the hallmark of all Beeches: It was comfortable (as in roomy) for the occupants. In a general aviation world where most designs crammed people shoulder-to-shoulder, this alone was a good selling point. The Sierra (and fixed-gear Sundowner) cabin is two inches wider than any Bonanza or Baron.

While it was an option in 1970, in 1971 Beech capitalized on the design's comfort by adding a second cabin door along with enlarging the baggage door and moving it to the left side.

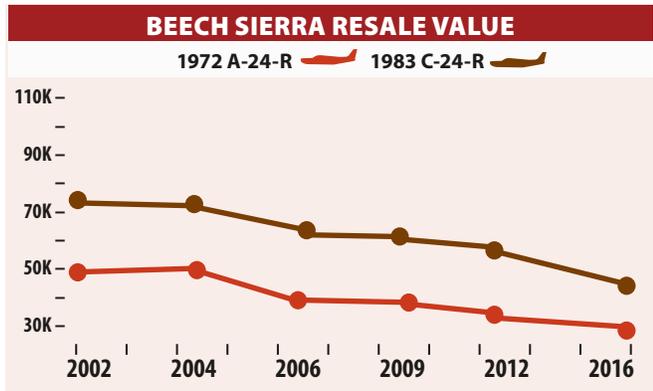
These changes made loading and unloading much easier. The split passenger seats could now be removed literally in seconds, for loading pets, bikes or cargo. Many also discovered the big aft door, with its child-resistant inner handle, was perfect for placing squirming children in the rear jump seat. In 1973,

That's a 1977 C24R, top. A Sierra may not turn heads on a ramp, but it has an impressive range and load-carrying ability.

BEECH SIERRA



BEECH SIERRA MODEL HISTORY							
MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1970 A-24-R SIERRA	LYCOMING IO-360-A1B	2000	\$30,000	59	1140 LBS	131 KTS	±\$27,000
1972 A-24-R SIERRA	LYCOMING IO-360-A1B	2000	\$30,000	59	1140 LBS	131 KTS	±\$29,000
1973 B-24-R SIERRA	LYCOMING IO-360-A1B	2000	\$30,000	52	1039 LBS	131 KTS	±\$30,000
1975 B-24-R SIERRA	LYCOMING IO-360-A1B6	2000	\$30,000	52	1039 LBS	131 KTS	±\$32,000
1976 B-24-R SIERRA	LYCOMING IO-360-A1B6	2000	\$30,000	52	1039 LBS	131 KTS	±\$33,000
1977 C-24-R SIERRA	LYCOMING IO-360-A1B6	2000	\$30,000	57	1054 LBS	137 KTS	±\$34,000
1979 C-24-R SIERRA	LYCOMING IO-360-A1B6	2000	\$30,000	57	1054 LBS	137 KTS	±\$36,000
1981 C-24-R SIERRA	LYCOMING IO-360-A1B6	2000	\$30,000	57	1054 LBS	137 KTS	±\$38,000
1983 C-24-R SIERRA	LYCOMING IO-360-A1B6	2000	\$30,000	57	1054 LBS	137 KTS	±\$39,000



- ### SELECT RECENT ADS
- AD 89-24-09** INSTALL INSPECTION PORTS/INSPECT AILERON BEARINGS EVERY 100 HOURS
 - AD 88-10-01** REPLACE FUEL BOOST PUMP PER BEECH SERVICE BULLETIN MSB 2217
 - AD 87-02-08** INSPECT/REPLACE STABILATOR HINGE FASTENERS EVERY 100 HOURS
 - AD 85-05-02** MODIFY FUEL SELECTOR GUARD BY INSTALLING NEW STOP AND DECAL

SELECT LATE-MODEL COMPARISONS

PAYLOAD/FULL FUEL		CRUISE SPEEDS		PRICE COMPARISONS	
'77 BEECH SIERRA	~680	'77 BEECH SIERRA	~135	'77 BEECH SIERRA	(\$34,000)
'77 CESSNA 177RG	~650	'77 CESSNA 177RG	~150	'77 CESSNA 177RG	(\$49,000)
'77 PIPER ARROW III	~650	'77 PIPER ARROW III	~135	'77 PIPER ARROW III	(\$62,000)
'77 MOONEY 201	~650	'77 MOONEY 201	~160	'77 MOONEY 201	(\$68,000)
'77 AA5B TIGER	~700	'77 AA5B TIGER	~135	'77 AA5B TIGER	(\$40,000)



The Sierra's panel easily accommodates big-screen avionics upgrades. The one shown at the top sports an Avidyne IFD540, plus a refurbished instrument panel. The complete BendixKing stack in Paul Wurbin's Sierra, bottom, has a KSN770.

Beech introduced the new instrument panel featuring quadrant-style engine controls. They also changed props, going from the original McCauley to a Hartzell.

In 1977, the C24R was introduced. Last of the line (production ceased in 1983), the C model featured several improvements. New aileron bearings resulted in a smoother control feel. Usable fuel was again certified at 28.6 gallons per side, following a brief hiatus involving misoriented fuel pickups in some tanks.

The cabin vent system was changed, improving what was already an excellent system by most owners' reckoning. A larger-diameter prop was hung out front to provide a bit more thrust. A rather modest

drag-reduction program was instituted and leading and trailing fairings were added to the main wheel wells, plus gascolator and battery venting.

The ailerons gained nominal gap seals. In fact, the changes made in mid-1978 and 1979 could easily have qualified for a D-model designation and included a 28-volt electrical system, different brake calipers and disks, and much more.

All models, even the fixed-gear Super IIIs, were powered by a 200-HP Lycoming IO-360, with the retractables getting the -A1B6 version. Total production for all retractable 24R versions came to 793.

COMFORT AND UTILITY

The Sierra's cabin comfort has always been one of the design's better

points. Owners tend to rave about it. Beech has always been known for building airplanes that didn't squash occupants, and the Sierra was no exception. But there's a price to pay for comfort, and in the Sierra as in so many other designs (like the Rockwell 112/114), the penalty for all that space is greater fuselage wetted area, translating into drag. The partially unenclosed landing gear does nothing to help here, particularly on the A and B models.

If there's one uncomfortable aspect of the Sierras, it's noise, probably resulting from the numerous windows. These days, with noise-canceling headsets, that's not as big a problem as it was in the day. If refurbishing a Sierra, thicker glass is an option, especially if you're willing to trade some useful load for noise reduction, while sound-insulating foam in the doors and sidewalls might be a better way to spend money as today's ANR headsets do solve the noise issues.

As mentioned, and despite the windows, the fresh-air vent system—especially on later models—is capable of keeping back-seat passengers from frying under the summer sun. In winter, the heating system is able to get warm air back there, too, preventing cases of flying frost.

Yes, you could get all six pax in there and still have enough load ability left to carry 50 gallons of fuel (and remain within the CG envelope, too). There aren't many 200-HP airplanes that can do that realistically, if at all.

If it's not people you want to haul, the Sierra still may be a good choice: The rear compartment is rated to a staggering 270 pounds. And, unlike many other aircraft, that's not just a marketing number. It's entirely possible to toss in all that with two adults up front. The middle and jump seats will have to be vacant, but most of the competition couldn't do this, anyway. If you're ever going to haul Uncle Ernie's antique anvil collection, it's nice to know you can do it with a Sierra. Owners have reported hauling kitchen ranges and clothes dryers, shower door sets, two-blade constant-speed props and other unlikely cargo.

The Sierra's 60-gallon fuel capacity enables a wider tradeoff between

range and effective cabin payload. As one result, comparing a Sierra to its competition's full-fuel payload can be misleading (yet we'll still do it on page 25). But few of the competition allow as much load flexibility as the Sierra—having a higher useful load is useless if CG or access restrictions prevent you from using it. The Sierra's useful load is more of a real-world thing. An IFR-equipped Sierra can haul three adults, 60 pounds of baggage and full fuel. Or fill the seats, keep the baggage loaded and still have more than two hours in the tanks.

PERFORMANCE

Going somewhere? Don't be in a rush. Speed is not the strong point of these smallest-engined of the retractable Beeches. As we've hinted, what the large print giveth in comfort, the small print taketh away in drag.

Consider the Rockwell 112. It, too, is known for its comfortable, roomy cabin. And, like the Sierra, it's not known for getting places quickly. The Piper Arrow, also with an IO-360 bolted up front, books in about 7 knots faster. Cessna's Cardinal RG, also the same basic engine, has about 11 knots on the Sierra. At the far end of the scale is the Mooney 201, which traded cabin space for speed and comes out a blistering 20-plus knots faster.

Something important to keep in mind here, though: Most comparisons are based on book numbers. Reports from the field tell us the Sierra will nearly always meet or beat the book numbers. Others? Not so much. And if you are really after max fuel economy on a local burger run, you can operate a Sierra lean of peak at an indicated airspeed of about 95 knots and burn only 4 GPH. That's Light Sport territory, with a huge cabin.

So the Sierra isn't going to get you anyplace fast. And it's also not known for getting in and out of tight fields with any degree of aplomb. Some owners consider their airplanes to be fit for paved-runway duty only. Short grass strips are not normally an appropriate venue for the Sierra, at least with an inexperienced pilot behind the controls. However, owners tell us low-speed operations based on the go-around configuration, as outlined in per-



Lukas Salyer, top, began flying his Sierra as a 10-hour student pilot, which proves how simple the aircraft is to fly. A large baggage door, middle, makes for easy loading. Passengers will like the Sierra's wide cabin, bottom.



formance charts, allow Sierras to easily handle most common turf strips.

HANDLING

Like most of the Beech line, the Sierra is considered an absolute delight in the air. The controls are light and smooth, and fluid handling through graceful maneuvers is a breeze. The controls make it handle like something lighter, while providing a smoothness normally found only in much larger aircraft. Owners boast that the Sierra's full-deflection roll

response is impressive.

All this is true, until you try getting the thing on the ground. While the Sierra may be slow in cruise, it's pretty fast on landing. VSO is 60 knots, making for a fairly high approach speed. For comparison, consider that the Mooney 201,

BENT SIERRAS: ENGINE/MECHANICAL

We were impressed by how few Beech Sierra accidents there have been—we had to look back 40 years to find a full 100 accidents to review. We were also impressed by the absence of runway loss of control (RLOC) accidents—only seven, by far the fewest for any type we can recall in years of doing accident reviews. It's a testament to the airplane's manners on the ground.

There were only two gear-up accidents, less than half of what we expect to see on folding-gear birds.

Engine/mechanical issues brought down 22 Sierras—and virtually all of those were due to improper maintenance, not something wrong with the design of the aircraft or engine. We saw the usual malpractice: from fuel lines that were left disconnected or only connected finger-tight, through cylinder bolts that were improperly torqued to the wrong fuel pump being installed.

We were fascinated by two gear-related events: In one, the nose-wheel fell off just after takeoff (the pilot brought it back around and had a noisier than normal rollout); in the other, the nosegear started to retract during the takeoff roll and the prop took divots out of the pavement as it started to pretzel itself. Amazingly, the pilot pressed on. Once in the air, he reconsidered the flight and set up for a landing on a nearby road. He hit trees with a wingtip before touchdown leading to a loss of control and extensive damage to the airplane.

Of the inflight loss of control, hard landing and stall accidents, 11 were precipitated by a cabin door coming open shortly after takeoff. Several pilots attempted to return for landing while flying the pattern at altitudes well below 500 feet and then either stalled or lost control.

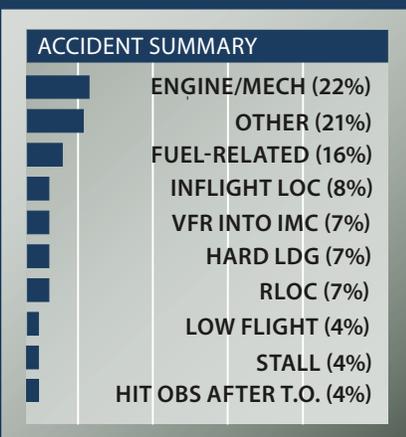
The POH says that aircraft handling is not adversely affected by an open door; however, rate of climb will diminish by at least 150 FPM. Our takeaway is that if the door comes open, focus on flying the

airplane, maintain airspeed and do everything as normally as possible rather than cut corners trying to land as soon as possible.

Over half of the fuel-related accidents involved pilots who ran a tank dry and either didn't switch to the other tank, didn't do so in time for a restart or didn't follow the restart procedure in the POH. There is no "both" position on the fuel selector, which, from our review of thousands of accident reports, means that some pilots will manage to mismanage the fuel system and not make use of all the fuel they have on board.

Falling into the "other" category were several takeoff accidents in which the pilot tried to get performance out of the airplane that was never built in. The Sierra is not a short-field airplane—and attempting to take off downwind or at high density altitudes should only be done with lots of runway available. Several pilots complained that their airplanes didn't seem to want to accelerate or climb after they had aborted takeoffs and went off the end of the runway or hit obstructions after takeoff.

There were two inflight breakups: one VFR on an overcast night, the other IFR. In both cases there were thunderstorms in the immediate vicinity. VFR into IMC claimed seven Sierras. Most of the accidents were fatal; however, one pilot was able to land after he flew into low clouds and then hit a guy wire on a tall tower.



considered a "hot" landing airplane, actually has a stall speed 5 knots slower than the Sierra. Other competitors, like the Arrow, also have lower stall speeds (11 knots slower in the Arrow; 9 for the Rockwell 112B).

So, your speed down final is a bit higher to start with. And speed control is absolutely vital in the Sierra. A bit too fast and she'll float badly. As you slow, the stabilator's declining authority can lead to some pretty wild oscillations and overcontrolling. It's not a pretty picture. Try coming down final a bit on the slow side and you're in for a hard nose-first arrival, unless you carry some power.

The same stabilator that had so much authority when the airspeed was too high tends to run out of ability when the plane gets too slow—especially at forward CGs. This generally results in a wheelbarrowing landing. On the other hand, if you get the nose up while the airspeed is too low, the escalating sink rate makes for a hard landing—same result, just for different reasons.

Compounding all of this is the fairly stiff trailing-link landing gear. The shock absorbing system consists of rubber donuts, as on a Mooney. These have never been noted for their give, and age does nothing to soften their disposition. That said, what you give up in shock absorption might be gained back from savings on conventional strut maintenance. If there's a secret to getting good landings out of the Sierra, it's carrying some power into the flare. A little throttle jockeying can go a long way toward making for a smooth touchdown, provided your airspeed is right on the money.

To be fair, most owners report no problems at all with landing qualities. And on the plus side for landings, the Sierra's gear has an admirably wide stance and can handle tremendous impacts. Crosswinds are easily handled with a crab to the flare and then dropping the upwind wing just before touchdown to straighten out the nose. At the same time, avoid coming down final in a slip. The airplane is placarded against slips of more than 30 seconds in duration, due to fuel unporting problems if the low tank is selected during uncoordinated flight.

Despite these vices, the Sierra is



The Sierra offers signature Beechcraft handling, which is well-balanced and responsive.

a most pleasant airplane, at least up until landing. The stall is gentle and gives good advance warning. At forward loadings, it's more likely to simply hunt the nose up and down with a prodigious sink rate, rather than snapping down or over if the ball is not kept centered.

One handling virtue of the Sierra is the great strength of the landing gear in flight. As a speedbrake, with those huge flat-faced castings, gear-lowering speed is pretty close to cruise speed—you can drop them at up to 135 knots. If you need to get down fast, or slow down fast in an emergency, dropping the gear is a good way to do it. Owners tell us the Sierra can handle a slam-dunk approach with aplomb: Fly it at 140 knots or more down final with the gear up, then close the throttle, throw out everything and land safely from a quarter-mile out. Spiraling down at rates exceeding 3000 FPM is reportedly possible, without exceeding any limitations.

MAINTENANCE

A recent review of FAA Service Difficulty Reports (SDRs) indicates some common items require regular attention. Broken nosegear steering lugs (from bad ground handling), nosegear actuators that internally bypass fluid, cracks in the nosegear yoke (usually impact damage), binding or broken nosegear downlock springs and so on all added up to indicate that the nosegear merits

special attention, as is really the case on any aged retractable. Owners tell us the auxiliary nosegear downlock switch called for in Beech Service Bulletin SB-2683 is really a must-have on a Sierra, but most are still missing that switch.

We also found several instances of airframe components requiring repair or replacement due to cracks or corrosion. From our research, fuselage components coming in contact with fresh air ducting need close examination, as this apparently is an area experiencing rampant corrosion. The Sierra's type club, the Beech Aero Club, has teamed up with a supplier that provides premium replacement parts for the standard ducting.

The Sierra has had its share of type-specific and shotgun ADs, but most of these are better than 20 years old and should long since have been complied with. Some relatively recent ones are: 89-24-9, aileron rod end bearings (see below); 88-10-1, replacement of fuel boost pump; 87-2-8, inspect the stabilator hinge fasteners every 100 hours; and 85-5-2, modify the guard on the fuel selector (this guard had been replaced as the result of a 1975 AD). Owners tell us none of these ADs have proven onerous thus far.

When searching for a good used Sierra, there are some points to remember. One of the first things to look at is the front end. Examine the engine mount and firewall for evidence of a hard wheelbarrow. This is where the damage occurs, so a careful check is in order. Also, examine the logs carefully for evidence of a gear-up landing.



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Another item to look for in the logs is replaced aileron rod end bearings. Over the years there have been many instances of these concealed forward bearings seizing due to lack of proper lubrication during 100-hour servicing, leading to stiff or even frozen controls. Ultimately they were targeted by AD 89-24-9, which calls for installing inspection ports and inspecting the bearings every 100 hours. All of the C-Model Sierras came from the factory with the improved inspection and lubrication access.

MODS, TYPE CLUB

Perhaps due to the relatively low production numbers—only 793 retractable Model 24 airframes left Beech's now-closed Liberal, Kansas, factory—or maybe because owners are happy with their decision, few modifications seem to be available for the Sierra. Nothing, at least, like its bigger brother, the Bonanza. Sure, one can install just about any electronic gauge or avionics one wants, including a Garmin G600 glass panel or Precise Flight's (www.preciseflight.com) Pulselite control unit for landing/taxi light systems. But the list of available airframe mods isn't a long one.

Globe Fiberglass (www.globefiberglass.com) and a couple of other suppliers offer fiberglass wingtips and other fairings, which reportedly are far preferable to the crack-prone

A fuel-injected Lycoming IO-360 isn't a powerhouse, but it makes a Sierra's operation both simple and efficient.



ABS plastic ones Beech put on at the factory. Meanwhile, Micro AeroDynamics (www.microaero.com) offers a vortex generator kit for wings, stabilator and vertical stabilizer it says will reduce the clean stall speed by as much as 10 knots, with a correspondingly shorter takeoff and landing roll. This might be just the ticket to cure the Sierra's runway-related shortcomings, including regular operation at unpaved strips.

Hands down, the best resource for Sierra owners is the Beech Aero Club, an internet-based type club (www.beechaeroclub.org). The organization takes its name from the way in which Beech marketed its training and personal aircraft beginning in the 1960s. Its website has plenty of resources you'd expect from a type club, including AD listings, contact info for CFIs experienced and knowledgeable with the type, service bulletins and—through experienced owners—a wealth of knowledge. Another online resource is Beech Talk (www.beechtalk.com), which is focused on Bonanzas and Barons, but also enjoys active participation among Musketeer, Sport and Sierra owners.

OWNER COMMENTS

Although the Beechcraft Sierra was marketed primarily as an advanced trainer aircraft for commercial pilot and CFI students, it is a remarkably capable personal traveling machine. I have owned and operated my 1981 C24R for over 15 years and 2500 hours of personal flying.

My Sierra came out of the factory as a six-seat plane, but I fly and insure it as a four-seat plane, enjoying extraordinary baggage space and access. The three large doors make loading passengers and baggage easy. The wide CG envelope makes it easy to load light or heavy and still stay within limits. There is a noticeable increase in climb rate and speed once weight is a few hundred pounds below gross, but it still makes book performance numbers at maximum gross weight.

The Sierra is not the fastest cruiser or the best climber in the 200-HP complex class, and it is not a short runway hero. But, the balance of all these combined with exceptional cabin comfort and operating efficiency makes the Sierra perfect for my needs. I often load baggage and two adults, top the fuel tanks and fly more than five-hour legs at 130 knots. My home-to-destination block times are often far quicker than many six-cylinder planes with similar loads. The low fuel burn allows me to forego a fuel stop that many other singles would need on these types of trips. I routinely plan on 9 GPH fuel burn at 130 knots. With 57 usable gallons of fuel, we are all ready to get out when we get close to my one hour reserve limit.

Compared to the fixed-gear Musketeer, the cost of maintaining the retractable gear and the constant-speed prop are well offset by the faster cruise speed with lower fuel burn. If used for longer trips, the Sierra makes financial sense over the fixed-gear versions.

I have periodically updated my IFR avionics and found that the panel has plenty of room for the current large screen displays. The later 24-volt electrical system allows plenty of battery reserve to keep it operating in case of alternator problems.

Beech generally turned out its models with adequate corrosion protection and my plane has had no problems living near the ocean. The only real corrosion issues seemed to come from the old black steel wire scat hose that Beech used as ducting. I replaced all mine years ago with modern ducting. When doing a pre-buy exam, examine the ducting and know that black hoses are the bad ones, while the replacements are red.

The biggest financial benefit comes at overhaul time. I think the IO-360 has lower maintenance and overhaul costs than the six-cylinder engines of the similarly performing Cessna 182, which was a consideration during my shopping. My starting annual inspection cost is the same as my shop charges for all similar small retracts. I tend to do a fair amount of preventive maintenance, so I rarely end up paying for a basic annual inspection. Parts that are specific to the Sierra model are rarely needed and there are some specialty sources. In the 15

years owning this Sierra, I have not found any parts that were impossible to find.

The Beech Aero Club organization is an absolute must-have for a Sierra owner. It has saved me a lot of money and time over the years for sourcing parts, advice and old documentation. There is a strong group of owners, pilots and A&Ps in the group and most questions posted on the website get a legitimate answer within a few hours.

My insurance, which is based on lots of time in type and an \$80,000 hull value and \$1 million dollars of liability with no sublimits, is roughly \$1300 yearly.

In summary, after 15 years and 2500 hours of Sierra ownership, I can't think of a better plane for my needs. In today's market, the Sierra is nicely priced among other traveling machines. It is thoroughly capable of comfortably carrying myself and three friends from Virginia to the Bahamas with one fuel stop. Maintenance is relatively simple and there are few ADs. It's also an easy plane to fly, given its initial design goal as an advanced trainer. You can use it for training flights or \$100 burgers, plus it's roomy enough for long trips. That's a balance that is tough to beat.

Paul Wurbin
via email

I've owned a 1977 C24R (N699DK) since May 2013. I was casually looking for a Sierra because I had trained for my private pilot certificate in the late 1970s in a BE19 Sport at the University of Illinois. I admired the aircraft's sturdiness, roominess and stability.

Compared to the Sport, the Sierra offers more speed and a cavernous 24 by 30 foot baggage door. Another selling point is the easy removal of seats for added carrying capacity, plus the large fuel tanks.

Maintenance has been straightforward and the IO-360 engine is reliable going into the 1900-hour mark. I've replaced the main gear donuts last year with an aftermarket set, which was roughly \$550 for each gear. That's not cheap, but the old set was original. Annual inspections have averaged \$2000 because I have a very thorough IA. Fuel burn is between 9 to 10 GPH and cruising

speed is 120 to 125 knots.

Last winter I added GPS and ADS-B capability with an Avidyne IFD540 and Avidyne AXP340 1090ES transponder. Beacon Aviation in Grand Ledge, Michigan, did a great job cleaning up and painting the panel.

Overall, I'd say this is a great aircraft for me. It's not the fastest in the class, but it's certainly comfortable, roomy (I'm 6 foot 4 inches tall and weigh 240 pounds) and a great IFR platform. It's also a great value—comparable complex singles usually demand as much as \$20,000 more than a Sierra.

David Hast
via email

I purchased N1960, a 1976 B24R, in November 2010 at the age of 30 and with a total of 10 hours experience (all in Cessna 172) as a student pilot. Many folks advised me to purchase a 172 and then resell it once I completed my training. Since the hardest part of the purchase was convincing my wife that airplanes are a good investment, I had to look for something that was economical, within our budget (\$30,000 to \$60,000) and could serve us for years to come.

It was almost by accident that I stumbled upon the Beech Sierra, but it didn't take long to see that this was one of the most efficient and economical airplanes ever manufactured (especially for our budget). Where else can you find a 135-knot airplane with one of the most reliable and efficient 4-cylinder engines available, a 900-pound useful load, a range of over 600 miles, plus the widest and roomiest cabin in class—with two entry doors and full-size cargo area that can hold up to 270 pounds—all at an entry price well under \$60,000?

The Piper Arrow makes the best attempt at comparing itself to the Sierra, but all it takes is a look inside the cabin and one flight to see the Sierra separates itself from all of its competitors. The large cabin combined with a stable platform in turbulence provide exceptional comfort for pilots and passengers on long cross-country trips. The large cargo door allows for you to haul big bulky items. I have placed as many as seven large travel bags in the baggage area, plus I have hauled two sets of golf clubs and baggage for three adults.

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BEECH SIERRA

(continued from page 31)

I now have over 500 hours in my Sierra, and I completed both my private pilot certificate and instrument rating in it. I'm currently working on my commercial certificate.

My annual runs about \$1200 for a basic inspection and insurance is about \$1200 (with an insured amount of \$65,000). I flight plan for 9 GPH in cruise. I figure my operating costs are around \$75 to \$80 per hour, including insurance, annual inspection, fuel, oil, engine and prop reserve. Obviously this varies with amount of hours flown and I average around 125 hours per year.

The most valuable recurring cost is my Beech Aero Club membership. A nominal yearly fee of \$50 provides full access to a club focusing solely

Like any retrac, it pays to look carefully at the Sierra's trailing-link landing gear during the pre-purchase evaluation.



on the Musketeer/Sierra. This has saved me thousands of dollars in labor and parts. I have posted questions related to operation or maintenance, and within minutes received multiple responses from members.

When I purchased N1960L (for around \$45,000), it had new custom paint and interior, a midtime engine, a three-blade McCauley prop, IFR avionics, plus an S-TEC two-axis autopilot.

We have invested in upgrades for the airplane—most of which have been avionics—including a Garmin GNS430W, GMX200, Century HSI, Dynon D2 and a L-3 Lynx NGT-9000 ADS-B system. Despite adding these avionics, we have managed to keep pace with the average book value of the aircraft.

As for performance, our Sierra doesn't disappoint. Critics are quick to point out the trailing-link landing gear, and what they feel is an underpowered engine for the airframe. The weight of the gear might slow the plane's top end speed a bit, but you can have full confidence that it can withstand a lot of imperfect landings. At roughly 900 FPM at 105 to 110 MPH on most days (figure 500 to 600 FPM for max gross takeoffs on hot days), it's an average climber.

The Sierra has an aileron/rudder interconnect system, which can make the controls feel a bit stiffer than other light singles, but responsive enough to ease hand-flying in turbulence.

The airplane has an

FEEDBACK WANTED

CESSNA 210



For the February 2017 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Cessna 210 (non-pressurized) Centurion. We want to know what it's like to own these aircraft, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your airplane to appear in the magazine, send us any photographs (**full-size, high-resolution please**) you'd like to share to the email below. We welcome information on mods, operating expenses or any other comments. Send correspondence on the 210 by December 1, 2016, to:

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excellent CG envelope and allows for several configurations of fuel, baggage and passengers. The Sierra's CG moves forward as fuel burns off.

Overall, I think Beechcraft achieved its goal of developing and manufacturing an economical cross-country airplane that's designed for the regional business traveler or a recreational pilot looking to get away with the family for the weekend. The Sierra reflects the Beechcraft quality, while also providing excellent efficiency.

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