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The Aviation Consumer

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DAVID CLARK: A STORY OF SURVIVAL

I remember the drill like it was yesterday. Self-announce the 45-degree entry to downwind by shouting into the Telex hand mic, stow the Telex mic between the knees, power back, carb heat on and work in some flaps as the cabin speaker in the old Cessna 150 screeched with garbled combined radio calls from every Unicom within a 100-mile range. Those were the bad old days of flying without headsets, of course. Then I stepped up a layer in the food chain and blew my college partying wad on a David Clark headset and never looked back. I think my first model was the company's H10-30—you know, the set with the signature green domes, shiny mic boom and clamping pressure higher than a college-age teenager on a Friday night.

Chances are you've flown with a David Clark headset at least once, and you might even own a set or two or three. As my short attention span flashed back to 1986, or so, it seemed fitting to try David Clark's latest Pro-X2 model for the field report we ran in the October 2019 *Aviation Consumer*. When the article (and the video chaser) hit, some wrote in saying they were happy the company was still selling headsets because like me, David Clark was the first headset they bought—and the set still works.

When the Pro-X2 came off the *Aviation Consumer* test bench, I brought them in none other than a rented Cessna 150—the way some buyers might use them today as I did all those years ago. I could have easily grabbed the set and jumped in a Cirrus or Pilatus to try them out, but that's giving the supra-aural headset (which sits on top of the ear instead of totally enclosing it like a circumaural set) a free pass. Nope. The way to evaluate these things is in a stark, well-worn trainer with inch-wide gaps in the door seals, plugged into a battery-powered portable intercom and keying up a Cessna RT328 navcomm via a coil-corded push-to-talk switch. Watch the video and you'll see what they're made of and some first impressions. Kudos to Clark for getting the second-gen version of these things right, if you can accept some compromise in noise-canceling performance for serious comfort.

But the real story here is David Clark's near 40-year survival in a competitive aviation headset market long dominated by Bose, and Lightspeed, too. There are plenty of other good sets worth considering, of course, but I'm not sure any of them deserve the tip of the editorial hat quite like Clark does. Without argument, the David Clark brand loyalty was well earned and I'm afraid that the loyal grey-bearded David Clark customer base is thinning out with the pilot population. And it was David Clark that impressed that dying demographic with exceptional customer service and a product that took a serious beating. I proved it by not being gentle.

My old Clarks followed me from that old Cessna 150 into a step-up Mooney, they survived aerobatics 101 in a Mudry Cap 10B, they looked good on my youthful head as I got a taste of the corporate world in a Cessna Crusader and the set even survived a hard smack against a Cherokee's hat rack when they departed my wife Ericka's head in vicious turbulence one frigid morning cruising through the New York TCA. Impressed my bride was not.

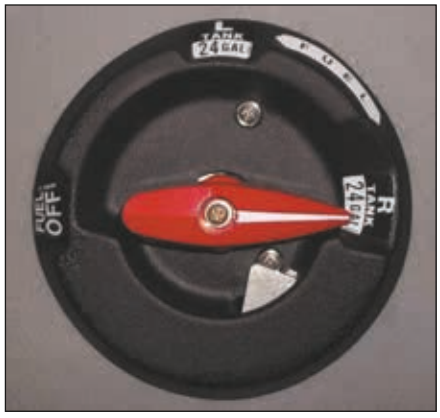
I remember doing what a lot of pilots flying in the Northeast did when they needed their David Clark headset fixed: Fly into Worcester Regional airport in Massachusetts and borrow a crew car to make tracks to where Clark still lives today on Franklin Street in Worcester. I did that twice, I think. Once for a new set of dome pads and another for a microphone swap.

continued on page 23

PIPER FUEL SELECTORS

I find your monthly Used Aircraft Guide section to be the most valuable content among all other aviation publications. Since I'm in the market for a Piper Cherokee, I hit your archives but the last report is before the recent concern of the fuel selectors in these aircraft.

Simple question, which may not have a simple answer: Which is the preferred fuel selector for the PA-28 and should I be concerned about getting stuck with an airplane that will be hit with an eventual AD?



Rick Hastings
vie email

It's the airplanes with the first-generation fuel selectors you want to be cautious of. In August 2019 the FAA issued an airworthiness concern sheet (ACS) that requests PA-28 owners and operators of first-gen fuel selectors (these are the round, flat-plate selector assemblies installed in the lower sidewall) to provide operational input. It wants to know if operators have mistakenly selected the Off position instead of the intended Left or Right Tank position. It could turn into an AD.

Worth mentioning is that there was AD 71-21-08 way back in 1971, which mandated changing the selector, but in 1972 Piper issued a service letter (SL590) and in 2014 the FAA issued Special Airworthiness Information Bulletin SAIB CE-14-22 advising—but not mandating—that second-gen selectors be replaced with third-gen selectors. Those are the ones pictured above. It's clearly the best of them all because it has a mechanical detent that prevents the selector from rotating past the Right Tank position to the Off position. The plastic housing also has more defined positions so you can feel when the selector is in the detents. Got a problem with an early selector design? Email Boyce Jones at Boyce.Jones@faa.gov.

BE YOUR OWN CREW CHIEF

I read Larry Anglisano's First Word commentary in the October 2019 issue about not ignoring service bulletins and have to disagree with the statement that "your biggest resource for this ownership responsibility is your shop."

The best and most interested source is you—the owner. If you're involved enough in aircraft ownership to be an owner/pilot and read *Aviation Consumer*, you're involved enough to keep up with the myriad of SBs, SLs and ADs that come out on your own particular aircraft and its equipment. Many larger shops service 100 or more aircraft every year and in some cases only see them at annual. They probably don't run full databases on what particular mods or STCs your particular airplane has. Many smaller shops are generalists, but you are a specialist on your own airplane, your equipment and your STCs. For most, the aircraft is one of their most expensive assets so it's worthwhile to pay attention.

In 30 years of selling hundreds of aircraft, I've found most owners treat Part 91 "on condition" maintenance on Part 23/CAR 3 aircraft like SBs or recommended TBOs with an attitude of "not needed until it comes apart because it's just the manufacturer trying to screw me." A shop that went to the trouble to send out notes that this or that SB recently came out on their aircraft would be looked upon as a money-grubbing operation looking to stick it to the owners and just be ignored. Almost every aircraft has an online owner's group. Lots of great knowledge to be learned, along with a fair amount of BS. Sort through it and learn. It's a great resource.

Jim Taylor, McCreery Aviation
McAllen, Texas

DAVID CLARK FAN

Nicely field report (and video) on the new David Clark Pro-X2 headset for the October 2019 *Aviation Consumer*. It made me pull the trigger and buy another set to complement the first-gen Pro-X that I've been using for passengers in the cabin of my Baron.

The first set has served me well. It has taken a beating (passengers are not gentle), has good audio quality and passengers really like the comfort of the on-ear design. What prompted me to spend the dough on this set rather than doubling the investment for a Bose A20 (I own two of them also and love them, by the way) is David Clark's proven customer service. I've been flying for 40-plus years and David Clark has always stood behind earlier models I bought. That's rare these days.

Chris Stranding
via email

On The Cover: That's the Garmin Pilot tablet app sporting an ADS-B FIS-B weather image in the cockpit of a light jet. For older jets and turboprops without modern EFIS, a tablet is the only way to get such modern amenities. If you're in the market for a used step-up turbine, our ADS-B For Jets article starting on page 4 is written just for you.

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Jettech in Colorado has an STC for installing Garmin's G700 TXi displays in older Citations, main image. It includes ADS-B In and Out via Garmin's GTX 345R remote transponder, inset. Garmin has the most STC approvals for ADS-B transponders.

ADS-B For Jets: Garmin, FreeFlight Tops

If you're buying an aging jet or turboprop on the cheap, an ADS-B upgrade won't be. There's plenty of equipment, but a long wait for installation.

BY LARRY ANGLISANO

It's no surprise that the U.S. fleet of GA turbines will fall short of the upcoming ADS-B equipage mandate. At press time, 70 percent of small jets and turboprops comply. Some call this the forgotten part of the market—the category between pistons and mid- to large-size bizjets and airliners. And if you're ready to pull the trigger on the purchase of a small step-up turbine that isn't ADS-B equipped, you'll have a problem flying in the ADS-B airspace in a couple of months.

There's no shortage of equipment. When we scanned the market we found that there's a solution for just about every small turbine out there. Garmin and FreeFlight have been concentrating on this market for years and both offer the most comprehensive solutions, and there are others.

But since the market procrastinated, finding a shop to put the equipment in is the real dilemma, just as it is in the piston market. For jets and turboprops it's worse, since installations might take longer. Here's a look at what you'll be faced with when adding ADS-B to what we'll call step-up turbines.

TRANSPONDER AND GPS

Just about all ADS-B solutions for jets and turboprops include transponder work, and in many cases a GPS upgrade. If the aircraft has a TCAS II traffic system, it will require a transponder with diversity, which has dual (top and bottom) antennas. In most cases the existing L-band transponder antennas can be used, which avoids at least some interior and cabin disassembly. But if the aircraft doesn't have an appropriate WAAS position source—and some vintage jets don't—the solution will have to include a WAAS engine and the installation of a GPS antenna. Since that antenna will likely require drilling through the pressure bulkhead for mounting, additional FAA engineering approval is needed. That could cost thousands, on top of the job. Welcome to the world of turbines. But the good news for the rest of the installation is that regulatory approval should be the easy part. There are plenty of STCs in place for installation without having to go through the FAA field approval process. It's no surprise that Garmin has the most, so let's look at Garmin's offerings first.

GARMIN GTX-SERIES TRANSPONDER

Garmin's GTX 345 ADS-B transponder is as dominant in the Part 25 turbine world as it is for piston applications, based on the shops we talk with. Eyeballing the STC approval list and the interface potential is proof. Garmin smartly added an interconnect protocol to these units so that they can be controlled with or without a Garmin display, solving a problem in turbine airplanes still equipped with old avionics.

The $5000 GTX 345 and remote GTX 345R have built-in WAAS GPS, ADS-B Out and In, plus a Bluetooth interface for streaming weather and traffic to tablets running Garmin Pilot and ForeFlight. For jets that have TCAS II traffic systems, Garmin's remote GTX 3000 transponder has the required diversity circuitry.

If you're in the market for a used Cessna Citation that needs ADS-B, there are plenty of solutions and shops have been aggressive in earning STC approvals for installation.

Avidyne's new Atlas multifunction flight management system, top left, is intended to drop into the center pedestal of legacy jets. It's also a good solution for old jets like the Falcon 10, upper right, still equipped with early-gen Collins Pro Line avionics because it has an ADS-B SBAS position source for driving a 1090ES transponder. Another option for GPS position source is the FreeFlight 1203C WAAS GPS and antenna system, bottom.

Columbia Avionics and Aircraft Services in Connecticut (www.columbiaavionics.com) is the STC holder for the panel-mounted GTX 345 (and non-Bluetooth GTX 335) for the Cessna Citation I, I/SP, II, S/II, Bravo, V, Ultra, Encore and Excel/XLS. The STC also includes interfacing with Garmin GTN-series retrofit navigators for displaying traffic and weather.

Florida-based Southeast Aerospace (www.seaaerospace.com) smartly engineered an interface that connects the Garmin ADS-B transponders with the common Gables 7534-series transponder control heads found in a variety of jets and some turboprops. That simplifies the installation and allows you to retain or add common transponder control heads without having to buy a Garmin navigator to control the transponder (the GTN-series navigators have the capability to tune the transponder from the display).

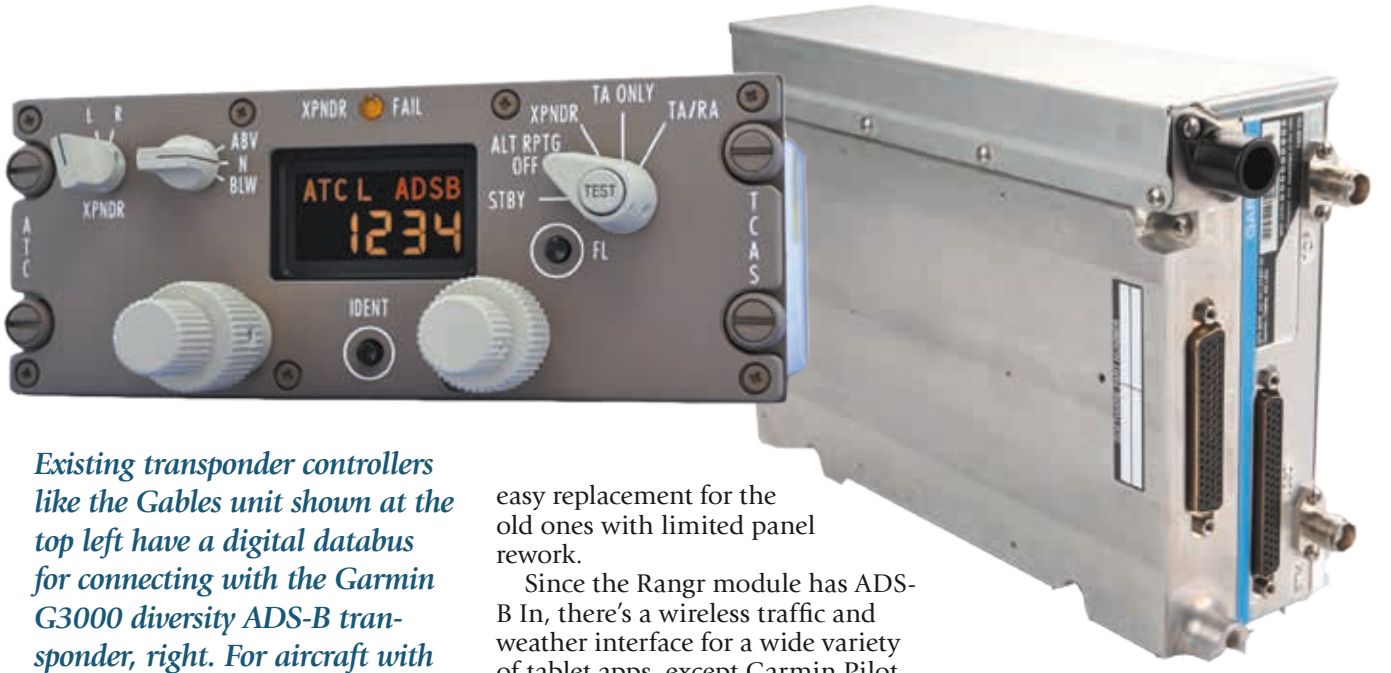
For aircraft that have dual Collins TDR-90 transponders, for example, a typical ADS-B upgrade could otherwise soar above $80,000—and that's just to get ADS-B Out. The STC for this interface essentially reduced the price to under $50,000 using dual Garmin GTX units, which also solves the WAAS GPS position source dilemma since they're GPS equipped. The Gables control head can fit onto the existing transponder controller cutouts without having to do a lot of metal work.

Another popular interface for Citation models (including the Citation II/SII and Citation IV) comes from Jettech (and some other approved Garmin dealers) and it includes installing dual G700 TXi touchscreen displays to replace the old screens. It also installs Garmin GTN-series navigators in the panel, adding LPV approach capability.

Elliott Aviation's Garmin ADS-B STCs replace existing Collins TDR-series transponders with dual remote-mount Garmin GTX 3000 smart transponders. Thinking outside of the box, Elliott will install a Garmin GDL 88, GA 36 GPS antenna and Flight Stream 110 wireless module to provide WAAS GPS position source to the GTX 3000, along with FIS-B and TIS-B traffic and weather streamed to a tablet running Garmin Pilot or ForeFlight.

Elliott's STCs are good for the Citation 560 Excel/XLS, Beechjet 400A/Hawker 400XP, Beech Premier I/A and a variety of Hawker jets with Collins Pro Line 21 avionics. Contact www.elliottaviation.com.

Worth mentioning is you don't



Existing transponder controllers like the Gables unit shown at the top left have a digital databus for connecting with the Garmin G3000 diversity ADS-B transponder, right. For aircraft with TCAS II, it's an easy but pricey solution.

necessarily have to go to the STC holder to have the work done. Other shops can purchase the rights to the approved data. Contact www.garmin.com for a full list of STC approvals and install centers.

FREEFLIGHT SYSTEMS

Texas-based FreeFlight Systems was an early player in ADS-B tech with one of the first certified UAT solutions, and eventually focused on solutions for airline applications. It recently reworked the UAT-based Rangr product (taking out the 978 MHz transmitter), while retaining the ADS-B GPS position source and the ADS-B In receiver and paired it with dual 1090ES ADS-B Out remote transponders.

The target market for this solution, which is around $16,000 for the equipment, are aircraft with legacy transponders that simply aren't cost-effective to upgrade, including the Collins TDR-90. Aircraft examples include legacy King Air, Cessna Conquest and Piper Cheyenne twin turboprop models. Worth mentioning is the FreeFlight transponders don't have diversity, so they won't work with TCAS II traffic systems.

But the FreeFlight transponders do work with 2 1/4-inch round control heads made by Trig Avionics, which could make them an easy replacement for the old ones with limited panel rework.

Since the Rangr module has ADS-B In, there's a wireless traffic and weather interface for a wide variety of tablet apps, except Garmin Pilot.

For interfaces that require a mandate-approved position source (and lots of legacy jets and turboprops lack the capability), FreeFlight has the 1201C SBAS/GNSS standalone GPS receiver, plus the 1203C version, which meets the position source requirements for RNP (Required Navigation Performance) ops. Both receivers have TSO-C145c certification. Contact www.freeflightsystems.com.

BECKER AVIONICS

This company doesn't get the market exposure of others, but it does have a worthy ADS-B transponder solution for TCAS II-equipped aircraft with the Prime Line BXT6500 remote transponder. The transponder has an ARINC 429 interface for EFIS displays and also an ARINC 718 databus for connecting with some standalone control heads.

We like that the BXT6500 has antenna diversity as standard, but there's also a single-antenna version for non-TCAS aircraft. The transponder also takes input from the FreeFlight model 1203C SBAS/GNSS sensor for position source (it doesn't have built-in GPS). Contact www.beckerusa.com.

BENDIXKING

The company has been offering a fairly easy solution for Cessna Citation 525/525A and Citation Bravo models that were delivered with and still have the Honeywell CNI-5000 radio suite. The upgrade includes two BendixKing KT-74 digital ADS-B Out transponders that slide into the existing CNI-5000 radio rack. The upgrade also includes a new panel overlay to match the transponders.

The KT-74 Mode S transponder has been around for years and it still requires an external WAAS GPS position source. To do that, part of the CNI-5000 upgrade includes the BendixKing KGX-150 remote WAAS GPS system with ADS-B In receiver. There's also an optional Wi-Fi adapter for sending traffic and weather out of the KGX-150 into a tablet. Keep in mind your shop will need to install another L-Band antenna on the aircraft for the ADS-B In function to work with the KGX-150. The price for the CNI-5000 upgrade including the Wi-Fi adapter is $21,872, plus installation. Contact www.bendixking.com.

AVIDYNE'S NEW FMS

At press time, Avidyne announced a new product aimed at legacy jets that haven't seen an avionics upgrade in years, and it can serve double duty in a new ADS-B interface. The Atlas flight management system is a standalone Dzus-mounted box that's designed to mount in the pedestal, replacing older FMS units that don't have a WAAS position source.

YouTube See a video on ADS-B for jets at http://tinyurl.com/j95ht2a.

For early Garmin G1000 suites like the one in a Cessna Mustang, top, the remote GTX transponder is the retrofit solution offered by the aircraft OEM. Thanks to Joe Musumeci for the photo. BendixKing KT-74 ADS-B transponders are in the bottom of the Honeywell CNI-5000 radio stack, lower photo, and a solution for Citation models 525/525A and the Bravo.

It's as modern as it gets and far more than a WAAS GPS receiver.

Based on Avidyne's IFD-series panel navigators, the Atlas is a Satellite-based Augmentation System (SBAS) GPS navigator with Required Navigation Performance (RNP) and Area Navigation (RNAV) capability, including Localizer Performance with Vertical Guidance (LPV), Lateral Navigation/Vertical Navigation (LNAV/VNAV), LNAV-only, and Approach Procedures with Vertical (APV) approach modes. The system has a full QWERTY keyboard, plus Avidyne's unique page and tab/hybrid touchscreen user interface. The touchscreen also provides full color moving map and Jeppesen approach charts and airport diagrams, plus it can overlay satellite and ADS-B weather. There will also be an optional weather radar interface. Like the IFD navigators, there's both Wi-Fi and Bluetooth built in.

Avidyne is currently working on STC approvals for the most popular turbine applications. The company has already penetrated this market with the IFD545 for pre-EFIS flight decks, and has configurations for Collins Pro Line 21 and Honeywell Primus-equipped airplanes.

An Atlas installation could be a worthy all-in-one (including ADS-B) solution for old jets that have an avionics bay full of old analog equipment because like the Avidyne IFD navigators, versions of the FMS will have comm (16 watts) and nav capability. This will save panel space and significantly reduce weight, while offering a big shot of modern tech to jets begging for an upgrade. Many of these jets have aging Collins Pro Line avionics that have become expensive to maintain, while support could dwindle in the coming years.

Speaking of Collins Pro Line, the current Collins TDR-94D transponder is fully ADS-B Out compliant, accepts an external WAAS GPS position source and is compatible with TCAS II traffic systems.

Avidyne said the starting price for the base FMS will be around $45,000 and the VHF radio will be a $15,000 option.

"Our hope is that you'll be able to get two of these installed for well under $100,000, perhaps with a decent credit for removed equipment," Avidyne's Dan Schwinn told us. Given the proposed capability and applications, we think that's fair for an aging jet. Contact www.avidyne.com.

INSTALLATION TROUBLES

Given the number of available approved solutions, we favor the products from both Garmin and FreeFlight, and how you choose will simply depend on your current configuration.

As for the installation, retrofitting a jet with ADS-B isn't that difficult, but it could take longer than a typical piston. Garmin's Bill Stone summed it up with accuracy.

"It's just a big-old airplane and ADS-B for Part 25 applications really isn't a big deal, but at this point finding a qualified shop to install it is a big deal," Stone said. In a smaller piston you might avoid flying in ADS-B airspace while you wait for shop time, but that'll be tough in a jet.

Sporty's PJ2 Radio: Inexpensive VHF

The portable VHF radio market has a quiet backwater, but Sporty's sees sales in a stripped-down, easy-to-use comm-only model.

by Paul Bertorelli

For a couple of hundred bucks, why argue about whether a handheld VHF radio is worth having? Top-of-the-line tablets can cost five times as much and navigate with élan, but no comm. The VHF market isn't nearly so vibrant as things that run apps, but Sporty's is out with a new one called the PJ2.

With the exception of accepting the full-sized jacks on a standard aviation headset rather than requiring a cheesy adapter, there's not much new in the PJ2. But Sporty's figured it was time for a product refresh, so here we are.

Heretofore, we've been impressed with Sporty's iteration of the portable VHF, specifically, the SP-400 that's festooned with not just a 760-channel radio, but VOR and ILS functions that actually work. At $199, the new PJ2 isn't meant to replace the SP-400. It will stay in the product line, says Sporty's, at $299, even if those higher-level functions have been displaced by the nav capabilities in a tablet or smartphone or Garmin's GPS portables.

SP-400 STAYS

The SP-400 is ably manufactured by Japan Radio, but for the PJ2, Sporty's found a new vendor called Rexon, a Taiwanese company with a modest line of portable radios, including a VHF aviation model. Because Sporty's didn't like the operating logic of Rexon's off-the-shelf RHP-530, despite its $40 lower retail price, it commissioned Rexon to build a clean-sheet design for its new radio, says Sporty's Doug Ranly. "No one knows about it [RHP-530] because it's not very user friendly. That's one reason we didn't want to sell it because of complications in programming and using it," Ranly says.

Velcro'd to the window frame, the PJ2 provides good VHF performance in a no-electrical-system taildragger. For acceptable performance, it does require an external antenna.

Customers have complained about various nits in the SP-400 and the Icom line, but one consistent complaint is having to haul around an adapter and a push-to-talk switch to use these radios with a standard headset. While you'd certainly want to do that in the airplane with the radio in the backup role, a headset—especially a noise-canceling model—just delivers better performance even on the ground or on the ramp.

BIG JACKS

The standard-size jacks are on top of the chassis behind the two knobs used for on/off and squelch. They're equipped with rubber caps to keep the inevitable flightbag lint and cookie crumbs from tanking the radio's guts.

They're accessible enough, but it's a tight fit because the top of the chassis is as small as it can possibly be to keep the form factor more or less standard. I tried the PJ2 in our Cub, where a portable—an Icom IC-A6 lately—serves as full-time comm. This lash-up requires a push-to-talk switch and the generic PTT we've had for five years worked both with the jacks plugged directly into the radio and through the airplane's Avcomm AC-2EX portable intercom.

As is the fashion these days with gadgets of all kinds, the PJ2 has more high-level features than most users will ever need or want. I mean really, we just wanna talk back and forth a little, have enough power to do that and maybe store a few frequencies. The PJ2 does all that and more, of course.

It will store up to 20 frequencies and has a last-frequency flip-flop that's handy when the radio is primary comm and you want to sneak a listen at the AWOS before flipping back to CTAF. It also has discrete channels for NOAA's weather channels. Ranly said one design goal was large, easy-to-use frequency input buttons and the input logic is predictable: Punch in all six digits of a frequency and the radio will

The SP-400, left, will remain in the product line at $299. The comm-only PJ2, right, sells for $199.

automatically tune it. There's no need to push enter. There's a single button to flip one frequency to the standby window. Scrolling the other stored frequencies is done through a dedicated recall button, which lists the freqs that you can then scan through to select.

Power is provided by six AA alkaline cells; there's no rechargeable option. Well, let me qualify that. The radio ships with a USB-C cable that can be plugged into a standard 2.4-watt USB charger to run the radio. (A lower-wattage charger won't provide enough power to transmit.) You can also use one of the Flight Gear backup lithium-ion packs that Sporty's sells.

GOOD PERFORMER

For ground and on-the-ramp use, the onboard rubber-duck antenna is adequate to summon the fuel truck or check AWOS. The transmitter is rated at 5 watts peak envelope power, but like other handhelds, it radiates about 1.5 watts in general use. That's a relative whisper compared to a 10-watt panel mount transceiver so don't expect comparable performance. And don't expect much of anything unless the radio is connected to an external antenna with a cable terminating conveniently in a BNC connector in the cockpit.

Our Cub has one of those installed inside the fuselage cage on a ground plane behind the pilot's seat. Conceding that this antenna probably doesn't perform as well as one installed outside the cage, the PJ2 still functioned well for routine Unicom and CTAF calls in the pattern. Comm checks with control towers up to 12 miles away yielded readable but scratchy signal quality reports. But it took several calls to get a reply and some ATC frequencies never did respond. Distant airborne aircraft returned good signal reports.

If the PJ2 has a shortcoming, it's display readability. It has brightness and contrast controls and reverse contrast for night use, but scrolling through these various options never yielded a display quite as readable as Icom's or even the SP-400.

Yes, it was functional, but with effort and not without removing sunglasses. The audio quality and sidetone—both through the radio and the intercom—were crisp and readable.

If you already have a VHF portable—whether seldom or frequently used—the PJ2 doesn't bring enough to the party to consider replacing an older radio. The SP-400 is a more capable radio and has the VOR and ILS options. In the age of ubiquitous and cheap GPS, these are unlikely to be pressed into use, but they're there if you want them.

If you have no VHF portable at all, the PJ2 is a good, bargain-price choice and Sporty's has a good rep for supporting such products after the sale.

VHF PORTABLES	STREET PRICE	SIZE	RECEIVER	COMMENTS
ICOM A16	$300	2.1 x 4.4 x 1.3	COMM / NOAA WX	BUILT-IN BLUETOOTH FOR HEADSET; 6 -WATT TRANSMITTER; $260 WITHOUT BLUETOOTH
ICOM A25N	$500	2.3 x 5.8 x 1.3	COMM / NOAA WX	BUILT-IN BLUETOOTH AND GPS; 8.33 MHZ SPACING; 6 -WATT TRANSMITTER
ICOM A25C	$300	2.3 x 5.8 x 1.3	COMM-ONLY VERSION OF A25N	WITH ALKALINE PACK; GOOD CHOICE FOR STORED BACKUP; 8.33 SPACING
SPORTY'S SP-400	$300	5.5 x 2.5 x 1.4	COMM / VOR / LOC / GS/ NOAA	TOP PERFORMER IN PREVIOUS TESTS; EXCELLENT DISPLAY
SPORTY'S PJ2	$200	2.3 x 6 x 1.6	COMM ONLY / NOAA WX	ALKALINE PACK ONLY; CAN RUN ON USB POWER; FULL SIZE JACKS FOR HEADSET
YAESU FTA 750L	$375	5.5 x 2.5 x 1.4	COMM / VOR / LOC / GS/ NOAA	INCUDES ONBOARD WAAS GPS; LI-ION AND ALKALINE BATTERY OPTIONS
YAESU FTA 550L	$289	2.4 x 5.2 x 1.3	COMM / VOR / LOC / NOAA	SIMILAR TO 750L, BUT WITHOUT GPS; INCLUDES HEADSET ADAPTER AND USB CABLE

Phillips 66 New Oil: Lycoming Additive

The new Victory AW 20W-50 engine oil combines multi-viscosity, ashless dispersant with built-in Lycoming anti-scuff treatment.

by Paul Milner

CHECKLIST

- The AW in the Phillips 66 Victory oil means it has the anti-wear additive that's mandated by Lycoming.
- The oil comes in both straight weight and a multi-viscosity version for around $7 per quart.
- Proven additives like Camguard aren't a substitute for the anti-wear AD.

Phillips 66 has announced two new Victory oils, both a straight weight and a multi-viscosity version, with the Lycoming-mandated anti-wear additive already blended in. If you're required by AD to include the Lycoming additive in your engine, of course, you comply.

But for the rest of us, these oils and the additive in particular may not be such a good deal and it's often said to avoid them. Phillips also makes claims of reduced oil consumption with multi-viscosity oils that we consider.

Previously only Shell offered a multi-weight oil with the additive already in place. There are sizable difference between this new Victory oil from Phillips 66 and Aeroshell 15W-50 oil. Shell is a semi-synthetic oil, plus the viscosity range is narrower for Victory.

HISTORY

In 1977 Cessna introduced the 172 N model, employing the newly developed O-320-H2AD engine and allowing Cessna and Lycoming's common parent to save money and offer slightly more horsepower. Unfortunately, the engineering compromises made in the valve train resulted in camshaft lobes and associated lifters that were quite corrosion intolerant. Cost saving led to minimizing the size of the hardened surface, so the contact pressures became extreme. The design was barely adequate, as long as no rust occurred. But any rust increased pressures beyond what the oil could handle, and metal-to-metal contact would occur, rapidly wearing away the valve train components in as little as a few hundred hours.

In addition to counseling owners to fly frequently (which is why the Lycoming H2AD engine did OK at flight schools), Lycoming got the FAA to issue an AD,

80-04-03, now on revision 2, requiring use of a special anti-wear additive. This AD applies both to the 8,331 O-320-H2AD engines included in the 172N and a small handful of O-360-E, LO-360-E, TO-360-E and LTO-360-E engines of similar design included in certain twin-engine aircraft. The anti-wear additive used initially was tricresyl phosphate, TCP. In the presence of water (a byproduct of combustion) and metal surfaces, TCP dissociates to free a phosphate group, which attaches to the lifter surface, providing an anti-wear surface.

TCP occurs in three different molecular configurations, called isomers. In the 1990s, the EPA recognized that one of them was a potent neurotoxin. The commonly available formulations included all three of the isomers, including the neurotoxin. The EPA regulated against it, and most of the industry moved to TPP, triphenyl phosphate (see Chemistry section for differences and discussion).

HARMS FROM TPP IN OIL

Not generally recognized in the industry at that time is that TPP dissociates much more readily than TCP, at lower temperatures. This dissociation also frees up phosphoric acid that attacks copper-containing alloys in the engine, notably oil coolers, and certain types of engine seals, like push-rod shroud gaskets. Shell soon received complaints from users of its straight-weight and multi-vis oils that included TPP; oil analysis that had been showing 5-ppm copper suddenly started showing as high as 500-ppm copper, which was naturally concerning. And the engines were leaking oil.

Shell added a copper corrosion inhibitor to the oil, which reduced copper attack. But the phosphoric acid continues to attack seals and even magneto cushions, allowing them to fall into the sump, retarding engine spark timing.

There's also an issue on Continental engines, which don't have any requirement for TCP- or TPP-containing oil. But, if someone

None of the available oil additives, top, are approved to comply with the Lycoming AD requirement. The chemistry symbology at the bottom, thanks to NEUROtike via Wikimedia Commons, is the three different forms (isomers) in tricresyl phosphate. The ortho version is considerably more neurotoxic than the others, and the basis of EPA pressure to remove TCP from motor oil. That's triphenyl phosphate at the bottom. The phenyl groups don't have the molecular sidechains that the cresyl groups do, which makes them less toxic, but also less stable and less able to provide antiwear functions in the engine.

chooses to add these oils from Shell or Phillips, the phosphate forming on the spring in the starter adapter can allow it to slip, eventually damaging the starter adapter. Interestingly, if everything is perfect—a good-condition starter adapter and a well-charged, high-capacity battery—there will be no starter adapter wear, and the presence of TCP or TPP won't enter into component dynamics.

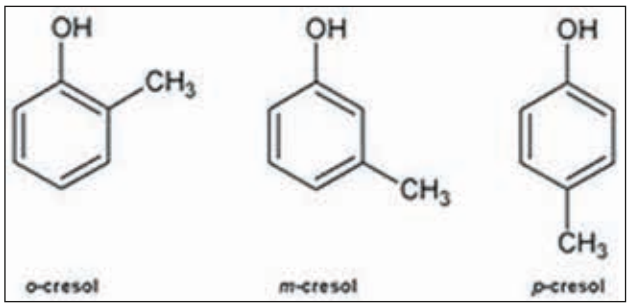
But, once the starter adapter begins to wear, the phosphate coating can lead to a spiraling decline in performance, resulting in failure in as few as a dozen starts.

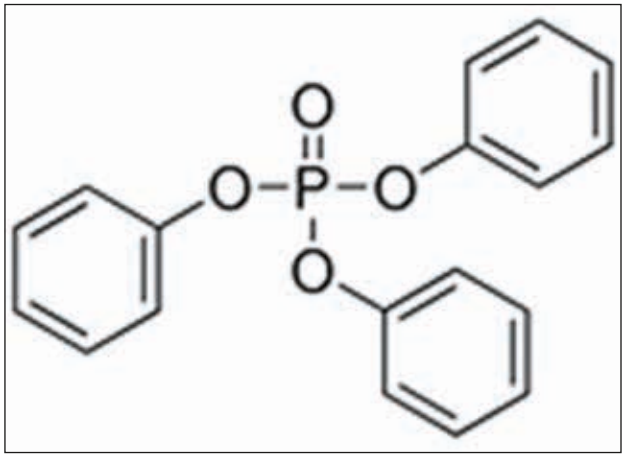
CHEMISTRY

Organic chemistry is the chemistry of carbon-containing materials. One of the staples of organic chemistry, and many of both the drugs and plastics we encounter in everyday life, is the six-carbon benzene ring. The six carbons share electrons, lending interesting properties to compounds containing benzene rings. Each intersection of the ring can attach to yet another molecule or chain of molecules, defining the characteristics of the compound.

The original Lycoming antiwear was TCP, tricresyl phosphate. Defining the cresol group, at one intersection of the benzene ring is a hydroxyl group, OH, oxygen and hydrogen. At another intersection of the ring is a methyl group, CH3, a carbon with three hydrogens attached, most of what you'd need to make a molecule of methane, natural gas. If the methyl group is next to the hydroxyl group, it's ortho-cresol, the most toxic of the three isomers. If there's an "open" intersection between the hydroxyl group and the methyl group, it's meta-cresol; if there are "open" intersections between the hydroxyl group and the methyl group, it's para-cresol. [Cresol isomers illustration].

To make up the tricresyl phosphate, three cresol groups, of whatever isomer, are attached to a phosphorus atom; the fourth "arm" of the phosphorous atom is attached to an oxygen atom. The three benzene rings make the phosphate soluble in oil, important for our application. When heat and water are applied in the presence of a metal surface (the lifter surface), the phosphorous/oxygen pair separates, attaching to the metal surface, where it helps prevent wear.





When the EPA encouraged industry to move away from cresol in consumer products, the Lycoming-compliant oils were reformulated to use triphenyl phosphate (TPP). TPP is very similar: There's still a benzene ring bearing a hydroxyl group, but instead of attaching a methyl (CH3) group, there are simply hydrogen atoms attached to the other locations of the benzene ring, aside from the home of the hydroxyl group. Aeroshell and Lycoming went to the butylated version of TPP, which

is more active (less hydrolytically and thermally stable). Phillips uses a form of TPP that is even more stable (less active) than TCP, and thus ineffective as an anti-wear, but at least they don't need copper corrosion control.

As discussed, this formulation was less stable than the TCP, and tended to come apart at lower temperatures, liberating the phosphate (PO, phosphorus-oxygen) group, which would combine with combustion byproduct water in the oil to form phosphoric acid—generally a bad thing.

Interestingly, Exxon took a different tack, convincing the EPA that the synthetic cresyl groups they were using in the late, departed Exxon Elite were much less biotoxic, and so they should be allowed to continue to use them. Instead of attaching methyl groups, Exxon used molecules with chains of two, three or even four methyls strung together at each of the benzene ring locations that typically bear only a methyl group in the original formulation. These longer side chains apparently have the effect of making the molecule less available biologically, and hence less able to cause nerve damage than the original TCP.

CONSUMPTION: SINGLE-WEIGHT VS MULTI-WEIGHT

Phillips also includes claims of reduced oil consumption with multi-viscosity oils. How could that be? One school of conventional thinking opines that, of course, multi-viscosity oils will be burned more in engines. To understand that thought, let's look at how multi-vis oils work. Multi-viscosity oils are blended by starting with a single viscosity oil that is typically the lowest viscosity, runniest oil if you will, thinnest at a given temperature. To that runny oil (say 20 weight oil in the Phillips 20-50 example) we'll add viscosity index improvers, VII. Viscosity index is a measure of how an oil's viscosity changes with temperature. In an ideal world, you might wish for an oil that doesn't become thinner as it is warmed ... but such oils don't exist. However, by choosing base oils carefully, and by adding viscosity index improvers, we can formulate oils that thin more slowly than conventional oils. In the case of Phillips 20-50, this means enough VII has been added so that at room temperature and below, the oil acts like a 20-weight, leading to ready flow under cold weather conditions, and rapid establishment of oil pressure on cold weather startup. However, as the oil warms, rather than the oil getting as thin as a 20-weight oil at engine operating temperature of say 200 degrees F, a multi-vis oil thins very slowly, so that at 200 degrees, it's only as thick as a 50-weight oil would be at that temperature—its temperature viscosity curve is different than normal oils.

So, historically, folks consider that multi-vis oils should be burned a bit more than single-weight oils; when the engine is cold, that thin 20-weight oil will more readily make its way into the combustion chamber, or be misted overboard with crankcase gases. Maybe so, but our engines don't spend a long time warming up, and typically most of their operating time is at temperatures where the 20-50 should perform just like a 50 weight.

However, remember the VII, the viscosity index improvers. They continue to work at temperatures above average oil operating temperature. And there are lots of places in the engine that are even hotter than the average oil temperature (or we wouldn't need to average, eh?) Cylinder walls come to mind.

Let's say the cylinder wall is operating at 300 F. Because of the VII, the 20-50 oil will be thicker on the cylinder wall at 300 degrees F than a straight 50-weight oil would be. The oil consumption performance will depend on the mix of internal temperatures the oil is exposed to, and how much oil resides in each temperature condition, so it's not surprising that some engines will consume more oil on straight weights, while other engines will consume more oil on multi-vis oils. Phillips hedges their bet: "Reduces oil consumption in most engines."

TPP IN OIL AND LEAD SALTS

The observant reader (typical of *Aviation Consumer*) may note that TCP is the same stuff included in Alcor's TCP lead scavenger additive for gasoline, developed by a former Chevron researcher, the late Al Hundere, decades ago. Will using an *oil* with TCP (or TPP) scavenge lead, thereby sparing one's spark plugs from lead fouling? TCP Fuel Treatment is 80 percent hydrocarbon (think kind of like gasoline) and 20 percent TCP. The instructions call for adding 1 ounce for every 10 gallons of 100 LL avgas.

During the combustion event, the phosphate group combines with the lead oxide molecules in the combustion gasses to form lead phosphate, which is much more volatile and easier for the engine to expel than the lead oxide that would otherwise form.

Lead oxide often sticks tenaciously to spark plugs. Unfortunately, perhaps, the TCP or TPP in the motor oil is not available in the vapor phase of the combustion process to provide this benefit.

WHAT ABOUT CAMGUARD AND OTHER ADDITIVES?

None of the above comply with the AD requirement, if you have an O-320-H2AD engine or one of the few afflicted Lycoming 360 models. Camguard does provide anti-corrosion protection, per the results of previous *Aviation Consumer* evaluations, that may stave off the corrosion failure cascade of the small hardened lifter/cam face interface.

As for pricing, the Victory AW oil sells for around $7 per quart. Consider that both Shell and Phillips offered single-weight oils preblended with the LW-16702 additive. These are priced around $45, which is enough to treat an eight-quart engine sump.

Bottom line: If I owned a Lycoming O-320-H2AD engine, I might use an airworthiness directive compliant oil like Phillips 20W-50, but I'd add Camguard to it to actually protect the lifters. And if I were really motivated, I might request an AMOC (alternative means of compliance) approval from the FAA to use Camguard alone.

Contributor Paul Milner is a retired Chevron chemical engineer, a Cessna turbonormalized Cardinal owner and the technical editor of the Cardinal Flyers Online type club. Visit the club's website at www.cardinalflyers.com.

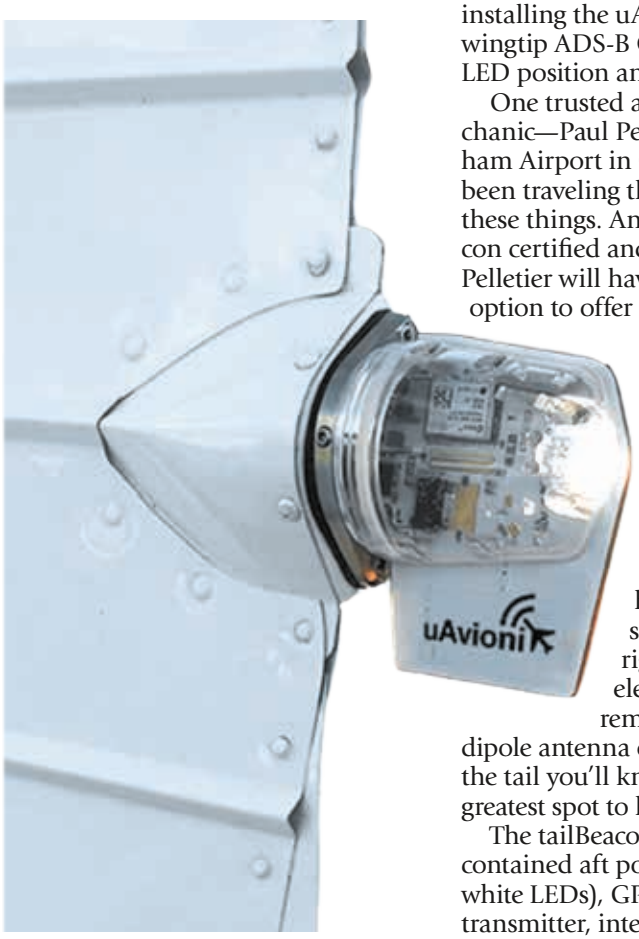
uAvionix tailBeacon: Another Low-Cost Option

First it was ADS-B on the wingtip, now uAvionix has a solution for the tail. Since it will live a hard life up there, long-term reliability is unknown.

by Larry Anglisano

UAvionix says a typical tailBeacon's physical install will take 15 minutes. That's possible for some, but knowing how things work on the shop floor we think that's unrealistic for many.

With its newly TSO'd $1999 tailBeacon—the follow-on product to the popular $1849 skyBeacon—uAvionix is hoping to pick up more sales from last-minute buyers looking for a simple solution for the approaching mandate. That shouldn't be tough because by the time this issue rolls off the presses it will be roughly T-minus eight or nine weeks until showtime for the FAA's ADS-B airspace equipage requirement.



And shops we talk with say ADS-B sales remain brisk, while scheduling remains a challenge. If you've waited until now, we wish you luck. It's as long as nine months to get on some schedules, and while some of the shops I talk with say they are installing primarily Garmin transponder-based solutions, I know a handful of A&P mechanics who have been busy installing the uAvionix skyBeacon wingtip ADS-B Out unit, which has LED position and strobe lighting.

One trusted and experienced mechanic—Paul Pelletier at the Windham Airport in Connecticut—has been traveling the country installing these things. And with the tailBeacon certified and shipping, guys like Pelletier will have another low-cost option to offer customers.

TOUGH LIFE, SIMPLE INSTALL

Face it, for the aircraft that lives outside, the tail section takes a beating. While cabin covers and even wing covers help protect the main structure, the tail is right up there in the elements. If you've ever removed an old VHF dipole antenna or position light from the tail you'll know that it's not the greatest spot to hang accessories.

The tailBeacon, with its self-contained aft position light (two white LEDs), GPS-equipped ADS-B transmitter, internal altitude encoder and Wi-Fi transceiver, is designed to use the existing position light wiring. That's as simple as connecting power and ground, while using the existing lighting circuit switch. The device is mounted with two #4 screws to the existing holes and nut plates for the old lamp with a mounting plate and gasket. No, there's not a strobe light in the tailBeacon.

I like that there's a gasket because the tail section is generally prone to water intrusion. Once wired, simply insert the device into the mounting plate and twist to lock it in place. The image below shows the installed unit—with the fin facing directly downward. Like the skyBeacon, the device is programmed and configured with the uAvionix app utility.

WHICH ONE?

But how do you decide between the new tailBeacon and the wingtip-mounted skyBeacon? "The choice comes down to physical fit and personal preference," uAvionix COO Ryan Braun told me. He makes a good point that some aircraft with wingtip lighting fairings aren't compatible with the skyBeacon, which bolts to the exterior of the wingtip. But, some rear position lights aren't well positioned for the tailBeacon because they may have an elevator or horizontal stabilizer directly above the light. That could obstruct the unit's required view of the sky for a good GPS signal.

If you already have a working strobe system you might not want to replace it, so the strobeless tailBeacon may be the better option. But for some aircraft, mounting the device on the tail just isn't a good idea.

"I've seen some low-hanging tail lights on taildraggers, and I wouldn't recommend installing a tailBeacon in its place due to the real possibility of a strike," Braun said. Good point.

The uAvionix tailBeacon and skyBeacon both have a two-year limited warranty, and I'm anxious to see how these units hold up after collecting ice, water and generally living tough lives on the outside of the aircraft.

To date, technical support from the company has been excellent, according to the installers I talked with. We're planning on installing a tailBeacon for a follow-up report, including a video to document the process, so stay tuned.

Your Flight Review: Inexpensive Prep Tips

There are plenty of inexpensive or free resources available to help you prepare for your flight review. A little homework can make the FR a breeze.

by Rick Durden

One would think that a fairly simple recurrent training requirement established by the FAA over 40 years ago would be a ho-hum thing by now.

One would be wrong.

The FAR Part 61.56 requirement to fly with an instructor biennially (every two years) and receive an endorsement of a pilot's basic fitness for flight is shockingly prosaic when compared to what professional pilots must do for recurrent training under Part 135 or 121. Yet the flight review (FR) still gives many pilots the vapors and has spawned a cottage industry in "how to prepare" courses.

We looked at review/prep courses, reviewed accident reports and statistics and spoke with instructors about flight reviews in coming to a number of conclusions about getting ready for and successfully completing a flight review. We'll state them up front:

• Frequent recurrent training is hugely valuable for pilots. It's a major portion of the reason why the accident rate for airlines, air charter, fractionals and business flying is so low. A flight review every two years helps reduce the risk that you'll roll an airplane into a ball and we strongly recommend one every year.

As we were researching this article Avemco and the National Association of Flight Instructors released data showing that over half of all aircraft accidents involved pilots who had not flown with an instructor in over a year. We think that is a giant red flag warning against going more than a year between flight reviews.

We also learned that as the insurance market is "hardening" with rates going up, the insurers are instituting more rigorous recurrent training requirements. If you're flying a piston twin, you probably have to take recurrent training annually now to get insurance. We anticipate the annual training requirement to trickle down to high-performance singles.

• If you're flying regularly, you'll probably complete your FR in one session—and that session won't take more than a total of four hours.

• Chances are that you have the materials you need to prepare for the FR in your personal library and/or can access what you don't have at no cost on the internet.

• There are very good commercial FR prep courses available at reasonable prices.

DON'T PANIC

Take a deep breath. To start with, it's impossible to fail a flight review. If you have an incredibly bad day with a CFI, it goes in your logbook as dual received. That's it. While we all want to score 100% of every test, it may take more than one flight to get the cobwebs off of your steep turns or slow flight. Big deal.

The only downside to not getting the FR endorsement on the first time you fly with a CFI is that if your 24 months has expired since your last FR, you can't fly as PIC (that includes solo) until you get a new endorsement. Um, that's also a very good reason for not putting your FR off until the last moment as the realities of aviation karma include delivering lousy weather for the one day you have available for the FR flight before it expires.

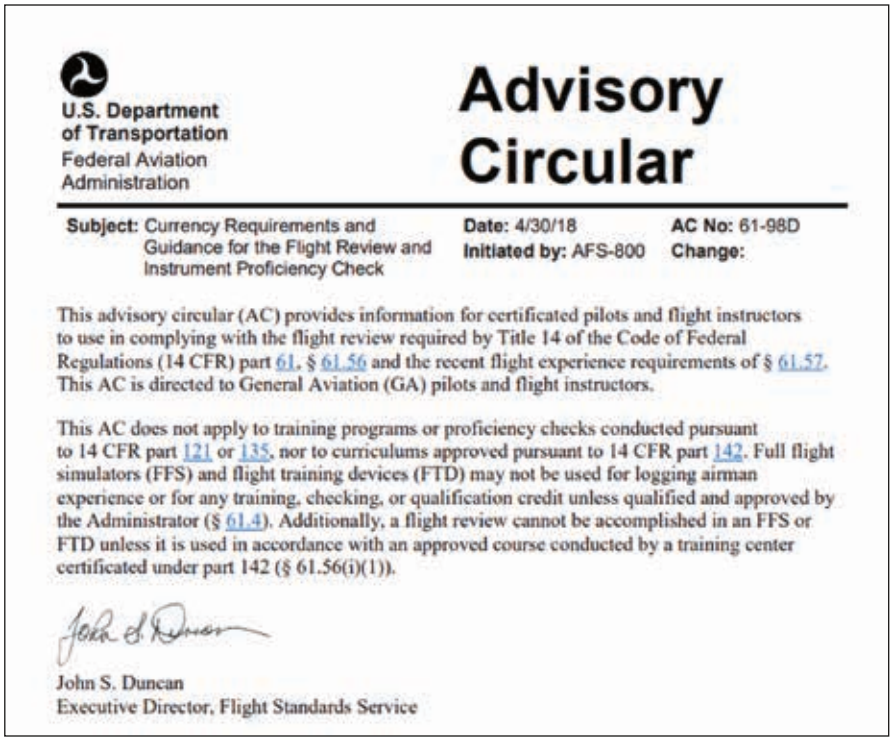
WHAT'S REQUIRED

FAR 61.56 mandates some sort of recurrent training for all pilots every two years. It may be satisfied in a number of ways—the most common for pilots flying under FAR Part 91 is a flight review.

However, there are alternatives: Pass a "pilot proficiency check" as part of military flight operations or what is generally referred to as a "checkride" for an additional pilot rating, certificate or operating privilege (you've been wanting to

Plan on doing a few steep turns during your flight review.

Among the free information about flight reviews is Advisory Circular 61-98D, which sets out guidelines for complying with the flight review requirements, above. If you're taking the review in a twin, you can count on some single-engine work, although instructors we spoke with simulate engine failures rather than conducting shut-down-and-feather exercises, below.



U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Currency Requirements and Guidance for the Flight Review and Instrument Proficiency Check

Date: 4/30/18 **AC No:** 61-98D
Initiated by: AFS-800 **Change:**

This advisory circular (AC) provides information for certificated pilots and flight instructors to use in complying with the flight review required by Title 14 of the Code of Federal Regulations (14 CFR) part 61, § 61.56 and the recent flight experience requirements of § 61.57. This AC is directed to General Aviation (GA) pilots and flight instructors.

This AC does not apply to training programs or proficiency checks conducted pursuant to 14 CFR part 121 or 135, nor to curriculums approved pursuant to 14 CFR part 142. Full flight simulators (FFS) and flight training devices (FTD) may not be used for logging airman experience or for any training, checking, or qualification credit unless qualified and approved by the Administrator (§ 61.4). Additionally, a flight review cannot be accomplished in an FFS or FTD unless it is used in accordance with an approved course conducted by a training center certificated under part 142 (§ 61.56(i)(1)).

John S. Duncan
Executive Director, Flight Standards Service

get that seaplane rating, right?) or complete one phase of an FAA-sponsored pilot proficiency program (WINGS).

The minimums for a flight review are one hour of ground and one hour of flight training that include review of operating and flight rules of Part 91 and maneuvers and procedures that the instructor thinks are necessary for the pilot to demonstrate safe exercise of the privileges of his or her pilot certificate.

GETTING READY

In our opinion, the first step in getting ready for your flight review is to contact the instructor you're going to fly with and spend 15 minutes on the phone—no, not texting—and talk about the kind of flying you ordinarily do and learn about the instructor's approach to flight reviews.

It's probably been a while since you took any dual, so take the time to get a good feel for the instructor. If you've never met or flown with the instructor, there's going to be some caution on both sides. You don't want an instructor who is going to set unrealistic standards and require three sessions of dual even though you are fully current and flew 180 hours in the last year. At the same time, the instructor wants to make sure that you're not the guy who can't analyze his own skills, has been desperately trying to find an instructor who will sign him off and is an airborne menace.

Coming into your FR cold is going to cost you more because you are going to spend time with the instructor sorting out your background and what will be accomplished during the flight review—stuff that could have been taken care of, probably without charge, during a phone call.

So, at the most basic, go through the POH for the airplane, list the appropriate V-speeds, review the emergency procedures and memory items for each and prepare two or three sample weight and balance scenarios.

PREPWARE

You probably have an aviation library that will get you well on your way to getting back up to speed on things that your instructor will want to discuss during your FR—airspace (a real biggie, not only VFR weather minimums but also TFRs as we approach an election year), FARs as they apply to the flying you do, radio communications for towered and nontowered airports, and systems and emergency procedures for the airplane you'll be flying.

FAA

In our opinion the first place to look outside of your personal library is the FAA's Flight Review Preparation course on the FAA's FAASTeam website (www.faasafety.gov). It's interactive, it's free and we think it's complete and well prepared.

AOPA

Our next suggestion is to spend 15 minutes reviewing AOPA's *Pilot's Guide to the Flight Review* on the AOPA website (www.aopa.org). Then click on their online courses and take the ones that not only apply to the flying you do, but that look interesting. Yes, you have to be a member, but the $59 cost of the membership gives you access to a large library of excellent courses and is cheaper than some of the commercial FR courses.

RUSTY PILOT REFRESHER: YOU'RE NOT ALONE

The combination of the implementation of BasicMed and long-running economic growth has caused thousands of pilots who had quit flying because of relatively minor medical issues or cost to act on their dream of returning to the skies. They've been supported by a surge in free and reasonably priced refresher courses designed to help those who need to rehone their skills and get their personal aviation knowledge database up to date.

We looked at a cross section of study materials available and attended one of AOPA's (www.aopa.org) free-to-AOPA-members Rusty Pilot seminars. We also spoke with CFIs who have flown with rusty pilots to get them back up to speed and through a flight review. Our conclusion is that there are some excellent resources available to a pilot who is willing to do the homework involved with getting back to flying.

Our first suggestion to pilots who haven't been flying in a year or so is to start reading. Go to our sister publication, *AVweb* (www.avweb.com) and search its extensive library for materials on rusty pilots and recurrent training. There are numerous videos on YouTube. The FAA's Safety Team website (www.faasafety.gov) is a treasure trove of information on getting back up to speed as an active pilot. There's no need to have a hair trigger to buy stuff—the current FARs and Aeronautical Information Manual (AIM) are on the FAA's website (www.faa.gov).

We think highly of the FAA WINGS (www.faasafety.gov) pilot proficiency program in general and are of the opinion that it is an excellent resource for a rusty pilot.

We are of the opinion that an AOPA membership is worth every penny to a rusty pilot. That buys admission to a large number of online, interactive courses that will help you get your groove back, starting with its Rusty Pilots course. It's a two-hour program that takes you through a cross-country flight scenario that includes just about everything you do when planning and flying a trip —dealing with airspace, regulations, weather and decision-making. There are short quizzes as you go and most pages have links that let you delve more deeply into specific topics. Plus, it helps you find flight schools, aviation medical examiners and how to connect with other pilots.

AOPA has a traveling Rusty Pilot seminar program. We attended one of the three-hour sessions at our local airport and then followed one of the attendees as he got back into flying (and through a flight review) after a nearly 10-year hiatus. The class was fast-paced and provided a good review of the topics that a pilot will need to study in more depth to get back into action and pass a flight review. There was no claim that the one class by itself would be enough to return a pilot to the cockpit—that's not realistic. It does, in our opinion, hit all of the subjects that a pilot is going to need to review in more detail.

The pilot we followed told us that he did a lot of additional reading and bought one of the tablet navigation apps (ForeFlight) and learned to use it, which helped him greatly in the process of getting updated on airspace, regs, weather and ATC. He made three flights with a CFI in completing his flight review.

While we like free stuff, we also think well of the commercial courses available for recurrent training that can be of value to rusty pilots.

Gleim's (www.gleimaviation.com) Pilot Refresher Course is priced at $29.95 and has the value of being aircraft specific—it uses weight and balance and performance charts for the airplane you'll be flying. It uses video presentations followed by quizzes with guidance for further study based on your quiz answers.

Rod Machado's (www.rodmachado.com) Rusty Pilot Collection is a collection of 20 books, audiobooks, eLearning courses and videos. Choosing the right ones can be a little daunting. We think the $49 Flight Review eLearning Course is a good place to start and we like Machado's humor-laced teaching style.

The Return to VFR Flying Kit offered by King Schools (www.kingschools.com) is not cheap, but for $299, it provides 17 hours of video courses that will take you through what we consider to be just about everything you need to know in one place.

At $99 we consider the Rusty Pilot Kit from Sporty's (www.sportys.com) to be the best value of the commercially available courses. It includes a flight review course, VFR communications course, the FAA *Pilot's Handbook of Aeronautical Knowledge*, current FAR/AIM and a kneeboard. One of the biggest challenges, in our observation, for returning pilots is radio communication, something we were pleased to see addressed well in Sporty's Kit.

Finally, we liked one recommendation we heard from a number of instructors—on a bad weather day when your intended airplane isn't flying, sit in it with the POH and go through all of the normal and emergency procedures. It doesn't cost anything and should help reduce the amount of dual needed to get flying again.

Sporty's online and TV flight review course offers high-quality graphics, above. Rod Machado's flight review course serves up the information you need with a dose of humor, below.

Among the AOPA online courses we recommend prior to taking your FR are: Know Before You Go (airspace), Runway Safety, Cockpit Weather, Say It Right (radio communications), Essential Aerodynamics and Do the Right Thing (decision making and judgment).

SPORTY'S

For $39.99 Sporty's (www.sportys.com) offers a flight review course in online and TV format. We've always liked the content, style and pacing of Sporty's training products and this one is in keeping with the high-quality tradition.

There are seven subject areas broken into 49 segments. It takes about two hours to complete. There are quizzes at the end of each lesson. To complete the course, a final review quiz becomes available—after you've seen all of the videos. A score of 80% or better generates a flight review ground training endorsement that satisfies the one hour of ground training requirement of FAR 61.56.

We note that the instructor you fly with for your FR will probably still want to spend some time on the ground with you prior to the flight.

ROD MACHADO

Rod Machado (www.rodmachado.com) offers his Flight Review E-Learning Course bundle for $49. It consists of seven hours of interactive video consisting of two courses, the Interactive Airspace Course and Interactive FAR Course.

We like Machado's in-depth presentations and humorous style; however, we'd prefer to see a course that was tailored for the flight review rather than a combination of courses that are usually used for pilot training.

GLEIM

As with its Pilot Refresher Course, Gleim's (www.gleimaviation.com) $29.95 Flight Review course is airplane specific—it uses performance and weight and balance data for the airplane you'll be flying. We like that.

The interactive course consists of a series of study units with questions and detail on the answers. There are no videos; however, we feel that the course covers what you will need to know to prepare for your flight review.

KING SCHOOLS

King Schools (www.kingschools.com) offers its Flight Review Online Bundle of three courses—VFR Regulations Refresher, Pilot Communications and The Complete Airspace Review—for $119. The courses are broken by subsections into video labs. The information is presented clearly with relevant illustrations. Total time is about three hours.

We have always liked the quality of King presentations. We like the selection of courses presented in the bundle, but would like to see King prepare a dedicated flight review course that takes the best from this bundle and adds material it does not include such as aircraft performance and emergency procedures.

ASA

From ASA (www.asa2fly.com) comes a book (hard copy, $12.95 or e-book, $9.95) entitled *Guide to the Flight Review.* It's targeted at both pilots approaching a flight review and CFIs giving them.

It provides a comprehensive review of need-to-know information as well as a practice quiz and a sample written test that a CFI might give a FR applicant.

CONCLUSION

While the idea of taking a flight review generates the heebie-jeebies for a lot of pilots, a little preparation and early communication with the CFI can turn it into a low-pressure learning experience. Believe it or not, it sometimes turns into a lot of fun as a CFI coaxes abilities out of a pilot he didn't know he had. We've seen it happen.

In researching this article we were extremely pleased to come to the conclusion that the prep materials available to a pilot for free—or the price of an AOPA membership—are more than adequate to get ready for the FR.

Finally, while we know we may sound hopelessly out of touch with the real world, we recommend, in the strongest possible terms, that pilots take a flight review at least annually to substantially reduce their risk of bending an airplane.

Clarity Aloft Flex: Less Weight, No BT

Aloft Technology's latest Flex in-ear headset delivers big on comfort and performance, but for the price we wish it had Bluetooth connectivity.

by Larry Anglisano

CHECKLIST

- ⊕ Fit and build quality is excellent, plus without the metal headband, head weight is reduced.
- ⊕ The audio quality—including the microphone—is among the best we've tried.
- ~ For $775, we think buyers will expect Bluetooth audio input. It's missing.

These days we've mostly moved beyond passive headsets in favor of ANR models for all but the quietest cabins—including jets and turboprops. But as a worthy alternative, ITE (in the ear) passive models can offer noise-canceling performance that's on par with flagship circumaural ANR headsets, less the noggin-clamping pressure of even the lightest sets.

While an in-ear headset isn't for everyone, among other in-ear models a favorite in our field reporting is the Clarity Aloft line from Aloft Technologies. Moreover, we have an early-gen Clarity Aloft in the flight bag and it's proven itself such that in some cabins it's the only set we'd reach for over the Bose A20.

That's why we were anxious to get the company's latest and lightest $775 TSO'd (TSO makes it an approved accessory for airline flying jobs) Clarity Aloft Flex model in in the ears to see if it's worth the major price delta over Aloft's entry-level Classic model. Here's what we found.

DURABILITY COUNTS—A LOT

Minnesota-based Aloft Technologies has offered the Clarity Aloft line since 2004 so there's been plenty of time to improve the overall design. There are currently four models in the lineup including the Classic, the Bluetooth-equipped Link, the Pro Plus and the latest Flex.

One important trait we've always favored is the Clarity's durable build quality. Remember, the idea of an ITE model is to make the wearing experience a minimalist one. It's all about freedom from the intrusive nature of circumaural or even supra-aural designs. But to succeed the set has to be lightweight, yet durable enough to survive the abuse a typical pilot asks of them. Bend them, sit on them, step on them and drop them. And those thin wires—they're asking to break. We've tried all of the above and still can't break the Clarity.

The set is worn over the ears and the securing band rests behind the head. But unlike the other models in the Clarity line, which use a stainless steel headframe, the Flex has an adjustable flexible band that

The Clarity Aloft Flex is somewhat eyeglasses friendly. Notice the ear hook that secures the microphone boom in place, left photo. As you can see in the photo to the right, the set is minimal, which means unobtrusive.

The flexible strap on the Clarity Flex generally sits at the bottom of the head, as show in the top photo, where it's well secured. The control module, middle, is small and houses a linear rotary volume control. That's a patch cable plugged into the side of it for inputting tunes from an iPhone. The bottom photo shows the included earbuds.

just to us simply feels less intrusive than the metal band. It also makes the set feel lighter on the head, and it is. The weight on the head is 1.35 ounces, compared to 1.5 ounces for the non-flexible models.

Tweaking the fit is easy. Simply tighten or loosen the strap, which is worn on the bottom of the head, until it's secure. Some hair, no hair and long hair—everyone who wore the set noted that the Flex was comfortable without any pressure points on the head or tugging at the hair.

The ear hooks can be a point of pressure, especially with some larger eyeglass temples, but it's acceptable, based on our trials.

PERFORMANCE

All of the models are lab spec'd to provide between 29 to 47 dB of noise reduction. That's traditional ANR headset territory, but this performance is also highly dependent on getting the right fitting Clarity Comply canal tip foam earbuds. Clarity includes a tin of six pairs, which includes 12 medium (the most common size) and two each large and small buds. A pack of 12 (six pairs) replacement earbuds is $25. For some, the best performance might come with a different size bud in each ear. For many, the medium tips work well.

The drill here is to roll and squeeze the bud as small as you can get it, stick it in the ear canal and let the bud expand. Do it right, and get the right size bud, and the audio performance is quite good.

One nit we had while using the Flex is that the buds would frequently come off the small speakers. It's an easy attachment process—screw the bud onto the speaker—but while handling the set in the cockpit we found ourselves hunting for buds that came off. Good thing there are spares—we lost several to the dark hole that exists between the cabin seats. One user tugged a bit too hard on the speaker wire and the bud separated while in the ear canal. When using the small buds, this might be challenging to get the buds out of the ear.

The audio performance is excellent, which sort of makes sense because the tiny speakers are well-positioned right in the ear canal. The set uses an dual electret microphone that provides excellent, crisp modulation.

We like that the microphone can be worn on either side of the set—something that can't be done with the other Clarity models. It's an easy swap, too.

The control module on the Flex is minimal and includes a rotary volume knob that's accurate and has a solid, high-quality feel. There's also a stereo/mono slide switch. If the aircraft is equipped with stereo audio jacks you'll get true stereo separation in each ear. Set it to stereo when plugged into mono jacks and you'll only get audio from one ear. There's also a balance control potentiometer on the module for tweaking more or less volume in each ear. Most won't use it, but we like the flexibility, especially for those with hearing loss.

CLARITY ALOFT MODELS COMPARED		
MODEL	PRICE	COMMENTS
CLASSIC	$525	Head weight is 1.5 ounces, non-TSO, metal headband, one-side mic
LINK	$795	Same as the Classic, but with Bluetooth module
PRO PLUS	$725	Same as the Classic model, but has FAA TSO
FLEX	$775	Has FAA TSO, flexible headband, 1.2-ounce head weight, left or right side microphone positioning

As for entertainment input, it's a wired interface—no Bluetooth. Frankly, these days we think buyers might expect a set priced at $775 to have Bluetooth as standard but the Flex doesn't. Instead, plug a stereo patch cable into the entertainment input jack on the control module for piping in your tunes. And those tunes sure sound good through those small speakers—better than some non-aviation earbuds. But there's no auto-muting of the music when there's radio chatter. These days we expect it because it's been the standard function in aircraft audio entertainment input for years—both on audio panels and on headsets with a music input feature. Bose takes this function to high levels in its A20 and on its ProFlight in-ear set.

For Bluetooth you'll have to buy Clarity's Link model. We reviewed the Link in our last in-ear headset roundup for the December 2017 *Aviation Consumer* and it performed well and had a good fit and finish. But we dinged it for having two controllers—the set's primary module for controlling volume and also the Clarity BluLink Bluetooth module, which attaches to (and is removable from) the set's downcable.

WRAP IT UP

We like the Flex better than any other Clarity model simply because the flexible headband is better than the metal one, and the set is lighter on the head. We also like that you can swap the position of the microphone. If we had to ding the set it would be because it doesn't have Bluetooth. Since we fly with music, it's a deal-breaker, but for others, it might not matter. Visit www.clarityaloft.com.

NFLIGHTMIC: ROLL YOUR OWN ANR

Always looking for creative ways to increase comfort—and save some dough—we decided to try an interesting product from a company called NFlight Technology. The company makes the NFlightCam line of aviation camera accessories and also sells the attachable NFlightMic noise-canceling electret aviation microphone. It's pretty creative and turns any noise-canceling headphone that has a 2.5-mm wired audio input jack into an aviation headset by attaching the microphone to the headphone earcup with a 3M Dual Lock attachment. It wasn't the first with this idea but it says it's the only company to offer a universal microphone that's compatible with a wide range of sets, including Bose. A 3.5-mm adapter is available for some Sony models.

We tried the Nomad (Pro Version, with volume control), priced at $299.99, on a Bose QC25 (used for around $150) noise-canceling headphone. This is one consumer model you might use as an airline passenger, and it's generally a good performer. The Classic microphone, priced at $249.95, doesn't have entertainment input and a volume control.

Setup was easy: Attach the 3M Lock pad to the headphone's earcup (it's not Velcro, it's very secure and it won't leave residue), plug the mic into the headphone's input jack, attach the mic to the earcup and off you go.

We tried the setup side-by-side with a Bose A20 (and the Clarity Flex) and found performance to be quite good. Not as good as the Bose A20 as far as noise cancellation, but we couldn't tell much difference between the mic audio performance among sets. A $50 Bluetooth module is available and plugs into the set's input jack. That's more bulk than we like in the cockpit, but it works for passengers who want tunes on the fly. Visit www.nflightmic.com.

ICAO Flight Plan Codes: Required For IFR, VFR

If you've been putting off dealing with the new ICAO flight planning equipment codes you now have no choice but to get it straight.

by Luca Bencini-Tibo

Since late August 2019, the ICAO flight plan form is required for all filed flight plans, both VFR and IFR, in domestic airspace. Interacting with fellow pilots, there still seems to be some confusion on the equipment codes, which are perhaps the most confusing part. Let's dig deeper.

EQUIPMENT CODES: ITEM 10

Specifically, on the form there's Item 10 Equipment and Item 18 Other Information. Item 10 has two parts: avionics and surveillance capability. What makes the codes confusing is that unlike the older domestic flight plan form that used installed equipment, the ICAO flight plan goes a step further. The codes not only could refer to installed equipment (e.g., "D" for DME), but also capability ("B" for LPV) and approvals ("W" for RVSM Approved—reduced vertical separation minima, above FL290) and at times, combinations such as "Y" for VHF with 8.33 kHz channel spacing capability. Got that?

The first question that comes up is: Do I need to use all the relevant equipment codes? The short answer is no. To fully understand the equipment codes, we need to consider NextGen navigation, which focuses more on navigational capability rather than simply installed equipment. We also have to understand what is meaningful to ATC—one of the key customers of the flight plan. The other customer group is search and rescue (SAR) organizations including the Civil Air Patrol and the U.S. Coast Guard.

Let's start with a relatively well-equipped light general aviation aircraft with VHF comm, VOR and ILS, WAAS GPS and ADS-B. The WAAS GPS in this case not only would provide position input to ADS-B Out transmitters, but also allows navigation capabilities for enroute segments and approaches. (However, some ADS-B Out equipment has embedded WAAS GPS to provide position but cannot be used for navigation purposes, so we'll ignore this situation.)

The Code would be SG, meaning VHF comm, VOR, ILS and an IFR GPS. That is probably all that is needed. We could add a "B" for LPV capability, because it is a WAAS GPS. ATC would not care because they will never clear an airplane for an "LPV approach" because such an approach does not exist. ATC would provide a clearance for an RNAV (GPS) approach to RWY XX; the pilot decides which MDA or DA applies: LPV, LP, LNAV or circling. I fully realize that in day-to-day talk we all call them "LPV approaches," which is a lot less verbose compared to "RNAV GPS approach flown to an LPV DA".

Surveillance equipment means transponder and ADS-B Out. For ATC purposes, we know that the only thing that counts is ADS-B Out and not ADS-B In. There are two options in the U.S., of course: a Mode S extended squitter transponder (code E) on the 1090 MHz frequency and a UAT (Universal Access Transceiver) on 978 MHz. What complicates UAT is that it has to be associated with a transponder—which could be a Mode C or Mode S transponder. Does ATC care about ADS-B In? The answer is no, but also keep in mind that ADS-B In could consist of panel-mounted or portable receivers and panel-mounted or portable displays. For the flight plan code purposes, only panel-mounted UAT-In devices count.

These are the options for ADS-B: EB1, CU1 and SU1. If we want to show ADS-B In, the codes change to B2 and U2, but the "In" is superfluous to ATC. Additionally, with ADS-In traffic, the only thing ATC wants to hear when calling out traffic is "in sight" or "looking," not "got 'em on ADS-B traffic." While we're talking about it, ADS-B traffic cannot be used to take evasive action; only through visual contact with the traffic can such action be taken. However, let's be clear; the addition of ADS-B traffic and weather (FIS-B) has contributed to safety, so I don't want to minimize the value of ADS-B In.

Minimalist Item 10 codes would be SG/EB1, SB/CU1 and SB/SU1. If we want to add panel-mounted ADS-B In capability, we would

COMMON EQUIPMENT CODES

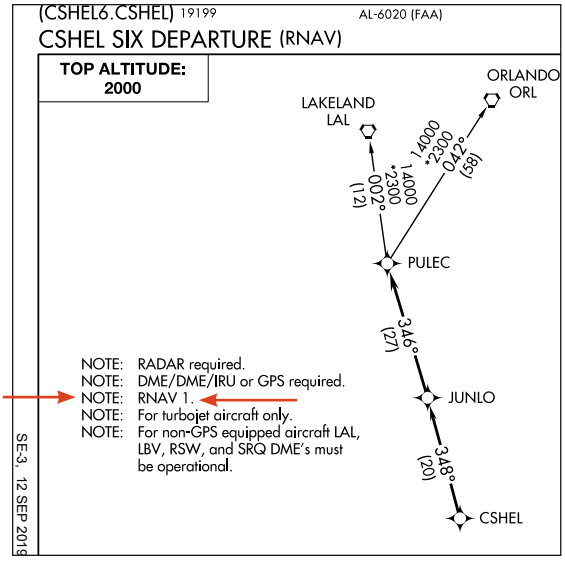
EQUIPMENT	CODE
DME	D
ADF	F
GNSS/GPS	G
VHF Comm, VOR, ILS	S
8.33 VHF Comm Transceiver	Y
VOR Receiver	O
GPS WAAS LPV Approach	B
Other equipment	Z

COMMON SURVEILLANCE CODES

EQUIPMENT	CODE
Mode A Transponder	A
Mode C Transponder	C
Mode S Transponder w/ press. alt., aircraft ID	S
Extended Squitter ADS-B Transponder	E

COMMON ADS-B CODES

EQUIPMENT	CODE
1090 "Out"	B1
1090 "Out" and "In"	B2
UAT "Out"	U1
UAT "Out" and "In"	U2



Notice the RNAV 1 navigator note on the charted RNAV departure procedure for Naples Municipal Airport, top. Filing in your Cirrus like the one pictured? With dual IFR GPS and VHF comm and navs, Mode S transponder and ADS-B Out, Item 10 is SBGRY/EB1 and Item 18 is PBN/B2C2D2.

use B2 or U2. We could add (in alphabetical order after the S) the following: "B" for LPV capability, "D" for DME, "F" for ADF and "Y" for 8.33 kHz spacing. Do keep in mind that the additional codes don't matter to ATC, especially the "Y" code, because no U.S. ATC frequencies use 8.33 kHz spacing.

PERFORMANCE-BASED NAVIGATION (PBN)

While PBN is one of the central tenets of NexGen it appears to be the 800-pound gorilla in the room since it is perhaps the most confusing part. The fundamental concept of PBN is navigation based on installed avionics capabilities and not specific equipment. This probably started with airliner flight management systems (FMS), which simultaneously use several sensors or receivers to calculate position. Such sensors include GPS, inertial navigation, VOR/DME, DME/DME/IRU (due to geometry DME/DME only is not approved in the U.S.; it needs to be augmented with an "inertial reference unit").

A PBN value is a measure of accuracy and consistency of the navigational system. It is a probabilistic concept; for example, RNAV 1 means that 95 percent of the time, the airplane is within a 1-NM radius of the true, but unknown, position. For example, we really don't know the cylinder head temperature, all we know is what the CHT gauge indicates; if not accurate, we might get a distorted view of reality. All the navigation systems have a PBN value including the astrolabe that Columbus used in the 15th century—it only measured latitude—and was highly dependent on "operator" technique and stability of the platform. In other words, the pitching of the ship.

For Part 91 (excluding Subpart K operations) there are really only two relevant PBN codes—C2 for RNAV 2 GNSS (GNSS is the international name for GPS), and D2 for RNAV 1 GNSS. The code B2 RNAV 5 GNSS can also be used, but if the navigator meets RNAV 1 or 2, it has to meet RNAV 5. Let's try and simplify this.

To fly RNAV SIDs and STARs, we need RNAV 1, and to fly T and Q routes (airways wholly dependent on GPS) we need RNAV 2. From the AIM 5-3-4: "Published RNAV routes are RNAV–2 except when specifically charted as RNAV–1. These routes require system performance currently met by GPS, GPS/WAAS, or DME/DME/IRU RNAV systems." See the chart of the CSHEL Six Departure in the upper left of this page, and red arrows pointing to the charted note.

If we file PBN/C2D2 in Item 18 Other Information, we are telling ATC that we are willing and capable of flying RNAV SIDs and STARs as well as T and Q routes. We can also add B2, but that would be redundant. If we file PBN codes, we must add an "R" PBN Approved in Item 10 Equipment to signal that we are filing PBN capability; also a bit redundant, in my opinion.

DO YOU EVEN HAVE PBN?

How do you know if that megabuck GPS in your panel is approved for PBN? The answer should be in the avionics supplement (which is required by the regulations) of the POH. If it's an aftermarket install, there should be a flight manual supplement. For example, in the Garmin GTN navigator supplement, it says: "The Garmin GNSS navigation system complies with the equipment requirements of AC 90-100A for RNAV 2 and RNAV 1 operations. In accordance with AC 90-100A, Part 91 operators (except subpart K) . . . are authorized to fly RNAV 2 and RNAV 1 procedures." There you have it. When was the last time you read the supplement? It's worth a read—and it must stay in the aircraft.

Lacking that, check with your avionics manufacturer, but I can safely say that most, if not all, IFR WAAS and non-WAAS GPSs meet RNAV/B2C2D2 standards. Garmin publishes a spreadsheet with the PBN capabilities of its navigators. In case you are interested, the standards for B2 are found in AC 90-96A CHG1 and for C2 and D2 in AC 90-100A CHG1. Not exactly an exciting read.

RNP CAPABILITY

I also get the question: Can I file Required Navigation Performance (RNP) capabilities? Technically yes, since some GPS navigators do meet RNP standards. However, it does not add any additional value for ATC purposes. This is the issue—RNP sometimes is used as a synonym for PBN, but it also refers to other capabilities that light Part 91 aircraft don't have: mainly RNAV (RNP) RWY XX approaches.

What else do we need to file in Item 18 Other Information? Defi-

nitely file the ICAO hexadecimal code that is associated with the tail number; it is part of the aircraft airworthiness certificate. It is found in the FAA Aircraft Registry database. For example, CODE/A00002 is associated with the Goodyear Wingfoot One airship N1A, based in Pompano Beach Airpark, Florida (KPMP).

We could also file Radio Technical Commission for Aeronautics (RTCA) codes for ADS-B Out Standards; SUR/260B and SUR/282B for 1090 MHz extended squitter and UAT. I don't think ATC would care and I would assume that all certified ADS-B equipment meets the standards. But maybe there are some in the fringes that don't. For most light GA aircraft, the following codes would be sufficient assuming it is ADS-B equipped:

Item 10: SG/EB1 or SG/CU1 or SG/SU1 ITEM 18: PBN/B2C2D2. If you want to show LPV capability, add a "B" to Item 10.

If, however, you want to signal to ATC that you are willing and capable of flying RNAV SIDs and STARs and T and Q routes, the codes could be:

Item 10: SGR/EB1 or SGR/CU2 or SGR/SU2 Item 18: PBN/B2C2D2. See the Cirrus example on page 22.

GOOD THING FOR APPS

The reality is that most of us now file flight plans using aviation apps that allow us to save aircraft profiles for filing purposes, so go ahead and use all the codes that apply. Keep in mind that most of the additional codes like "F" for ADF or "Y" for VHF comm frequency spacing don't mean anything to ATC, but might give you a warm feeling documenting them. Go for it.

Last, I mentioned at the beginning a second customer group—search and rescue organizations or SAR. Do help them and yourself by identifying Survival Equipment in Item 19 on the form. It is not transmitted to ATC as part of the flight plan but if you ever need the help, the information exists.

When he's not perfecting his superior knowledge of the confusing new ICAO coding and writing for sister publication IFR Refresher, contributor and FAA FAASTeam Lead Rep Luca Bencini-Tibo is flying his well-equipped Mooney in southern Florida.

First Word

(continued from page 2)

Both were no-charge repairs, presumably a way for David Clark to spread the good word across a small industry. It's a similar story I hear to this day from other owners. Just like bad service, favorable experiences are lasting.

But David Clark knows darned well the demographics are changed for good, even though its products might be the top sellers in the budget headset market. Mark Estabrook, David Clark's VP of business development and an aircraft owner, recognizes young pilots as core customers and ones who are likely to shop the mid-priced headset market for their first one.

"The word that really hasn't gotten out to the younger pilot demographic is that it's more about hearing protection than comfort," Estabrook told me. He's done extensive research on hearing loss and reiterates that even turbine cockpits require good protection. Just because there isn't the brain-rattling noise and vibration from piston engines doesn't mean these cockpits are quiet. The same can be said for gliders. Worth mentioning is that the Pro-X2 was actually targeted to the airline crowd, a market that's partly long served by headset manufacturer Telex with the Airman series.

One current model from Telex is the Airman 8. It's priced at around $430. Like the Pro-X2, it has ANR circuitry, an FAA TSO (a requirement for airline ops) and is a supra-aural design. But David Clark doesn't see the set even remotely being a competing headset. I've ordered one to see how it performs and will put together a field report. I have an age-old Telex Airman 750 in the bottom of my flight bag and it's stood the test of time, but offers little if any noise protection.

I asked John Zimmerman at Sporty's for his take on where Clark fits in today's competitive market. Zimmerman said the David Clark classic H10-13S is still a Sporty's best seller for being rugged, reliable and an overall good value. "A lot of loyal David Clark customers step into the circumaural model ONE-X and pass along the older set for passengers," Zimmerman told me. He also said that while David Clark sets are popular purchases for flight schools, so is the Bose A20. A relatively new player in the aviation headset market is Faro, which offers a variety of designs at various price points. There's also Sigtronics, ASA and some others that we'll cover in a future budget headset roundup. Some have noise-canceling circuitry and some are passive. And then there are in-ear models, including the Clarity Aloft that we covered in this issue of *Aviation Consumer.*

I'll call it straight—I'm a happy Bose A20 owner. Nope, not parting with them. Indeed they are flagship priced. The A20 with Bluetooth wireless as standard is $1095. Still, in my estimation David Clark might be overshadowed in the current market but it's clear that the company is sticking to its roots by catering to the utilitarian buyer with affordable and well-made models, and with healthy customer service tacked on. For the upscale buyer on a budget, modern sets like the surpra-aural Pro-X2 and quieter ONE-X easily fill the gaps in the mid-priced ANR market. While plenty of other headset makers have failed, what a success story David Clark is.

—Larry Anglisano

Piper Comanche:

Piper's timeless PA-24 Comanche series has solid handling, respectable cruising speed and is well supported. But don't underestimate the maintenance on these old birds.

If you're shopping the used four-place retrac market no doubt you'll consider a Comanche. And you should. Sure, the Piper PA-24 series is old—one of Piper's first metal, non-tailwheel cruisers—and ultimately a competitor to the Beech Bonanza and Cessna 210. With a tapered laminar-flow wing, respectable speed (big-engine models make downright impressive numbers), solid handling and lots of available speed mods, the right Comanche could be one of the most desirable vintage piston singles.

But unless you buy one that's been particularly well-restored and cared for, getting an old Comanche up to snuff can be a pricey proposition. The good news is that lots of shops can work on them (although as the accident reports show, pick one that knows the model well), parts are available and market prices are steady, yet reasonable.

MODEL HISTORY

The Comanche hit the market running in 1958 and in its first production year, Piper offered the 180-HP PA-24-180 (Lycoming O-360) and the 250-HP PA-24-250 (Lycoming O-540). Both models had carbureted engines mated to constant-speed props. Piper kept the Comanche's electromechanical manual landing gear relatively simple, although it can be a source of woes when not maintained properly.

Owners of big-engine Comanche 400 models with speed mods say 200-knot cruise speeds are a way of life.

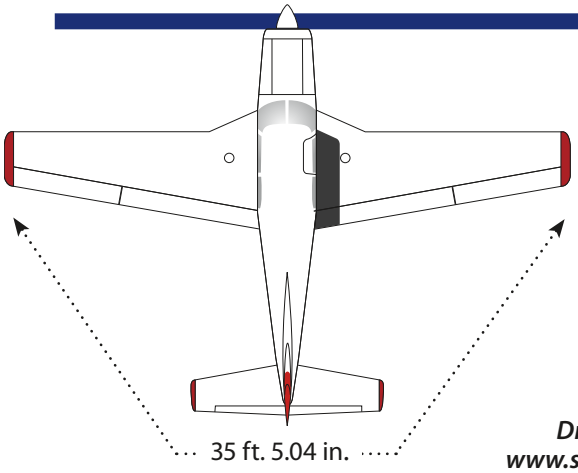
The 180 and 250 Comanche airframes are the same and there's an STC to upgrade the 180 to the larger engine—although the 250 boasted a significantly higher gross weight: 2800 pounds versus 2550 pounds for the 180. Piper didn't distinguish between the 180 and 250 in its serial number records, but total production for 1958 was 336, comparing favorably to the 396 J35 Bonanzas Beech cranked out that same year.

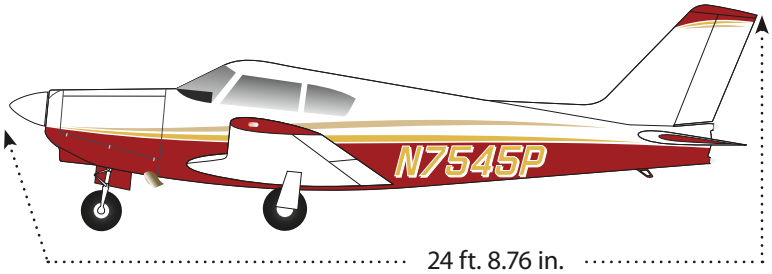
The basic airframe proved successful and wasn't changed much during its production run. Still, there were some notable improvements over early models. Initially the airplane was equipped with hand brakes, but after 1960 most Comanches were delivered with optional toe brakes.

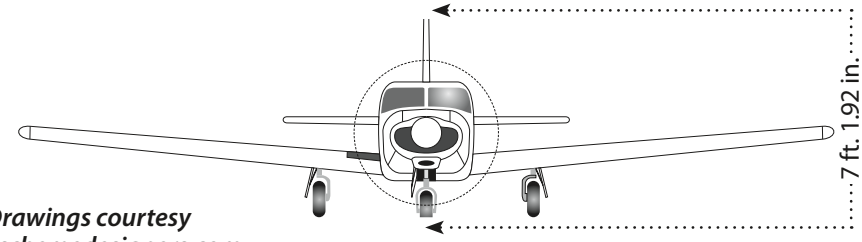
The original airplane had a 60-gallon fuel system. In 1961, Piper offered an optional 90-gallon system, which gave the Comanche 180 seriously long legs: nine hours, provided it was only loaded with the pilot, one passenger and a little baggage. Range remains one of

John Spoor sent the lead photo of a Comanche 260 in cruise. Like many Comanche owners, he's loyal to the airplane—owning that Comanche and two others over the years, including a twin Comanche and his current 400 single.

PIPER COMANCHE





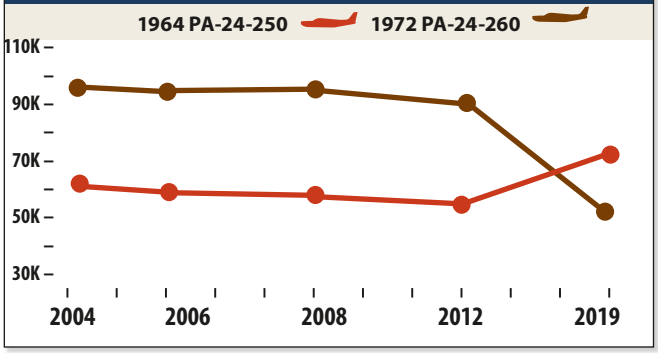


Drawings courtesy
www.schemedesigners.com

PIPER COMANCHE MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1958 PA-24-180 COMANCHE 180	LYCOMING O-360-A1A	2000	$23,000	60	1020 LBS	139 KTS	±$30,000
1958 PA-24-250 COMANCHE 250	LYCOMING O-540-A1A5	2000	$28,000	60	1110 LBS	157 KTS	±$38,000
1964 PA-24-180 COMANCHE 180	LYCOMING O-360-A1A	2000	$23,000	60	1020 LBS	139 KTS	±$35,000
1964 PA-24-250 COMANCHE 250	LYCOMING O-540-A1A5	2000	$28,000	60	1110 LBS	157 KTS	±$50,000
1965 PA-24-260 COMANCHE 260	LYCOMING O-540-E4A5	2000	$30,000	60	1172 LBS	158 KTS	±$57,000
1965 PA-24-400 COMANCHE 400	LYCOMING IO-720-A1A	1800	$65,000	100	1490 LBS	185 KTS	±$105,000
1966 PA-24-260 COMANCHE 260B	LYCOMING IO-540-D4A5	2000	$35,000	60	1372 LBS	158 KTS	±$59,000
1972 PA-24-260 COMANCHE 260C	LYCOMING IO-540-N1A5	2000	$35,000	60	1427 LBS	161 KTS	±$75,000
1972 PA-24-260 TURBO COMANCHE C	LYCOMING IO-540-N1A5	2000	$40,000	60	1427 LBS	161+ KTS	±$78,000

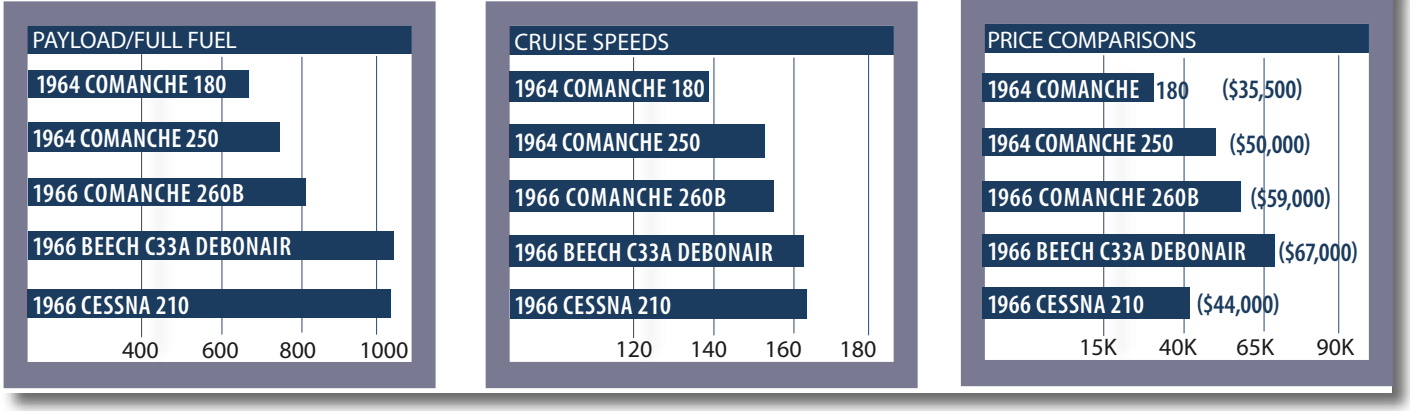
PIPER COMANCHE RESALE VALUE



SELECT RECENT ADs

AD 2002-09-09	INSPECT/REPLACE/REWORK HARTZELL Y-SHANK PROPELLER BLADES
AD 2006-20-09	REPLACE ENGINE CRANKSHAFT AT OVERHAUL OR AFTER 12 YEARS
AD 2007-04-19	REPLACE CERTAIN SUPERIOR AIR PARTS CYLINDER ASSEMBLIES
AD 2008-14-07	INSPECT/REPLACE CERTAIN EXTERNALLY MOUNTED FUEL INJECTOR LINES

SELECT MODEL COMPARISONS



You'll find a variety of avionics in Comanches. Bill Donald's 1961 Model 250, top, has dual Garmin G5 displays, a PMA450 audio panel, Garmin GTN 650 navigator, GNC 255A navcomm and Stratus ADS-B transponder. The custom metal panel at the bottom has an Aspen EFIS, S-TEC 30 autopilot, Garmin portable GPS in a dock mount, a GNS 430 and King KX170B.

the Comanche's strong points and many have been fitted with even more fuel capacity in tip tanks and fuselage tanks to give it impressive endurance. In 1961, the gross weight of the 250 was boosted by 100 pounds. Electric flaps replaced the manual ones in 1962 models. Production of both the 180 and 250 ended after the 1964 model year. The 180, which obviously came second to its bigger brother in load carrying and was not selling as well as the 250, was dropped altogether while the 250 was upgraded to the 260.

COMANCHE EVOLUTION

The 1965 Comanches are transition airplanes in that they have the earlier fuselage mated to the later 260-HP engine, albeit with a carburetor. The big engine gives these airplanes excellent climb performance, as much as 1500 FPM. In 1966, the Comanche B, with a fuel-injected 260-HP Lycoming IO-540-D4A5, a boosted gross weight (now 3100 pounds) and two more seats, was added to the lineup, starting with serial number 24-4300.

These and later Comanches can be spotted by the extra cabin window and rear baggage door on the left side, which doubles as an emergency exit. The airframe dimensions are identical, but the internal fuselage structure was changed to accommodate the additional window. The added seats are in the baggage compartment.

The Comanche C was rolled out in 1969, with further refinements, including another gross weight increase and a distinctive "shark nose" cowl starting with serial number 24-4804. The 100-pound rise in gross gave the airplane a hefty 1427-pound useful load. The airplane also gained cowl flaps and an aileron-rudder interconnect.

By the time these models were introduced, the Comanche's production run was about to end without warning, so this variant is comparatively rare.

RAYJAY TURBO AND A BEASTLY EIGHT-BANGER

A turbonormalized version of the Comanche C was offered alongside the normally aspirated model in 1970. Dual turbochargers allow operation at altitudes up to 25,000 feet. The Rajay system essentially had a "second throttle" wastegate control the pilot used to manually set boost at altitude. Piper did the turbo 260 installation the right way by providing check valves and a turbo oil sump. Upon shutdown, this allows the oil to drain from the hot turbos instead of remaining inside them and cooking.

A side benefit of the standard turbo installation is that it's quieter than the normally aspirated Comanche C. The -N1A5 engine, beefed up to handle the boost pressure and higher temperatures at altitude, is just as robust as the normally aspirated engine; both have a 2000-hour TBO. Also, as with the fuel injection system, earlier airplanes can have a turbo added.

Meanwhile, the ultimate in wretched excess, or perfection, depending on your point of view, has to go to the Comanche 400. It was introduced in 1964 and discontinued only a year and 146 airplanes later. This beast had a normally aspirated, fuel-injected, eight-cylinder Lycoming IO-720-A1A fitted with a three-blade prop. The airframe is essentially identical to the 250, except the 400 uses the Piper Aztec stabilizer.

Here that sucking sound? That's the 20 to 22 GPH at 75 percent power that engine is consuming. To hold more fuel needed to feed it, there were optional 130-gallon tanks. That engine has an 1800-hour TBO and the current *Aircraft Bluebook* says the overhaul is around $65,000. But for the lucky 400 owners the cost of admission is worth

We spotted a show-winning 1964 eight-cylinder Comanche 400 at AirVenture. It's worth showing—beautifully restored by Lee Hussey, top. Peter Simpson just re-engined his 250-HP Comanche, also adding an Electroair electronic ignition, bottom. The airplane started life as a 180 model before the STC'd engine and three-blade prop.

it—most big-engined Comanche owners say that with speed mods, 200 knots is a way of life.

When compared to a Comanche B, the 400 has a gross weight 500 pounds higher. However, the empty weight is also higher, by 337 pounds. That extra payload has to go for fuel to feed the IO-720, meaning that for flights of more than 300 miles, the 400 actually has less payload available than the 260.

In 1972, there were two single-engine Comanche models still in production—the 260 and turbo 260. Their excellent build quality with total corrosion proofing before assembly and compound curve panels meant that the underlying cost structure was greater than emerging designs from either Piper or its competitors.

Then Tropical Storm Agnes drove the Susquehanna River out of its banks and wiped out Piper's Lock Haven factory. This gave Piper a reason to pull the plug on the Comanche, choosing to concentrate on the more-popular, less-expensive and higher-profit PA-28 line, including the PA-28R Arrow being produced at the Vero Beach site.

Some years ago, there was some thought given to resurrecting the design at the hands of the legendary and brilliant Roy LoPresti, but like the Swift Fury, it came to nothing. LoPresti did create some interesting and worthwhile aerodynamic mods for the airplane, however. Most Comanche owners can vouch for them.

HANDLING

You might hear some say the Comanche is tough to land smoothly, and that it floats when in the flare, and then drops on. Pilots who have mastered the Comanche tell us you probably won't make a smooth arrival every single time, but that it's not much different from some other high-performance singles.

We're told one way to smoothen those landings is by adding the Knots2U wing root fillets, which eliminate the vortex striking the stabilator when flaps are used. Still, the respected International Comanche Society (ICS) reports the best way to learn to land—and fly—this machine is to get some dual from an expert in the type, not the local flight school unless they have a Comanche expert on hand—and some schools even have Comanches. Based on our time in Comanches, we say fly it like it's meant to be flown, really, and you'll wonder what the barroom chatter was all about.

On takeoff there might be a tendency for the Comanche to wheelbarrow in crosswinds when holding the nose down to prevent the airplane from coming off the ground. Consider that the airplane had a tail-low stance when its weight is on the wheels. Some go as far as installing a smaller nosewheel tire and others simply pump up the main gear oleos to reduce the static angle of attack on takeoff.

Once off the ground, inflight handling is responsive and Comanche pilots will attest that it's a delightful airplane to hand fly. It's sturdy, which it makes it a good instrument airplane, plus it's easy to fly in busy traffic patterns since it's comfortably flown slow or fast. With practice and with the gear down, finals for a precision approach can be flown at 130 knots and, with the gear up, even faster. Slow it down in the last few hundred feet to land short and turn off at the first taxiway.

PERFORMANCE

What the 180-HP Comanche lacks for cruise speed it certainly makes

As small piston singles go, a Comanche has a reasonably spacious cabin. It's 45 inches wide and 47 inches high.

up for with endurance. It'll burn 8 to 10 GPH and cruise at 140 knots. For comparison, an American General Tiger with fixed gear goes just as fast and another contemporary retractable, the Mooney M20C or M20E, will outrun the 180. The Comanche 180 can climb at 700 to 900 FPM after using more than 2200 feet to clear a 50-foot obstacle. The 250 and 260 are better performers. Speeds are up around 155 to 160 knots at cruise, burning about 12 GPH. Still, these speeds trail contemporary designs of similar vintage and power, such as the P35 Bonanza.

The extra 10 GPH the big-engined Comanche 400 burns yields only about 10 to 15 extra knots. The 400 will, however, climb like a bat out of hell—every bit of 1600 FPM. Not many vintage singles in its class can match that.

The 180 Comanche's load-carrying capacity is ample but modest. With a gross weight significantly lower than later Comanches, cabin payload with full standard fuel (60 gallons) is about 660 pounds—think three-person airplane. The 250 can haul 750 pounds with full standard fuel, while the 260s and 400 can lift up to 1000 pounds.

The straight roofline giving the Comanche its distinctive crewcut looks also reduces visibility upward, although it's not as bad as some airplanes and does provide welcome shade in hot climates. The cabin itself is roomy and comfortable with good width, if a bit drafty and noisy, say some owners. Legroom is good for both pilots and passengers, and the cabin is definitely more spacious than the Arrow that followed. The fifth and sixth seats, when available, are suitable only for children or the smallest of adults.

The panel is what one would expect from a circa-1960s airplane, with good space for instruments but early, unrestored models will look dated by modern standards. The same goes for the interior, obviously, although we've seen some Comanches decked out with some pretty nice and modern custom leather seating and trim. The early panel layout doesn't conform to the later standard "T" configuration, so it may be unfamiliar to recently trained pilots or those coming from more modern rides. Those owners will eventually spend big money at the avionics shop for new metal panels and modern avionics, including autopilots and engine displays. There's plenty of instrument panel real estate to pretty much do whatever you can afford.

WRENCHING IT

There are mixed reviews from owners on maintaining a Comanche. First, we've worked on enough Comanches to say that the airplane is perhaps one of the best built all-metal singles of its time. Plus, it can be well-maintained at a lower cost than aircraft of lesser performance due to the widespread use of generic parts. There's also a good supply of aftermarket and PMA'd parts for commonly needed items. However, while the airplane isn't intrinsically difficult to service, understand and accept that this is an old aircraft—even the newest Comanche is nearly 50 years of age.

Moreover, the aircraft are relatively complex—certainly when compared to, for example, a Cessna 182—so don't assume it will be as cheap to maintain. However, with care (and that's important), costs will be more than manageable and once a system or component is properly repaired, it can be ex-

Bill Donald says a sweet spot for his 250 Comanche is between 9500 and 11,500 feet where it burns a miserly 12 GPH. Burning more at full throttle it does 157 knots.

pected to stay that way for a while. The trick—as it is with any older aircraft—is finding a shop or technician experienced in the type. If you find the right person and keep them happy, you'll be happy.

The landing gear on the Comanche gets our attention. No, it's not complicated but a review of service difficulty reports (and the NTSB accident reports) indicates it's a top sore spot, along with general airframe corrosion and engine/prop issues. Those familiar with the Comanche maintain major causes of gear-system problems are poor maintenance or rigging by mechanics unfamiliar with it. Pilots who don't understand the undercarriage and its various procedures, particularly the emergency extension procedure, also are a source of problems. We know of one flight school that had a Comanche on its flight line and it required renters to perform gear extensions and retractions with the airplane on jack stands. Kudos to them—we think every retrac pilot should witness a gear swing on the appropriate model.

The ICS is extremely resourceful, with a list of qualified instructors and shops familiar with the airplane. Aftermarket gear warning systems are also a good investment to supplement the system originally installed. Recurring ADs on any aircraft can run up the cost of operation, and Comanches are no different. One on the landing gear (AD 77-13-21) mandates replacement of landing gear bungees every 500 hours or three years to prevent landing gear collapse after manual extension. There's also an AD on the vertical fin attachment (AD 75-12-06). A prop inspection (AD 2005-18-12) is the most oft-complained about, costing nearly $1000 every 500 hours or five years. Also, a different prop AD (AD 97-18-02) can prove costly for 250/260 owners. As one result, many have opted to replace their old Hartzells for new two- or three-blade Hartzell or McCauley propellers, which terminates the AD. Apart from the aforementioned ADs, Comanches are unremarkable; most other ADs are minor and/or shotgun directives that apply to many airplanes.

NO SHORTAGE OF MODS OR CLUBS

There are so many mods available for the Comanche line that probably no two aircraft are alike today. You can modify its engine, its look, its handling, its panel and its features. Check a copy of the Comanche Flyer magazine or the ICS website www.comancheflyers.com for examples. For instance, it's possible to retrofit (via STC) the Lycoming O-540 engine into a Comanche 180 of 1960 or later vintage; there's at least one published report of this being done on an FAA Form 337, although we don't know of any shops offering the

COMANCHE CRASHES: FUEL, LDG GEAR

Ask someone about the Piper Comanche series and you're likely to get a comment along the lines of "with that laminar-flow wing and low ground clearance, it's a mutha to land—you float and float in ground effect, then it pays off and wham! you're down."

We kept that in mind as we reviewed the 100 most recent Comanche accidents. We did not find evidence that the Comanche has peculiar landing characteristics—there were only six hard landing events, well below what we would expect for an airplane that is truly difficult to land. There were eight runway loss of control incidents, low, we think—and one of them involved a student pilot.

To round out the landing accidents, only one pilot couldn't get stopped on the available runway—well below what we expect to see in our accident reviews. Seven approached so low that they hit an obstruction or impacted the ground short of the runway. That number is high, and we don't have a hypothesis to explain it, although we saw that three were at night and one of those hit power lines more than two miles short of the runway.

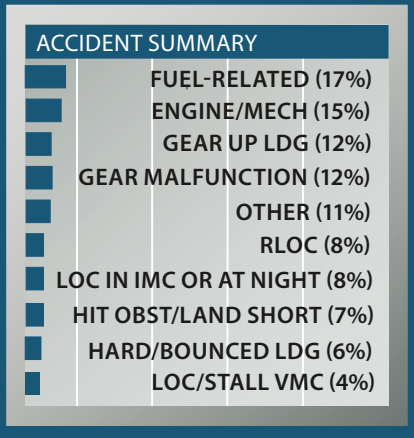
While we were pleased to find that the old wives' tales regarding Comanche landings were untrue, we were concerned by the number of landing gear-related incidents. Twelve pilots simply forgot to extend the Firestones before ground contact. That's more than twice the rate we expect to see on retracts—and is cause for concern for a potential buyer. Tied with 12 events in which the pilot could not extend the gear due to maintenance issues, it is our opinion that a potential Comanche buyer put attention to the landing gear system high on his or her checklist for ownership.

Depending on the model and mods, it seems like a Comanche can have a never-ending supply of fuel tanks. With the primitive indicating systems associated with many of the airplanes in the field, too often a pilot is faced with the dilemma, "Now where did I put that fuel?"

There were 17 accidents involving pilots either running completely out of fuel or running a tank dry and not then selecting a tank containing fuel and getting a restart in the time remaining in flight. We think at least two of those pilots did change to a tank with fuel, but didn't wait long enough for it to fill the empty fuel lines between the selector and the engine before concluding that the new tank was dry as well and switching into another empty tank (or the original tank).

There were eight LOC events in IMC or dark night conditions. Four of those involved inflight breakups—the clean Comanche airframe will smoke through Vne in short order once the nose is down or in a diving spiral.

Finally, we felt the pain of the pilot who flew to a neighboring airport for fuel, only to find the tanks locked. Not bothering with a preflight briefing, he took off and flew to his Plan B airport, where he learned, on Unicom, that it was closed. He headed back to home plate and ran the airplane dry on downwind. There would have been a happy ending, but he stalled the airplane on short final, over the runway, and stuck a wingtip into the ground.



mod without doing the full-up STC. Aside from the engine and prop, it involves the engine mounts, some baffling, controls and the exhaust system. The result is essentially a Comanche 250 with a low gross weight. Also, the carbureted O-540 found in the Comanche 250 may be upgraded to fuel injection.

Whelen Aerospace technologies (formerly LoPresti Aviation) is now at www.flywat.com and offers the $499 Slipper Fairing mod. It mounts just aft of the nosewheel well and helps the existing cooling air turn parallel to the belly of the airplane in a more efficient pattern, yielding a 3-MPH speed gain.

The familiar Wholey Cowl (which is no longer available for Comanche singles) eliminates the Slipper mod and boosts the top speed by a whopping 15 MPH. There's also the $289 Hubba Hubba wheel cap, with an access door for the tire's air valve. We like that it keeps grime and dirt away from wheel assembly. Cowlings are also offered by Aviation Performance Products (www.aviationperformanceproducts.com), which claims that its Eagle XP cowling increases speed, economy and improves maintenance access. The company also offers a stainless steel dual exhaust system. These mods are available for all Comanches except the 400.

There's also Knots2U (www.knots2u.net, 262-763-5100) that has, in addition to the wing fillet mod, a dorsal fin kit, speedbrakes and a variety of other mods for Comanches. For sure, the Comanche's list of mods, modifiers and parts resources is long and best accessed from involvement with the ICS and its members and publications.

Speaking of ICS, owners tell us the group is an exceptionally good resource for Comanche owners. It offers a magazine as well as other resources and can be reached at 888-300-0082 or via the website at www.comancheflyers.com. The ICS also offers a technical support service when you and your mechanic need someone to talk to. There's also the Delphi Airworthy Comanche Forum (https://forums.delphiforums.com/Comanches), and we spotted tons of useful threads on all things Comanche—from avionics to lighting to service parts. For training info, try www.comanchetraining.com.

Dave LoPresti sent us this image of a Wholey Cowl-equipped Comanche. It was once a popular mod and good for an extra 17 MPH with the prop upgrade, but it's only available now for Comanche twins and Senecas.

FEEDBACK

I have over 30 years' experience owning, flying, maintaining and modifying aircraft, including Piper Comanches. The old boys that I learned to fly with would say that if you can shut the door on whatever you got into a Comanche, it would fly away without a problem. I would prove that time and again in my Comanche 250.

In flight, the Comanche is smooth, stable and tight, with a climb rate that is impressive and difficult to prevent. As for range, even an old 250 model with 60 gallons of fuel will generally go from Western Massachusetts to North Carolina in 3.5 hours with one hour of fuel remaining. If you want to coax Comanche 260 speeds from a 250 model, try using the 260's power settings. The engines are identical, but with a different propeller redline.

The AD list is pretty long, but most of the items are one-time fixes, followed by future inspection. I've found that many aircraft are compliant. The number of available aftermarket mods for the plane is extensive; some are overpriced and pointless in my view, while others are fairly cheap and offer great results. Products from Knots2U and Webco are respected.

The mods that can offer the most speed include relocating the brakes to the inside of the gear forks, gap seals, wheel well slippers and wingroot fairings, both front and rear. Since it's important that the flight controls are properly rigged (while ensuring the landing gear and landing gear doors are retracted fully and fit flush) this should be the first step before any aftermarket mods are installed. I've found that landing gear bungees generally need replacement at every annual inspection.

After years of distance-traveling in my airplane (to places I never would have visited if it weren't for my Comanche), I believe a full-featured autopilot is perhaps the most useful avionics system you can buy. The Comanche market has two price points, really. Consider that you can buy a cream puff in the $125,000 to $150,000 range, and an airplane that needs serious work for $19,000. Either way, a realistic budget should be around $100,000. If you wanted to start out with a cheaper airframe, buy a 180-HP model and do a 260-HP conversion with fuel injection. In my opinion, there is no reason to own a 180 Comanche unless you are consumed with fuel range and can tolerate the vibration from the engine being so

Piper Comanche

(continued from page 31)

far out from the firewall. I've seen some IAs do the six-cylinder engine conversion and sign it off with a logbook entry.

Speaking of logs, before buying, examine the logbooks for entries that indicate the airframe has a history of good landing gear system maintenance and repair. With the plane on jacks, swing the gear and look for loose fits and bushings. All of the fuel bladders should be replaced with new ones. If not, the selling price should be adjusted to reflect a cost of $1500 per bladder. While Comanche engines are generally dependable, beware of top-end overhauls that were accomplished without replacing the cylinders with new ones.

While many Comanches sport three-blade propellers, some could have old clamp-style propellers. A prop can cost $15,000-plus. Cabin and cowling door repairs are often neglected, so be sure to inspect them for shoddy repairs and improper cabin door seals. A competent tech can generally rig a cabin door in an afternoon. Even heeding all of my advice, expect to spend money to acquire and keep an aging Comanche.

Don Gagnon
Montague, Massachusetts

I've owned my 1961 PA24-250 N7754P for six years, and the airframe has 2200 hours total and the engine has 980 hours since factory reman. It's a true traveling airplane and I flight plan for 157 knots when at full throttle. The Comanches have a "speed wing" so it's not a comfortable ride in moderate or greater turbulence, so slowing it down softens the bumps. I flight plan for 13.5 GPH, but flying from 9500 to 11,500 feet will reduce the fuel flow to around 12 GPH. My engine is carbureted.

The Comanche is gentle when it comes to stalls and is stable for flying instruments. It tends to be nose-heavy on landing so I use a lot of nose-up trim for an easier flare. My hardest transition in flying the Comanche was planning enough time to slow it up to the gear extension speed of 150 MPH and managing four fuel tanks (90 gallons total) and an electric fuel pump (on and off for landing and takeoffs). Most of my flight time is in single-engine Cessnas.

Insurance runs about $1600 per year. It went up in January when the panel upgrade was completed. The installation included dual Garmin G5 digital flight instruments, a PMA450 audio system, Garmin GTN 650 WAAS/GPS navigator and a GNC 255A VHF radio. The plane is ADS-B Out compliant with a Stratus transponder installed in 2016. Also installed was a new glareshield and a metal panel.

Insurance will vary with a pilot's experience. I hold commercial, instrument and multi-engine ratings, have 2300 hours total time with 500-plus hours of complex time, plus I've logged about 200 hours in my Comanche.

The plane has not been a drain maintenance wise. Basic annual inspections are done at a full-service FBO and run about $1400 when owner assisted. The only major issues have been a nosegear door repair and re-rigging the trim cable.

The International Comanche Society has been an invaluable resource for me. It has excellent technical advisors and sponsors a Comanche pilot proficiency school covering major systems and is complete with an optional checkride, which will be a flight review. I've taken the course twice. Keep it on the centerline!

Bill Donald
via email

BEECH BONANZA 36

It's time to take a look at the used Beech 36-series Bonanza market for the *Aviation Consumer* Used Aircraft Guide. We want to know what it's like to own these sturdy singles, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Bonanza to appear in the magazine, send us any photographs (full-size, **high-resolution**) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on the Bonanza by January 10, 2020, to:

Aviation Consumer
e-mail at:
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