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PURCHASE PLANNING HANDBOOK

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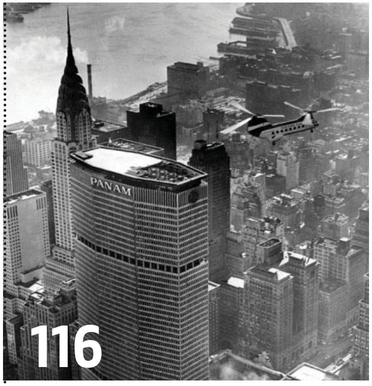

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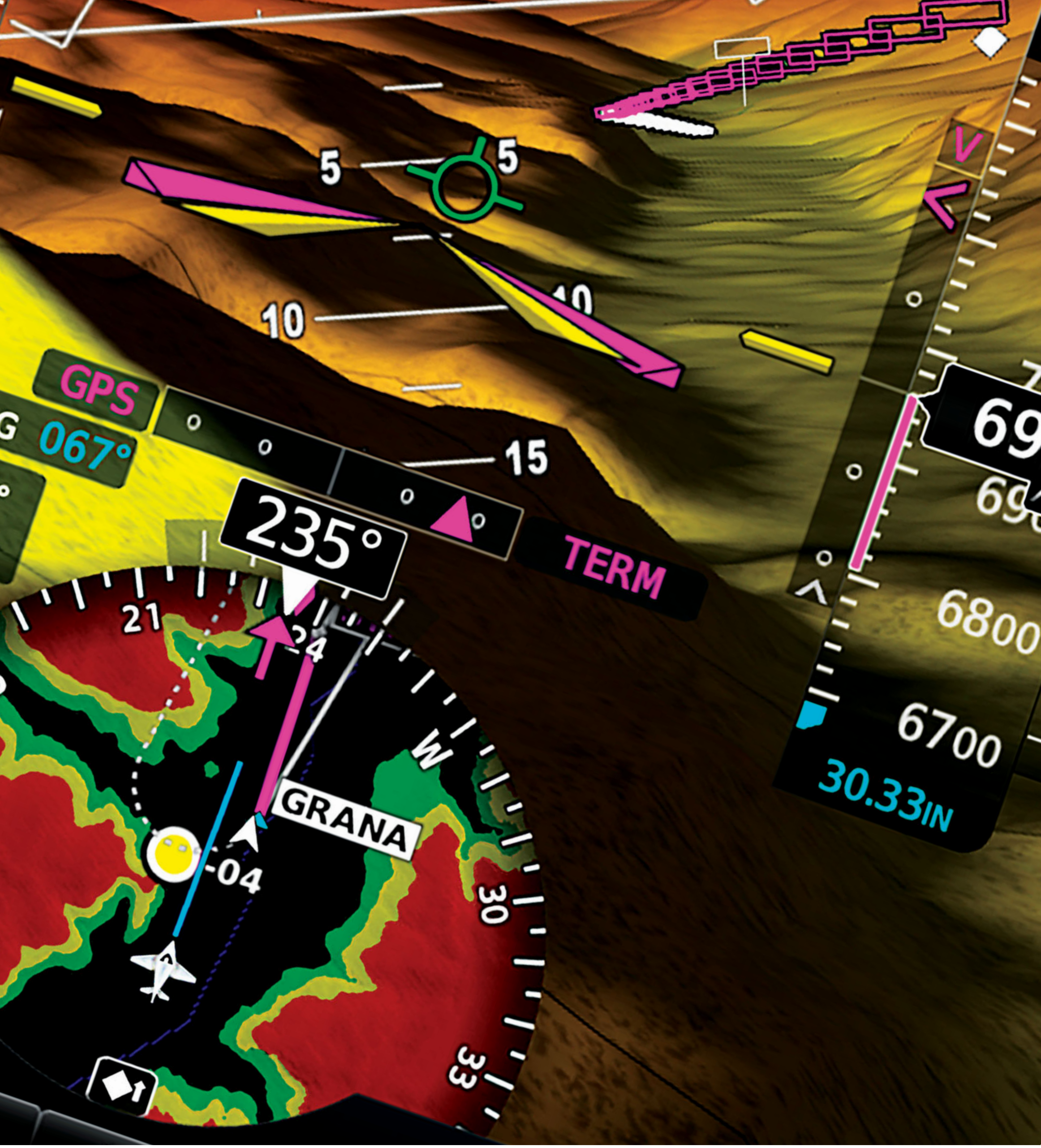

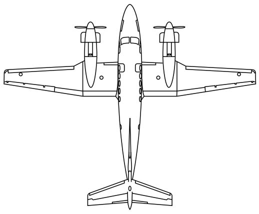

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Band of Brothers

Being **unified and resolute** are keys to success

THE EFFECTIVENESS OF ANY GROUP, BE IT AN ARMY PLATOON, Sunday choir or a surgical team in an operating room very much depends upon agreement among its members. They must all work to achieve the communal outcome. The shortstop can't head for the beach because his team is up by three runs in the sixth. The tanker captain can't change destinations on a whim.

Like it or not, Washington continues to provide excellent examples of both outcomes. The country's highest court now has a full lineup of "supremes" with the installation of Neil Gorsuch to the top bench, thanks to the Republicans in the Senate holding firm. Similarly, the Affordable Care Act, aka "Obamacare," continues as the law of the land thanks to the Democrats holding firm, and the Republicans not.

Similarly, those groups petitioning government must be clear in their intent and then stay true to the plan, lest fall short of the goal. Of course, compromises will likely be necessary since that's a reality of governing and life, after all, but all eyes must remain fixed on the real prize.

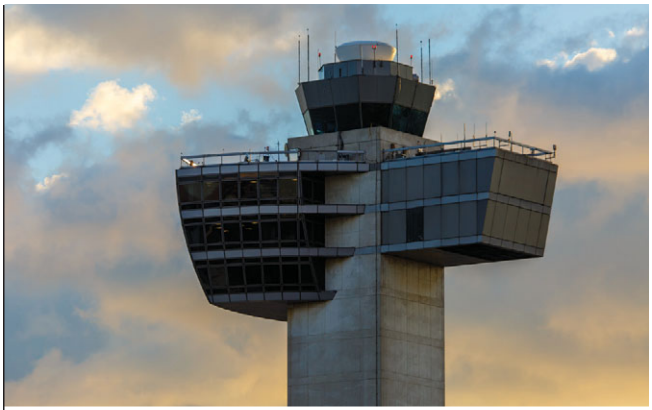
Considering the foregoing, the ongoing fight over the privatization of the U.S. air traffic control system, an idea Cessna Chairman Emeritus Russ Meyer last year characterized as "a disaster for general aviation," has produced some curious, possibly concerning, signs within the opposition.

One group wrote to members of the House and Senate committees debating the proposal to say it stood against the idea to "put this vital infrastructure under the control of a private entity dominated by the commercial airlines." Such a transfer of power, it warned, could result in new fees and taxes, block low-cost competitors, impede access and reduce service to small communities. The letter concluded, "Please say no to a privatized air traffic control system."

Another group wrote citing its concerns and requested "ample opportunity for all stakeholders and citizens to carefully review, analyze and debate any proposed legislation."

Now, which of those groups spoke for business and general aviation, the one unequivocally asking Congress to "just say no" or the second requesting further analysis and debate?

Surprising to me, the former comprised 10 organizations including the USA Rice Federation and National Grange, essentially representing the agricultural industry. Meanwhile, those requesting more review and debate included the General Aviation Manufacturers Association (GAMA), National Business Aviation Association (NBAA), National Air Transport Association (NATA), Experimental Aircraft Association (EAA), and 11 other business and general aviation organizations.



ISTOCK

Since Ed Bolen, the NBAA's CEO, has been strident, persistent and quite public about business aviation's absolute rejection of the privatization concept — as has the leadership of most of the other organizations — one is left to speculate about the reason behind such insipid demands now. I'm told the group delivered a similar request when privatization was proposed last year, but that doesn't explain the why. Could compromises among the members be a factor?

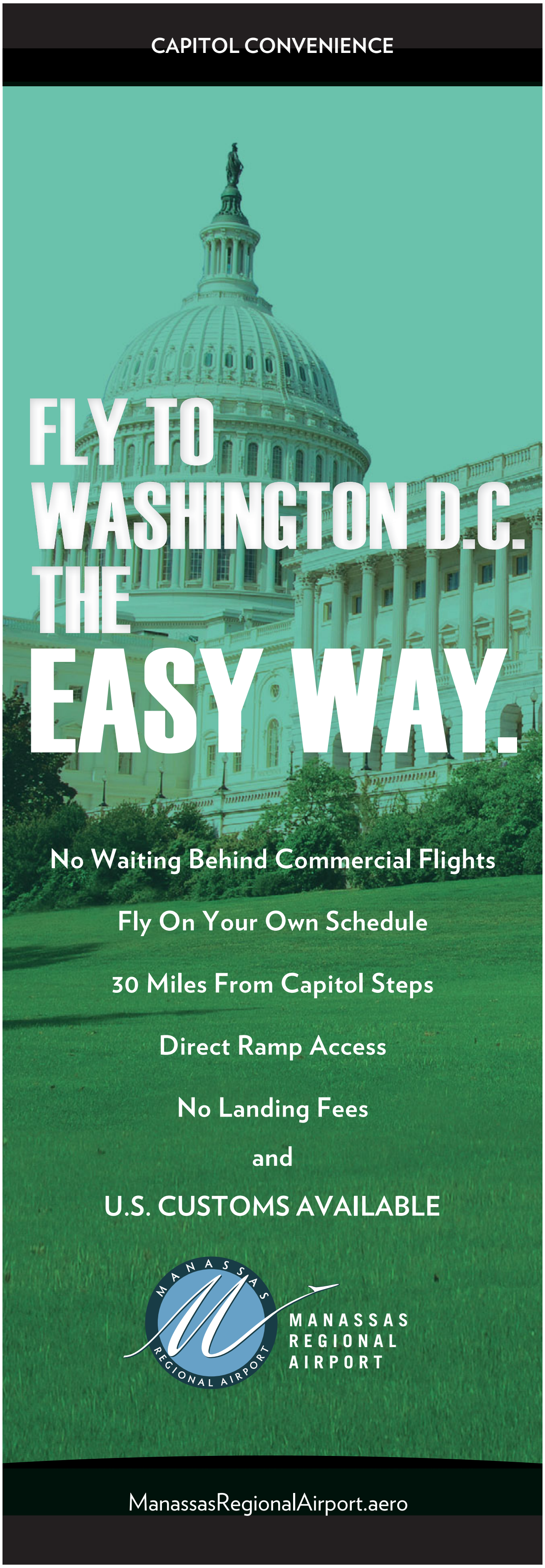
One of the many concerns about privatization is the introduction of fees for service. After all, someone's got to pay for all those controllers, maintainers and administrators and to keep the lights on.

In last year's failed proposal, business and general aviation operators were specifically excluded from any potential ATC fees, but not FAR Part 135 operators, a fact that did not sit well with the NATA. There's a good chance such exclusions will be repeated, a divide and conquer tactic.

Aircraft Owners and Pilots Association (AOPA) President Mark Baker says his organization will "strongly oppose user fees on any segment of GA," but is less clear on related matters. Then again, AOPA's most recent legislative focus was on Third-Class Medical reform, which it won. Now, it's on a lobbying crusade to have the government curtail FBO ramp fees and fuel pricing and guarantee unencumbered access between the ramp and parking lot — moves to which fellow petitioner NATA strongly objects.

That there are divisions and different priorities among the several aviation organizations is a given. It's always been so. However, those differences can be exploited by outsiders, including legislators and business interests, to their benefit.

Transferring control of ATC to a semiprivate entity is a flawed "solution" to a nonexistent problem and one that poses a real threat to the well-being of non-airline operators. However, its opposition must stand united and resolute, or this ever-recurring proposition could ultimately prevail. **BCA**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Readers' Feedback

When in Doubt, Don't

I read "Less is More: Merit in Cockpit Minimalism" **(March 2017, page 38)** with great interest. Having played a small part in this revolution, I can comment on some issues that presented themselves early on.

Collins Avionics attracted some brilliant engineers and their efforts changed how we fly airplanes today. Inventions such as the horizontal situation indicator (HSI) and flight director (FD), as well as the now commonplace command V-bars, are just a sample of their breakthroughs.

When EFIS first appeared, there was heartburn as to its benefit. Mal Harned, then senior vice president of engineering at Cessna, best summed this up saying, "This looks like a very eloquent solution to a non-problem."

Of course, OEMs didn't have the advantage of knowing that follow-on technology in navigation and systems would require the additional display capability.

Collins engineers, among others, recognized early on that just because it was possible, displaying more information might not be wise. As a result, Collins went to great lengths to understand the difference between enhanced safety, efficiency and crew awareness and displaying massive amounts of information "because you could."

My first exposure to an early, route-based FMS was in a then-experimental turboprop. During one flight, I asked the engineers how I could rapidly navigate to the nearest airport. Simple, they said: Go to the database (with layered key strokes), pull up and define a route, enter it, modify it with the new alternate airport and then follow the FD to the new destination.

While eloquent, it was too much data in a format not readily usable in a busy cockpit.

Other issues that came up involved basic performance air data. During development of early cockpit displays it was noticed that when experienced crews flew using vertical air data instruments alone, they lacked trend data, which in a round-dial cockpit was quickly discernable. The breakthrough came with the addition of trend vectors, which derived from a previously unavailable technology, acceleration-based attitude sensors. With it, pilots could quickly see what the aircraft is "going to do."

Concerned that it was possible to present so much data it could lead to a decrease in safety, pilot focus groups were formed and asked to evaluate ideas popular among the designers. The results came down to two broad desires — simplicity and reliability. In ranking items, for example, attitude was more important than heading, heading more than course displacement, comm frequency selection less important than nav issues, etc.

These results drove design direction. It led to the de-cluttering of basic flight control displays during unusual attitudes and to more data on the MFD rather than on the ADI and HSI, for example. It also led to the FMS "direct to" nav basis rather and to displaying only data needed for a particular flight regime. After all, does a crew need to know the weather in DEN while shooting an approach to minimums at LAX, or display terrain during VMC? The list goes on and on.

I suggest that when making display decisions designers and installers adhere to the axiom: "When in doubt, don't."

Mike Zonnefeld
Vice President
Omni International Jet Trading
Tucson, Arizona

ADS-B Issues Abound

I appreciate your candid assessment of GAMA sales numbers in “Chilling Numbers” (Viewpoint, April 2017, page 9).

I think a lot of folks in our industry have had their heads in the sand about this trend for some time. We saw it coming when I worked in marketing for Garrett AiResearch back in the 1980s.

Regarding the issue’s Fast Five (Page 22) with Aaron Hilkemann (CEO of Duncan Aviation), I own and operate a Bonanza for business travel and one of my FAA ratings is A&P mechanic. Having lots of avionics experience, I plan on doing my own ADS-B installation, which I’ll have certified by an FAA-licensed avionics shop.

Depending on how far I want to take things, it could cost me anywhere from $4,000 to $40,000. My avionics guy told me that for a turbine-powered aircraft, ADS-B might run from $40,000 to $400,000, and the cost to upgrade a transport category aircraft could be in the millions. Is it any wonder operators are dragging their feet?

The reason for this wide installation cost range is that most avionics systems are highly integrated and you can’t really change out just one or two boxes. The larger and more complex the aircraft, the more complex the hardware and software integration.

My avionics guy is having nightmares trying to solve ADS-B hardware and software interface issues and says he’s generally getting poor support from the manufacturers. This adds countless hours to each installation. He advised me to wait at least another year before I do anything.

In summary, I think the general aviation industry can be its own worst enemy.

Steven D. Zeller
President
Southbrook Technologies Inc.
Alpharetta, Georgia

From Around the Web

Learjet 70/75 Operators Survey, April, page 46

▶ Lets hope the Learjet 75 is NOT the last model in this iconic plane. Bill Lear did for the business [aviation] community what the 747 did for Boeing. A gamble that paid off. — spoilers

▶ The Leajet was the world’s first Corvette for the skies. Looks as fresh as the day it was introduced. — Robert Bradley

See, Not Believing, March, page 30

▶ A corrective action not mentioned is a review of archaic equipment requirements. Australia is a country that still mandates a radar altimeter, left over from those old days. Modern, multiple redundant GPS/AHRS/ADC systems can supplant those earlier ‘must haves’ but the regulations need to keep up with the technology and allow the performance and safety assessments to do their job. The root cause was a failure of the RADALT and poor integrity monitoring by the integrating processors before allowing an erroneous display to the pilot, rather than just annunciating the failure and ignoring it. So I wouldn’t call this a “Synthetic Vision” failure, it’s a systems integration failure. Things could have turned out very different if the crew had been less experienced. — DLF1

▶ The idea that such a prominent and compelling display that is difficult or impossible to ignore is also not to be used or be trusted for primary attitude and navigation is poor human factors engineering. We seem to be in a difficult point in our transition to integrated “glass” display technologies.

Perhaps the systems themselves need to trouble shoot the incoming data to determine if something is awry. Considering the size, cost and power for solid state IMUs, GPS, magnetometers, and air data sensors that a software algorithm could crosscheck and isolate offending inputs, including backup power, allowing for a graceful degradation of performance while keeping the crew informed and in the decision loop. — Jared Smith

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NEWS / ANALYSIS / TRENDS / ISSUES

▶ **A STARTUP WITH BACKING FROM BOEING** and JetBlue Airways is designing a hybrid-electric regional aircraft that could enter service in the early 2020s. **Zunum Aero aims to revitalize regional air transport by offering dramatically lower operating costs** in an aircraft that can compete with highway travel and high-speed rail to provide fast, low-cost door-to-door service. The Kirkland, Washington-based company is planning a family of 10-50-seat aircraft, beginning early in the next decade. The initial design will seat up to 19 passengers and be optimized for a 700-nm range, increasing to beyond 1,000 nm by 2030 as electric propulsion technology advances. Zunum is one of two early-stage investments made by the ventures arm of Boeing HorizonX, the new "innovation cell" within the aerospace giant. Meanwhile, Zunum's other announced backer is JetBlue Technology Ventures, an arm of the airline that invests in startups that can improve the travel experience, and facilitate future operations and maintenance, revenue management and customer engagement. **The startup has been working since 2013 and has emerged from stealth mode because it is ready to accelerate development efforts.** It plans to fly a prototype in two-three years —"closer to two if all goes well," CEO Ashish Kumar says. Zunum's initial aircraft is to be certified under the FAA's revamped Part 23 rules. A complete set of standards for electric aircraft is expected to be in place by 2018, with the first certification likely by 2020, when Zunum plans to begin production. Zunum is targeting 40-80% lower operating costs than current regional aircraft, mainly by using power-grid electricity rather than aviation fuel. For shorter ranges, the aircraft will fly on batteries alone, with battery swap-out or supercharger stations at airports to enable rapid turnarounds.

……

▶ **DAHER HAS ANOTHER UPGRADED VERSION** of its PT6-powered TBM 900 series. The new **TBM 910 features a Garmin G1000 NXi flight deck,** new cabin seat shapes and additional fittings. Deliveries will begin after certification, which is expected shortly. The standard aircraft is priced at $3.68 million, but its "elite" package raises that to $3.92 million. "Three words can describe the TBM 910: speed, readability and connectivity," said Nicolas Chabbert, senior vice president of the Daher Airplane Business Unit. "The TBM 910 is just as fast as its predecessor in flight, while offering pilots quicker access to cockpit information, along with safety-enhancing guidance and improved readability." The French manufacturer reports having taken more than 200 orders for TBM 900-series aircraft, which now includes TBM 900, 910 and TBM 930, since its launch. In all, 826 TBMs have been delivered.

……

▶ **QUEST AIRCRAFT'S KODIAK 100 HAS RECEIVED CERTIFICATION** from the European Aviation Safety Agency (**EASA**). **The award raises the total number of countries in which the utility single-engine turboprop is certified in to more than 50.** The award "will allow European operators with large payloads to access many more airstrips and locations that would previously have proven difficult," said Quest CEO Rob Wells. "We anticipate that Europe will play an important role in the continued growth of our company, even more so now with the recent and very welcome regulation changes in regards to single-engine turboprop commercial operations." The Kodiak will be sold and supported throughout Europe by Rheinland Air Service GmbH (RAS), headquartered at Mönchengladbach Airport near Düsseldorf, Germany.

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April 2017

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Central	$7.48	$2.42	$4.28
Southern	$7.53	$3.42	$5.51
Southwest	$7.98	$2.75	$4.72
NW Mountain	$7.20	$3.10	$4.78
Western Pacific	$7.60	$3.57	$5.28
Nationwide	**$7.50**	**$3.26**	**$5.02**

Avgas

Region	*High*	*Low*	*Average*
Eastern	$8.31	$4.70	$6.42
New England	$7.45	$4.55	$5.61
Great Lakes	$8.59	$4.29	$5.85
Central	$7.85	$3.99	$5.29
Southern	$7.99	$3.75	$5.85
Southwest	$6.99	$3.60	$5.30
NW Mountain	$8.46	$4.17	$5.72
Western Pacific	$8.50	$4.30	$6.23
Nationwide	**$8.02**	**$4.17**	**$5.78**

The tables above show results of a fuel price survey of U.S. fuel suppliers performed in April 2017. This survey was conducted by Aviation Research Group/U.S. and reflects prices reported from over 200 FBOs located within the 48 contiguous United States. Prices are full retail and include all taxes and fees.

For additional information, contact Aviation Research/U.S. Inc. at (513) 852-5110 or on the Internet at www.aviationresearch.com

For the latest news and information, go to
aviationweek.com/bcadigital.com

PC-12 NG Gets EASA Commercial Approval

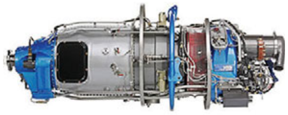
The Pilatus PC-12 NG has been approved by the European Aviation Safety Agency (EASA) for commercial operations in Europe. The decision means the single-engine turboprop can be operated commercially at night and under instrument flight rules across all 32 EASA member states. Nearly 1,500 PC-12s are in operation in the world. The PC-12 has long been in commercial use for business, medical transports and cargo flights in other parts of the world.

Continental Delivers No. 5,000

Continental Motors has delivered its 5,000th CD-100 Series engine. The company, which is based in Mobile, Alabama, has produced the engine for 15 years and the series Jet A-fueled piston engines have surpassed 5.25 million flight hours.

▶ **IN A SURPRISE EARLY APRIL ANNOUNCEMENT** Textron Aviation reported that Purdue Aviation, LLC had committed to adding the heretofore unannounced diesel-powered Cessna 172 to its training fleet. FAA and EASA certifications of the Turbo Skyhawk JT-A are expected later this year. The manufacturer said the new Purdue aircraft, which is powered by a Continental CD-155 engine and equipped with the next-generation Garmin G1000 NXi integrated cockpit, will be the first to be delivered. "We are thrilled to integrate Jet-A powerplant technology into the world's leading flight trainer," said Doug May, Textron vice president, Piston Aircraft. "The Turbo Skyhawk JT-A is an example of our commitment to modernize the piston product line and bring innovative technologies to market, allowing operators around the world to meet changing environmental regulations, while benefiting from faster climbs, increased range and fuel savings." According to Textron, the new model has a maximum range is 885 nm, a 38% increase over the standard Skyhawk, a maximum speed increased to 134 knots, and up to 25% lower fuel burn per hour. It also offers improved takeoff performance, especially in high and hot conditions. The Wichita planemaker had also been developing a diesel-powered Cessna 182, but placed that project on hold two years ago. Based at Purdue University Airport, West Lafayette, Indiana,

▶ **GE AVIATION HAS SUBMITTED A TYPE CERTIFICATION REQUES**t to the European Aviation Safety Agency (EASA) for its new H Series Aerobatic engine. The powerplant features a single lever to control both the engine and propeller, which the manufacturer says "will significantly reduce pilot workload and provide automatic limiting functions." The engine, which GE says is targeted for the aircraft in the 550-850 shp range, is expected to be awarded certification in 2018. The GE H Series engine with the single lever system received type certification from EASA last December, followed by FAA approval in March. The engine has been selected for four aircraft applications serving a multitude of uses including agricultural, business turboprops, commuter and utility aircraft.



▶ **TECNAM HAS LAUNCHED A SLOT DEPOSIT PROGRAM FOR ITS P2012** Traveler. The high-wing, 11-seat piston twin lists for $2.35 million. A deposit of $107,000 allows customers to take delivery positions in 2019 and freezes the pricing. Powered by two 375-hp Lycoming TEO-540-C1A engines, the Italian aircraft made its first flight last July and is on track for European Aviation Safety Agency (EASA) and FAA certification in 2018 with deliveries beginning the following year. Initial flight tests have allowed the design team to improve the maximum takeoff weight to 7,937 lb. Outfitted Garmin G1000 NXi avionics, the aircraft will first see service with Cape Air in early 2019. The Massachusetts-based airline is a major Cessna 402 operator, serving destinations in New England, the Caribbean and Micronesia. The Tecnam twin is intended to replace the aging Cessnas; the carrier could take delivery of as many as 100 aircraft.

▶ **THE AIRCRAFT OWNERS AND PILOTS ASSOCIATION (AOPA)** is asking the National Transportation Safety Board (NTSB) to conduct an internal review, saying the safety board has approved "speculative probable cause reports related to general aviation accidents" despite little evidence. The association said that several recent accident findings by the board have raised its concerns about the erosion of data-driven facts, including findings of medical incapacitation "contrary to other compelling evidence."

PHENOM 300: SAFETY, ADVANCED AVIONICS, COMFORT

"What inspired my purchase was a combination of the passion and love of aviation and to pilot a jet like the Phenom 300. But also for business purposes, I can fly around the world and meet with vendors who supply us raw materials. I can meet with retailers, so it's very exciting to fly very quickly to them and avoid the delays and cancellations of commercial air travel. Plus, you can fly into smaller airports that are closer to your destination.

And what got me so excited about Embraer was its DNA building airliners, the ERJs. I always tell people Embraer forgot it's building executive jets. They still believe they're building airliners for endurance, safety, redundancy.

Embraer treats me as well or better than its airline customers. The company goes out of its way to keep the plane upgraded with service bulletins, improving the systems of the plane, improving every aspect of the airplane. I like the fact that Embraer is just constantly improving the Phenom 300, and they do a phenomenal job of keeping parts in stock.

The plane is very stable. Passengers like the combination of the safety of the airplane, the advanced avionics, combined with the comfort of the plane. The lavatory being externally serviceable is awesome for both the owners/operators and passengers.

I wanted the latest, greatest, best, safest technology, and Embraer had it all, from the avionics to the engines to the systems."

- Wayne Gorsek, Founder & CEO, DrVita.com
Watch Wayne's story and request more information at
EmbraerExecutiveJets.com/Wayne

The Phenom 300 — the most-delivered business jet in the world — is a clean-sheet-design light aircraft that delivers best-in-class speed, climb and field performance, next-generation avionics, a spacious cabin and a largest-in-class baggage compartment. Its comfortable, highly intuitive cockpit, with large displays and state-of-the-art avionics, enhances situational awareness. Delivering superior comfort and style, the OvalLite™ cabin provides ample leg and head room and the largest galley and windows in its class, for abundant natural light. Up to 11 occupants also enjoy the best cabin altitude in the category. Contributing to its enviable presence on the ramp, the signature air stair leads to the largest entrance door in its class. The Phenom 300's superior overall performance, combined with class-leading fuel efficiency, reinforce its breakthrough status and strong acceptance in the marketplace.

Rethink Convention.

EMBRAER
Executive Jets

Embraer Delivers 400th Phenom 300

Embraer has delivered its 400th Phenom 300. The March 31 handover took place at the manufacturer's assembly facility in Melbourne, Florida.

The aircraft was delivered to Daniel Randolph, CEO of EliteJets.com, a startup charter company based in Naples, Florida, whose fleet includes four Phenom 300s and one Legacy 500. According to its website, EliteJets.com was to begin operations on May 1.

USI Launches Workforce Initiative

The Unmanned Safety Institute (USI) has launched a career and technical education workforce development initiative with high schools and colleges in the U.S. The program provides teacher credentialing and course materials. According to the company, students successfully completing the program are eligible to take an exam leading to Small UAS Safety Certification, which demonstrates expertise as a professional remote pilot, making them qualified for careers in the fast-growing drone industry. By 2020, the FAA estimates there could be as many as 2.3 million licensed UAS pilots. USI reports it has a network of nearly 100 certified instructors. The curriculum includes four courses with more than 150 hr. of instruction.

▶ **THE FLIGHT SAFETY FOUNDATION (FSF) HAS IDENTIFIED** the **"psychological drivers of noncompliance" behind pilots' "extremely poor" adherence to go-around policies.** The finding has spurred a revamping of the safety advocate's long-held stable approach criteria and guidance for when a go-around is prudent. The work is part of the FSF's Go-Around Decision-Making and Execution Project. This research effort by two internal committees and the Presage Group seeks to answer the question of why the industry has been "so poor at complying with established go-around procedures." A final report on the project was published March 27. "Compliance" refers to both pilots following standard operating procedures for performing missed approaches, and management in ensuring that procedures are being followed. The link between accidents and failure to go around is well established by forensics. A previous FSF study of runway excursions over a 16-yr. period determined that 83% could have been avoided with a go-around. The new study included web-based surveys of pilots and airline managers to understand the psychology of go-arounds. **It looked at 64 go-around events from 2000-2012 to understand potential problems with aborting a landing.** The decision to abort is theoretically driven by whether certain stable approach criteria — defined by altitude, speed and path thresholds along an approach — are met. Based on existing guidance, pilots on an instrument approach must have the aircraft in landing configuration and on path and speed at 1,000 ft. above ground to continue. For a visual approach, the same is supposed to be true at 500 ft. Beyond the initial gates, if the vertical descent rate is more than 1,000 ft. per minute, the pilots should perform a go-around. Despite the criteria, approximately only 3% of unstable approaches resulted in a go-around, according to the FSF. Approaches defined as stable during the approach were often problematic in the landing phase. More than half of the excursions involved aircraft that became unstable during the landing. The FSF noted that the go-around itself is not without, risk given how rarely pilots perform the maneuver — about once or twice a year for a short-haul pilot, and about once every 2-3 yr. for a long-haul pilot. **"It is evident that the state of noncompliance has been steady for many years and will remain steady unless changes are made,"** the FSF report said. It added that the industry must improve its awareness of the problem, and change its focus and cultural norms. "The problem of go-around policy noncompliance is real, and is arguably the greatest threat to flight safety today," the FSF said. It added that the "potential impact of improvement in compliance is significant." Part of the solution could be a reformulation of the stable approach criteria and instructions for when to abort — guidelines many pilots see as unrealistic. The FSF is proposing a two-phase criteria. This consists of a stable approach zone from 1,000 ft. to 300 ft., where pilots will ensure an aircraft is fully stabilized. It would also include the primary go-around zone from 300 ft. down to thrust-reverser deployment, where the focus shifts from stabilizing the aircraft to performing a go-around.

▶ **A YEARS-LONG EFFORT TO REWRITE EUROPEAN AIRCRAFT** certification standards for many types of light aircraft is done and the European Aviation Safety Agency's (EASA) new **CS-23 takes effect Aug. 15**. In general, the new rules are in harmony with the FAA's new Part 23 regulations, which were published in December. Both regulations shift from design-specific requirements to consensus-based standards in helping determine compliance and airworthiness. "The former approach was widely considered to be overly prescriptive for simple designs while requiring special conditions for complex designs," ASTM International said. "This led to confusion, delays, cost increases and other negative impacts." **The new rules include performance-based requirements that rely on "acceptable means of compliance,"** it said. They include standards from ASTM International's committee on general aviation aircraft. "This new approach will help foster innovation and new safety-enhancing technologies at the same time," said Greg Bowles, F44 chairman and vice president of Global Innovation and Policy for the General Aviation Manufacturers Association. "It's a win-win for the aviation community on a truly global scale.

Award-winning technology

Together, BAE Systems and Gulfstream are innovating to provide enhanced situational awareness for pilots by introducing electronically coupled active control sidesticks on the G500 and G600 business jets. The Gulfstream G500 will be the first fly-by-wire aircraft with active control sidesticks in service when it attains certification later this year. Learn more at www.baesystems.com/flightcontrols.

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Cessna Launches TTx Online Ordering Tool

Buyers of the Textron Aviation TTx single-engine aircraft may now customize their order through an online virtual-aircraft generator that allows TTx buyers to choose from one-dozen exterior paint colors and striping, along with interior and avionics options. Those include a traffic advisory system; Garmin XM weather and radio datalink; Jeppesen Chartview; automatic direction finder; distance measuring equipment; and other features. other extras. The aircraft's base price is $715,000.

Wearable Technology Industry Is Growing

Wearable technology — including head-up displays, embedded sensors, advanced textiles, embedded computing, energy harvesters, exoskeletons and communications — is being integrated into a variety of civil and military systems and components in ways not previously possible. Over the next decade, the wearable technologies market is expected to grow at a cumulative compound annual growth rate of nearly 40% and produce a cumulative global market of nearly $8 billion, according to Global Wearables Technologies Market Forecast to 2025.

RUAG AVIATION in Munich has completed a customer interior refurbishment of a new Bombardier Global 5000 registered in India to an unnamed customer. The client chose Bombardier's Authorized Service Center to install a custom configuration and RUAG to add upgrades to its inflight entertainment system and restyle additional interior elements, RUAG said. The refurbishment was completed on schedule, the company said.

UNITED AIRLINES ISN'T THE ONLY AVIATION COMPANY TO BE confronted with public outrage recently. Angry protestors gathered outside Bombardier's Montreal headquarters recently to express their ire over the company's **plan to raise the compensation of its senior executives by $32 million.** As a result on March 31, Pierre Beaudoin,the company's executive chairman, opted to forgo his extra pay — but his announcement was quickly followed by a combative statement from Bombardier's head of human resources, Jean Monty. Monty argued that the pay increases were in line with what other companies of a similar size offered, and that most of the remuneration was not guaranteed, but linked to long- and short-term performance targets. **"If the company does not perform; if it does not increase its share price and create value for our shareholders, this money will never be paid,"** he said. On April 2, Bombardier CEO Alain Bellemare went further and ordered that half of executive compensation decided for 2016 be deferred until 2020. Bombardier hopes this will be enough to calm public indignation about the pay bumps for 2016, a year in which it received $1 billion in taxpayer investment from the province of Quebec while proposing 14,000 job cuts. This year, the Canadian government is set to pump an extra $282 million into the plane- and train-maker. "By any objective measure, the Bombardier leadership team had an exceptional year in 2016," Monty said in defense of the remuneration policy. While that was certainly true with regard to Bombardier's share price, which climbed almost 300%, but in aircraft pricing and taxpayer support, its record was exceptional for all the wrong reasons.

CHINA'S DEER JET PLANS TO BUILD UP AN INTERNATIONAL NETWORK of FBOs, possibly by buying established facilities as a first step. The initial focus is on the U.S., with Europe not far behind, according to Zhu Yinan, general manager of Deer Jet's FBO management division, who says the first deal could be done this year. **Creating such a service network is part of the wider strategy of the HNA Group, Deer Jet's parent company,** for expanding its business internationally and building a global brand. Deer Jet's main activity is managing and operating business aircraft for clients. But it also has eight FBOs in China, while Hawker Pacific, an Australian business in which HNA has a majority interest, has such facilities in four Australian cities and at Singapore and Shanghai. Now the company wants its brand on FBOs outside of China. It sees four ways doing that, says Zhu: cooperating with an established foreign business; buying one; building an FBO in partnership with a foreign company; or building one independently. That last option, Zhu says, will have to wait until Deer Jet has set up a team of experienced FBO people outside of China through one of the other methods. Simply buying a facility would be a classic HNA approach. According to Zhu, targets for cooperation or acquisition in the FBO field must have strong businesses. Deer Jet will have to seek approval for any such move from HNA Tourism, the group division to which it belongs.

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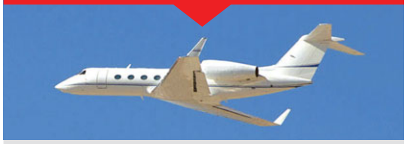
Pentastar E STC For Gulfstream GIV-X Data Technologies



Pentastar Aviation has received FAA certification of compatibility of wireless data technologies on Gulfstream Aerospace GIV-X (G350/G450) series aircraft, the company said. The Supplemental Type Certificate allows operators to approve the use of Transmitting Portable Electronic Devices onboard aircraft with wireless networks or Wi-Fi hot spots for passengers, who may email, talk, text and video conference without interfering with safety critical systems on the aircraft. The STC complements similar approvals for Gulfstream's G-IV, GV and GV-SP (G500/G550) and Hawker 800XP and 850XP aircraft.

Jet Aviation Vienna Gains FAA Repair Station Approval

Jet Aviation's maintenance center in Vienna has gained FAA repair station approval and is registered to provide line and base maintenance services to all N-registered aircraft it is approved to support. The Vienna facility provides maintenance support to owners and operators in Eastern Europe, where about 10% of all N-registered aircraft in EMEA and Asia are based or operating.

▶ **THE FAA HAS ISSUED ITS FIRST AIRSPACE RESTRICTIONS** that specifically apply only to unmanned aerial vehicles, aka UAVs or drones, banning flights under 400 ft. AGL within the boundaries of 133 military facilities. The special security restrictions took effect April 14. The agency warns that violations could result in criminal charges, civil penalties and the revocation of certificates and authorizations to operate UAVs. More restrictions may be coming. The FAA says it is considering additional requests from security and intelligence agencies. **In addition, it is also evaluating options with the Transportation Department for accepting petitions to prohibit or restrict UAV operations over critical infrastructure and other facilities.** The latest airspace restrictions apply to public aircraft operating under FAA certificates of authorization (COA), commercial operations under COAs or the FAA's Part 107 small UAV rule, and model aircraft. The agency said the restrictions are being imposed in response to requests from the Defense Department and U.S. federal security and intelligence agencies.

▶ **ACCORDING TO THE CHIEF ECONOMIC ADVISOR TO** President Donald Trump, air traffic control (ATC) reform — including privatizing ATC — could be a major element of the new administration's infrastructure buildup, but general aviation operators should not fear paying more for it. "We're probably not even going to tax general aviation," said Gary Cohn, director of the National Economic Council. "There's enough money in the aviation tax right now." Cohn made that comment during a so-called White House town hall on the U.S. business climate on April 4. Weeks earlier the president's 2018 budget outline said the White House would initiate a multiyear reauthorization proposal to shift the ATC function of the FAA to an independent, non-governmental organization. "Air traffic control, to me, is probably the single most exciting thing we can do for a lot of reasons," Cohn said. "It's kind of insulting that we are the last to do air traffic control [reform] and not the first to do air traffic control. A country that has Silicon Valley and all of the technology entrepreneurs that we have and we're playing catch-up; that's embarrassing for us."Still, Cohn acknowledged opposition to the privatization concept general aviation interests and lawmakers, specifically appropriators, reluctant to surrender their power of the purse. "They like that $40 billion, $50 billion a year flowing through their hands," he said, referring to aviation federal fuel taxes. "If we privatize air traffic control, they won't be able to touch that money." Cohn asked House Majority Leader Kevin McCarthy (R-Calif.), who was in the town hall, to help persuade lawmakers. But that will be a hard task as some in McCarthy's own political party have been the most vocal against privatization efforts since last year, when House Transportation and Infrastructure Chairman Bill Shuster (R-Pa.) pushed a similar move.

▶ **OIL AND GAS HELICOPTER OPERATOR CHC REPORTS** emerging as an "economically robust and agile competitor," 10 months after filing for bankruptcy protection. The Canadian operator, which has its headquarters in Texas, says the court confirmed its financial restructuring on March 24. The new CHC is lighter to the tune of 80 helicopters, $1 billion of debt, and another $1.4 billion in lease obligations. Some $300 million is being ploughed into a recapitalization of the company, while an additional $150 million will be provided by Milestone Aviation Group, which will be used for aircraft financing. "This is a pivotal moment in CHC's history," said Karl Fessenden, the company's president and CEO. "This process has allowed us to help secure CHC's long-term health and create a streamlined, highly competitive cost structure while establishing a fleet of aircraft better aligned with our customers' businesses."

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Bombardier Opens Service Center In Tianjin, China

Bombardier has opened a business jet service center in Tianjin, China, in a joint venture with the Tianjin Airport Economic Area. The Tianjin Service Center, located near Beijing, includes 95,766 sq. ft. of hangar space and back shop areas for maintenance, repair, overhaul and other activities. Bombardier forecasts demand for 1,100 business jets in Greater China, South Asia and the Asia-Pacific region over the next 10 years.

Frasca Delivers Mustang Sim to Paris Training Center

Frasca International has delivered a Cessna 510 Citation Mustang business jet simulator to its new training center in Paris, the company said. The dual-qualified simulator meets French requirements for Mustang initial and recurrent training. The simulation center was established by Oyonnair, a French business aviation charter company to train its Mustang pilots and pilots flying in other regions that hold a European Aviation Safety Agency (EASA) license.

▶ **TEXTRON AVIATION HAS BEGUN ASSEMBLY** of its Citation Longitude super-mid-size jet. The first four production aircraft are in progress inside the company's Plant IV manufacturing plant in East Wichita, Textron Aviation reports. **The Longitude is the first Cessna product to be manufactured inside a former Beechcraft facility.** In addition, the third Cessna Citation Longitude test aircraft has completed its first flight and has joined the flight test program. During the recent 1 hr., 40 min. flight, test pilots Corey Eckhart and UJ Pesonen and flight test engineer Mike Bradfield tested the aircraft's various systems. The aircraft will be used for avionics, systems development and the collection of flight simulator data. Certification of the $23.9 million Longitude is expected by year-end. "The speed at which our team is achieving these milestones is an important indication to our customers of the maturity of the aircraft's systems and the proficiency of our processes," said Brad Thress, Textron Aviation's senior vice president of engineering. **The first test Longitude flew in October 2016.** The first two aircraft have completed 125 flights and have logged 250 hr. The Longitude is a clean-sheet design and will have seating for up to 12 passengers.

▶ **HARLOW AEROSTRUCTURES, A COMPONENT SUPPLIER** to the aviation industry, has developed its first autothrottle for new general aviation aircraft. The company, based in Wichita, is seeking a launch customer for the equipment. It expects to receive certification for the new HAT-05 auto throttle by the end of April. **The objective is to get autothrottles onto more business aircraft, company President Jim Barnes said.** "There shouldn't be any reason for not having these." The next evolution of the product is to reconfigure it for single-engine turboprops, Barnes said. It would take only 60 to 90 days to reconfigure the device for turboprop use, according to Barnes. Harlow builds throttles for Textron Aviation's Scorpion and T-6 aircraft and Daher's TBM 900 and 930. Its Brazilian customer, Novaer, will also receive its first shipment of Harlow-designed throttles for its new clean-sheet aircraft shortly. The design effort at Harlow, which began last July, culminated with the first shipment to Brazil at the end of March. Harlow has also built throttles for the Citation X, XLS+, Sovereign, among other aircraft.

▶ **CIT GROUP MARKED THE END OF AN ERA APRIL 4** as the financial holding company exited the aircraft leasing market and closed the sale of its commercial aircraft leasing business to Avolon Holdings for a final purchase price of $10.4 billion. Avolon is an international aircraft leasing company and wholly-owned subsidiary of Bohai Capital Holding Co. Ltd. The deal was first announced in October, and CIT Commercial Air was rumored to be for sale long before then, including at Istat Americas 2016 in February.

▶ **CHARLES "CHUCK" MCKINNON, FOUNDER AND MANAGER OF IBM'S** flight department, died March 30 in Trussville, Alabama, at the age of 101. During World War II he flew for United Airlines, which had won an Army Air Corps contract to transport supplies and troops. In 1954 he flew IBM's first business aircraft, a twin-piston Aero Commander used to fly company engineers to sites around the country. He led the flight department until his retirement in 1977. In the early 1970s, McKinnon worked to save Paris-Le Bourget Airport, which was threatened with closure due to the development of Charles de Gaulle Airport. ***Photo: Chuck McKinnon (center) receiving the John P. "Jack" Doswell Award from NBAA***

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INTERVIEW BY **WILLIAM GARVEY**

Brandon Mitchener,
CEO, European Business Aviation
Association, Brussels, Belgium

A native of northwestern Indiana, Mitchener majored in German literature and international relations at Wabash College, and also studied in Austria and Switzerland. That cultural exposure had a lasting effect. After earning a master's degree at the Columbia Graduate School of Journalism, he was hired by AP-Dow Jones Newswires, which sent him back to Europe to cover events surrounding the reunification of Germany. He spent 15 years primarily on the Continent, reporting for AP-Dow Jones, The International Herald Tribune and The Wall Street Journal, before entering the business world as a communicator for several companies and organizations, including Monsanto, First Solar and APCO Worldwide. Now 52, he has lived and worked in Europe for 29 years and is fluent in Italian, French and German, a facility that has so influenced his native tongue that he's often asked where he learned to speak English so well. He began work at EBAA on April 3rd.

TAP HERE in the digital edition of ***BCA*** to hear more from this Interview or go to **aviationweek.com/fastfive**

Questions for Brandon Mitchener

1 **Being a European correspondent for *The Wall Street Journal* is an enviable assignment. Why did you leave?**

Mitchener: I'd been with the paper for nine years and wanted to do something different. However, the job was so interesting, nothing else available in journalism at the time held as much appeal. My family was in Brussels and didn't want to move and several firms there were courting me. Some in journalism might have viewed my decision to enter into public relations and lobbying as going to 'the dark side,' but I don't think of it that way at all.

2 **What of your experience and talents did the EBAA board members value most?**

Mitchener: I believe they saw three things as my strengths. First is my ability to influence and work with policymakers. I understand Brussels. I've been here 20 years as a lobbyist and journalist and I know how the EU operates. Secondly, I'm a decent communicator and we need to explain business aviation to the general public. The association hasn't spent lots of time doing that, and the board wants that to change. I consider myself a storyteller and finding and presenting good stories is a part of my job.

3 **And the third?**

Mitchener: The industry workforce is aging. It's not attracting younger people. We need to appeal to the next generation directly, to encourage them where they are. We have a Twitter account, but we could do more with it. We're going to focus on social media to tap into the online community that's passionate about business aviation.

4 **How is business aviation perceived in Europe?**

Mitchener: The EBAA conducted an audit on the subject and it revealed that policymakers know business aviation exists as a necessary and useful tool — everyone can see the airplanes taking off and landing at the airport — but don't really know its economic contribution. My father was a pilot and manager in the chemical industry. He had a Piper Cherokee that he used to visit production facilities and to take us to see family in Michigan, saving countless hours of road travel. Having access to that kind of mobility is something everyone would want. But they need to know that it's available to them.

5 **What about business aviation has surprised you since being approached by EBAA?**

Mitchener: How important it is, its utility and necessity. It's an essential part of the aerospace community. It serves hospitals, disaster victims, and transports medical personnel. So, in addition to serving business, it saves lives. Business aviation represents seven percent of European aviation and has an economic impact of 100 million euros per year, but it's underappreciated. That has to change.

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BY **FRED GEORGE** fred.george@penton.com

NTSB

The Phenom and its occupants clearly were doomed at about 800 ft. above the ground — too low to recover.

It was a chilly and rainy morning on Dec. 8, 2014, when Dr. Michael Rosenberg strapped into the left seat of his Embraer Phenom 100 at Horace Williams Airport (KIGX) in Chapel Hill, North Carolina, bound for Montgomery County Airpark (KGAI) in the Washington, D.C., suburb of Gaithersburg, Maryland. A well-respected physician, entrepreneur and adjunct professor of epidemiology and maternal and child health at the University of North Carolina, Rosenberg was meeting that day with staffers at the U.S. Food and Drug Administration.

Also on board for the 1-hr., single-pilot flight were Rosenberg's associates, David Hartmann, 52, and Chijioke Ogbuka, 31.

Departing KIGX at about 0945, the aircraft climbed to FL 230 and cruised normally en route to Gaithersburg for 12 min. before starting the descent into the Washington terminal area. Approaching the destination, the pilot requested the RNAV (GPS) RWY 14 approach.

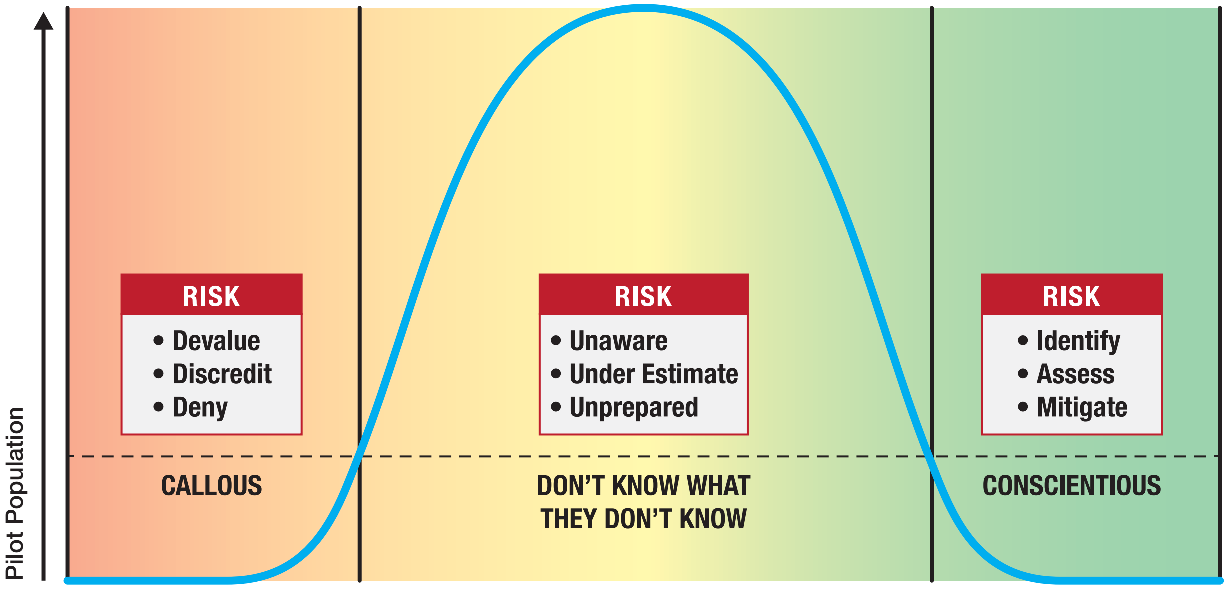
The weather at the airport was clear below scattered clouds at 2,100 ft. AGL with 10 mi. visibility. The OAT was -1C and the dew point was -8C. But weather conditions were ripe for icing as there was a ceiling at 3,200 ft. AGL, with tops at 4,300 ft. to 5,500 ft. MSL. A regional turboprop pilot, for instance, reported moderate icing in clouds in the vicinity between 4,000 ft. and 5,000 ft. During the descent and initial approach into Gaithersburg, the Phenom flew in conditions favorable to icing for at least 10 min. during the approach, according to NTSB.

Runway 14/32 at Gaithersburg is 4,202 ft. long, and thus plenty sufficient for a Phenom 100 at its 9,877-lb. max landing weight, assuming no icing, according to Embraer's OPERA (Optimized PERformance Analyzer) software. The aircraft had both a 2-hr. cockpit voice recorder and a multichannel flight data recorder that calculated landing weight to be 8,671 lb., according to the NTSB. Assuming use of full flaps, the VAC (approach climb) and VREF speeds were 100 KIAS and 95 KIAS, respectively. The dry surface, no wind, unfactored landing distance was 2,298 ft., providing 1,400+ ft. of cushion for rollout.

Even so, Rosenberg bugged VREF and VAC at 92 KIAS and 99 KIAS, respectively, during the descent, according to the NTSB's analysis of the FDR, speeds that were too slow for the estimated landing weight.

Further, if wing and stabilizer de-ice systems had been in use, landing weight would have been restricted to

Risk Mitigation Bell Curve



Source: NBAA

8,033 lb. to meet the one-engine-inoperative (OEI) approach climb gradient requirement if using full (36 deg.) flaps for landing. Reducing flaps to position 3 (26 deg.) improves OEI approach climb performance, allowing the aircraft to land at 9,091 lb., but would boost both V speeds to 121 KIAS and increase landing distance to 3,719 ft. Doing so would have left less than 500 ft. of margin for rollout at Gaithersburg, assuming a landing technique of test pilot precision.

With airframe deice systems in operation on a Phenom 100, the VAPP and VREF speeds are increased to compensate for stall occurring at lower angle of attack (AOA) should ice accrete on the wing and stabilizer leading edges. For instance, if the airframe ice protection system is selected off, the aural stall warning and stall barrier stick pusher respectively are triggered at 21.0 deg. and 28.4 deg. AOA for a full-flaps landing; at flaps 3 and with airframe ice protection systems selected on, they're triggered at 9.5 deg. and 15.5 deg. AOA, respectively.

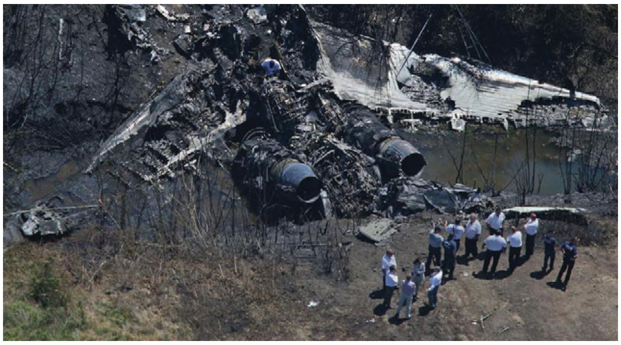
During the approach, the CVR recorded one of the passengers remarking to Rosenberg that it was snowing outside about 2.8 mi. from the airport. Yet, the pilot did not use wing and horizontal stabilizer ice protection systems during final approach.

Perhaps the omission was not intentional. The NTSB notes that Rosenberg's first Phenom 100 instructor said he "had a tendency to freeze up and fixate on a subtask at the expense of other critical subtasks." It's possible that he just forgot to turn on the systems in the high, single-pilot workload environment of the instrument approach procedure, the Safety Board surmised.

The pilot elected to fly a coupled approach with the autopilot following the RNAV glidepath to the runway. With gear and flaps extended, aircraft speed slowly decreased to 92 KIAS and AOA reached 16 deg., exceeding both the aural stall warning and stick pusher AOA trigger thresholds.

The aircraft continued to decelerate and shortly thereafter started to roll right, then roll left with the autopilot still engaged as it entered the aerodynamic stall. Stall warning was triggered at 88 KIAS as AOA reached 21 deg., the programmed aural stall-warning trigger point with airframe ice protection systems turned off. The autopilot snapped off, requiring Rosenberg to hand-fly the aircraft.

Thrust was increased to TOGA, but it's uncertain how he otherwise responded to repeated aural stall warnings with control inputs. The nose of the aircraft pitched up and then down, rolling as much as 59-deg. left wing down and then starting a series of roll oscillations. Finally, it rolled 100 deg. to the right and then 154.5 deg. right in just over 2 sec.



Imagine the pilots of that ill-fated GIV departing from Bedford in May 2014, explaining to their loved ones why they hadn't performed flight control checks to assure the gust lock was disengaged.

NTSB

The aircraft and its occupants clearly were doomed at about 800 ft. above the ground — too low to recover. Less than 1 sec. later, it snap-rolled left to 111 deg. and crashed into three houses on Drop Forge Lane, about 4,000 ft. from the runway threshold.

In one of the three houses, Marie Gemmell, a 36-year-old mother, was home with her 3-year-old son, Cole, and 7-week-old infant, Devin. The crash caused the Gemmell house to erupt into an inferno fueled by Jet-A. Gemmell and her two young sons died as a result, as did Rosenberg and his two colleagues.

Goal Fixation vs. Risk Management

The NBAA has long strived to increase safety awareness among its members. But the Gaithersburg crash riveted public attention on a recent series of fatal business aircraft accidents, including the Gulfstream GIV runway excursion at Bedford, Massachusetts, earlier in 2014 and a Learjet 35A that hit a construction crane while landing at Grand Bahamas International Airport in Freeport that same year. Subsequently, a Cessna Citation CJ1 crashed near Cedar Fort, Utah, in January 2016, and that was followed by a CJ4 impacting Lake Erie near Cleveland-Burke Lakefront Airport last December.

In recalling the Gaithersburg crash, Dave Ryan, a flight department manager, former head of Bombardier's flight operations and chairman of the NBAA's Safety Committee, says, "There's a natural struggle between being a successful entrepreneur and being a safe aviator. An entrepreneur has to get the job done no matter what. They operate in two dimensional space — accept risk or lose money." Achieve the goal or fail.

John King of King Schools adds that both entrepreneurs and aviators are goal oriented. "Risk gets in their way." The goal is to reach a successful outcome, whether achieving the business objective against the odds or landing safely on time at the destination airport. Goal fixation, though, can prove fatal when pilots fail to identify, assess and mitigate risks.

"Goal orientation pressure can come from pilots themselves, passengers, the company for which they work," says King Schools' co-owner Martha King.

That pressure is especially dangerous on flights conducted by owner/operators, as those pilots feel acutely responsible for making business appointments and in the doing can become blind to risks that jeopardize their lives, as well as those of their passengers and people on the ground.

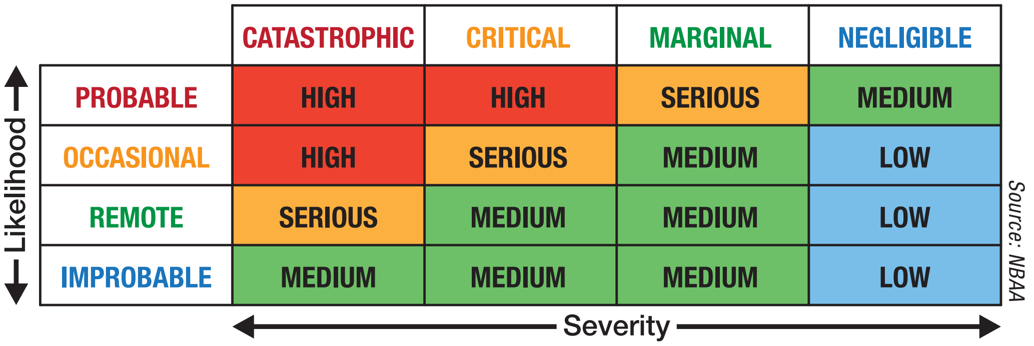
"Pilots and entrepreneurs are hard-wired to complete whatever they set out to do," John King observes. "They may think they're invincible." But they're not.

"The mission completion mindset is self-imposed," says Ryan. Assessing and mitigating risks may cause flights to be delayed and then rescheduled. Anticipating risks also may require changing route itineraries and destination airports to compensate for traffic or weather conditions, necessitating earlier departures to keep business travelers on schedule for appointments.

Sometimes safety of flight requires a mission to be scrubbed completely. As the Kings tell their passengers aboard their Falcon 10, "Bring your toothbrush."

Robert Wright, former manager of the FAA Flight Standards Service's General Aviation and Commercial Division and now a Seattle-based consultant, says that his former agency is largely to blame since historically it has emphasized skills training and testing rather than managing risks. This is reflected in the FAA's practical test standards for airmen certification, flight instructor qualifications and FAR Part 142 simulator-based training curricula.

Risk Assesment Guide



	CATASTROPHIC	CRITICAL	MARGINAL	NEGLIGIBLE
PROBABLE	HIGH	HIGH	SERIOUS	MEDIUM
OCCASIONAL	HIGH	SERIOUS	MEDIUM	LOW
REMOTE	SERIOUS	MEDIUM	MEDIUM	LOW
IMPROBABLE	MEDIUM	MEDIUM	MEDIUM	LOW

Source: NBAA

Wright maintains that until mid-2016, the FAA's risk identification, assessment and mitigation guidance, standards and doctrine were "woefully deficient." "It was all about instructors spoon-feeding their students during flight training to pass the skills test," he says. "They didn't require students to use their heads to evaluate risk."

As a result, he believes a lot of general aviation pilots just "don't know what they don't know" about risk management. "A study of accidents between 2006 and 2009 indicated that 71% of single-pilot accidents involve poor risk management. Forty of those accidents resulted in fatalities, including the one at Gaithersburg."

The same study indicated that the pilots could have known, should have known or even did know the risks they were taking but failed to identify, assess and mitigate them.

Recognizing this problem long ago, the Kings, among other business aviation leaders, worked with the FAA to introduce new certification standards for the private pilot license and instrument rating tests that incorporate task-specific knowledge and risk management elements. Using a three-prong approach, the FAA now requires applicants to demonstrate a specific level of aeronautical knowledge, risk management and airmanship skills to pass the new private and instrument tests.

In parallel, the FAA also issued new guidance by revising the Airplane Flying Handbook, Pilot's Handbook of Aeronautical Knowledge, Risk Management Handbook, Aviation Weather guide and Aviation Weather Services handbook.

What the FAA did not do, however, is tackle its Part 142 simulator training facility standards to reflect the same approach at a more advanced level for turboprop and jet operators.

So, at some sim training facilities, the familiar "if it's Tuesday, it must be engine failures" rote remains in place. Training scenarios that require risk identification, assessment and mitigation are scarce at best. Few centers require crews to use a formalized Flight Risk Assessment Tool (FRAT) that evaluates pilots, aircraft, environment and external pressures to determine when, how, or even if, it's safe to launch on a trip.

Both Wright and Ryan say that part of the pushback at Part 142 sim training centers comes from both single-pilot and multi-crew operators. Customers don't want to spend the extra time and money to use a FRAT template before they launch; their crews just want to check the required blocks and get back into their cockpits. Dynamic risk assessment takes a back seat to honing skills proficiency during recurrent training.

In addition to risk awareness, SOP compliance is another major challenge in the business aircraft community. At the urging of the NTSB and in the wake of the fatal GIV crash at Bedford involving partially locked flight controls, the NBAA worked with business aviation flight operations quality assurance groups to determine the extent of ignored or noncompliant pre-takeoff flight control checks.

The results were eye-opening. Examining flight operations quality assurance (FOQA) data for 30 types of business aircraft that conducted almost 144,000 flights from 2013 to 2015, the evidence showed that on more than one out of six of those flights, the crews failed to perform a pre-takeoff full flight-control check. The NBAA said the data was "very disturbing . . . [and] it is troubling to find that nearly 18 of every 100 business aircraft flights included in the data were not in compliance with manufacturer-required routine flight-control checks before takeoff, and that two of those 100 flights conducted no flight-control check before takeoff at all."

Part 121 air carriers regularly use FOQA data as feedback to train crews, change behaviors and improve safety margins. The crews must comply as a condition of employment. Relatively few Part 135 or Part 91 operators have such formalized FOQA feedback systems. Many business aircraft operators do not even debrief and critique missions to discuss how to improve pilot performance.

Ryan says the key to getting pilots to use FRAT, adhere to SOPs and become risk conscious is to become fully aware of the consequences of their actions on themselves, their passengers and innocent bystanders on the ground. They need to imagine the emotional impact on family and loved ones resulting from death, dismemberment and serious injuries suffered by people directly involved in aircraft accidents they might cause.

Wright says it's nearly impossible to eliminate all risk-related business aviation accidents. He suggests looking at a bell curve of the pilot population (Figure 1). On one side, there is a small group of conscientious pilots who are a model of best business aviation practices. They study their flight manuals, weather data, maintenance logs and accident reports. They invest in meticulous maintenance for their aircraft. They work with Part 142 training centers to develop challenging scenarios for sim sessions that require careful risk management. They use a FRAT card to identify, assess and mitigate risks for every flight. They carefully abide by SOPs and exercise cockpit discipline.

Most pilots fit into the middle. They don't know what they don't know. "Most pilots are not exposed to risk management. They have no formal risk management training. Seventy-five percent of general aviation accidents involved pilots not getting adequate data," to assess risk, says Wright.

To help move the middle of the bell curve toward the conscientious best practices group, Wright began a series of single-pilot safety stand-down seminars at the NBAA Convention. The meetings use the NBAA's Risk Management Guide for Single-Pilot Light Business Aircraft, authored by Wright, as a basis for how to identify, assess and mitigate risks. There is special emphasis on physiological, external stress and emotional pressures on pilots.

Ryan notes that duty days for owner/operator pilots must include all the time involved with non-flying business activities, not just the portion of the day associated with business flying.

Using the FRAT matrix for risk management is not a one-time exercise during preflight planning, according to Wright. The process may be started several days ahead of the flight to adapt mission planning for winds, weather, payload and crew duty time limits. The Kings, for instance, seldom fly home on the same day they complete comprehensive simulator recurrent training. They find those sessions so tiring that flying immediately thereafter makes for too long a crew duty day. Rather, they typically remain overnight to rest before proceeding home.

Wright believes the business aviation community can promote risk awareness, SOP compliance and other best practices by conducting seminars for user groups, similar to the NBAA's sessions, including model-specific owner/operator associations and local pilot organizations. He and others also are pressing the FAA to create an advanced "Pro-WINGS" proficiency program that will emphasize risk management, among other elements, for business aviation owner/operators. Further, he urges Part 142 simulator training centers, Part 141 flight schools and CFIs to embrace risk management training.

Even so, there remain the outlier pilots on the far side of the bell curve from the conscientious sector who are not receptive to risk management education. "They flaunt risk; it turns them on. Defying it shows how skilled they are as pilots," says John King. Such renegade pilots may even view risk management as a sign of emotional weakness, a lack of courage, a character flaw.

A prime example is a recent web video showing a Citation M2, registered in Poland as SP-KOW, flying a high-speed pass over a field at 10 to 20 ft. above the turf. This impromptu air show performed for the benefit of an acquaintance capturing the event with cellphone video illustrates blatant defiance of risk.

"These are the 'Sky Gods,'" says Wright. "The odds of reaching them are very low."

Cellphone video provided to airmen certification authorities may have the same chilling effect on such pilots as have videos of rogue law enforcement officers acting badly. But there may be an even more effective way of changing rogue pilot behavior.

Berlin's Survivor Scenario

The 2-hr. presentation by the late Jerome I. Berlin, Ph.D., the well-known aviation psychologist and bawdy humorist, was the highlight of the Bombardier Safety Stand-Down for several years. One of his most poignant training scenarios involved bringing a group of pilots up to the stage. He had them sit in chairs facing the audience.

He told them they had just died in airplane crashes as a result of rash decision-making, failure to mitigate risks, poor mission planning or execution, or inadequate preflight inspection. The late Capt. Eugene Cernan, the last man to walk on the moon, was a notable participant one year.

Dr. Berlin then brought a second group of people up to the stage who stood behind the seated "dead" pilots and played the roles of wives, husbands, children, loved ones and other successors. They questioned the "dead" pilots about their understanding of the emotional impact their untimely deaths had on their loved ones.

One in the second group played the role of Cernan's daughter, Tracy, whose initials he had written on a moon rock during his Apollo 17 mission in 1972.

"Dad, how could you have done this to me?" she asked. "What were you thinking? You went to the moon and back with such meticulous planning. And now you died in a business jet because of carelessness? Why did you take such risks? This wasn't just about you. What did you think it would do to me? How will I get along without you?"

Even though this was a training scenario, it obviously moved Cernan. His voice broke, a tear appeared in his eye and he tried to explain but couldn't. He was dead, gone from her life forever.

Similarly, imagine the pilots of that ill-fated GIV departing from Bedford in May 2014, explaining to their loved ones why they hadn't performed flight control checks to assure the gust lock was disengaged. This wasn't a one-time lapse. They'd failed to perform a complete flight control check on 98% of the previous 175 missions, according to the NTSB.

Now imagine Dr. Rosenberg being asked similar questions by his two children, along with Hartmann's and Ogbuka's family members. How would he respond to such questions from Ken Gemmell about the deaths of his wife and sons?

Dr. Berlin taught pilots not just to think about the consequences of their actions but also to fully appreciate their responsibilities in the cockpit. He knew he could have a greater impact on pilots by getting into their hearts, and not just into their heads.

Ryan, Wright and the Kings, among others, believe that reaching pilots emotionally is one of the most effective ways to get them to embrace risk management and adhere to SOPs. The emotional connection has great potential for moving the bell curve of pilots forward into the conscientious group of aviators.

Making the emotional connection might even alter some rogue pilots' behavior, causing them to consider the impact of their actions on others.

An increasing number of business aircraft have integrated avionics systems that feed multiple channels of data to FDRs. Many general aviation aircraft manufacturers have access to FOQA data downloaded from aircraft. They can detect trends, including deviations from SOPs, such as the comprehensive data analyzed by the NTSB from the FDR in the Phenom 100 accident at Gaithersburg and the GIV crash at Bedford.

Now, it's up to the business aviation community to use that data to impact the mindset of its pilots. Even more importantly, it's up to all to help those aviators truly grasp the impact of their aeronautical decision-making on the people at home who care for them most. **BCA**

EMPLOYEE TERMINATION

Applying For A (Check any that apply)
☐ Permit ☐ ID Card ☐ Renewal ☐ Replacement

Your Personal
Full Last Name
Full First Name
Date of birth Day / Month / Year
Gender ☐ Male ☐ Female
Nationality

Identification Information
Driver license? ☐ Yes ☐ No
Learner permit? ☐ Yes ☐ No
Non-driver ID Card? ☐ Yes ☐ No

The objectives will be based on how you gain sales by acquiring and keeping customers. A marketing strategy helps on making good messages with the right twist of marketing approaches in order to have a good outcome of your sales and marketing activities.

ID card number and Details
enter the identification number it appears on the card

Contact Details
Home Phone
Mobile Phon
Fax N

Your Personal Details
Hight cm / inches
Eye color
Email Address: (optional)
Status: ☐ Single ☐ Married ☐ Devorced
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Other change: What is the change and the reason fo
(new license class, wrong date of birth, e

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Letting Go

Knowing **when and how to fire** an employee

BY **MIKE GAMAUF** mgamauf@yahooo.com

A good maintenance manager sets the standard on work performance and conduct for all team members to follow. Those expectations then must be clearly communicated and disseminated.

In addition, the company should have a clear policy about things like severance, final paycheck and continuation of health benefits. These, too, should be shared with all employees either in a handbook or through a readily accessible online system.

After that, it's the manager's responsibility to monitor the team's functioning as a unit. This so-called "team dynamic" is the beating heart of the organization and good managers haves their fingers on its pulse at all times. That's because, as with all living things, teams evolve. Sometimes not for the better. Personalities and life situations change, and this constant churn will affect how the team performs.

As manager, you are responsible not only for setting performance expectations for each team member but also for ensuring they are met. Having a published standard and conducting periodic performance reviews can help to keep people on task. While grossly inappropriate behavior, to include insubordination, threats, assault, criminal activity and the like, makes for easy evaluation — and ready response — matters of performance and adherence to expected norms can be difficult.

For maintainers, technical performance is expected to improve steadily. As they become more experienced, task times should decline. Yet some technicians grow complacent over time and engage in risky behavior. Lapses in judgment and mistakes happen, but how many can be tolerated? Each case is unique and as a manager, it can be difficult to decide whether to terminate on the spot or take the time to modify the behavior.

In the end, it comes down to your judgment on how this person affects the team. Many technicians have personality quirks, and some are difficult to get along with, but poor performance should not be tolerated. You can work to improve it, but if the person is not willing to put in the effort to achieve the desired result, you shouldn't have to, either.

"What I discovered is that a set of strict operational rules and performance metrics must be known and enforced. Violation of those rules and performance standards is grounds for termination," one veteran maintenance manager told *BCA*. "Sounds so basic and simple on paper, but it's not so easy to have those rules in real life."

To illustrate the quandary, he asked, "Once someone makes the same 'mistake' three times, is it grounds for termination? What if the employee makes only one mistake [but] in each category? One airworthy issue, one significant behavioral interaction with the boss, one incident of insubordination? In the end, I hate to admit, it's a judgment call."

Despite all that, he admits to being "less tolerant of certain issues today. Poor performance is an immediate deal breaker."

If any team member fails to maintain workload, or even more serious,

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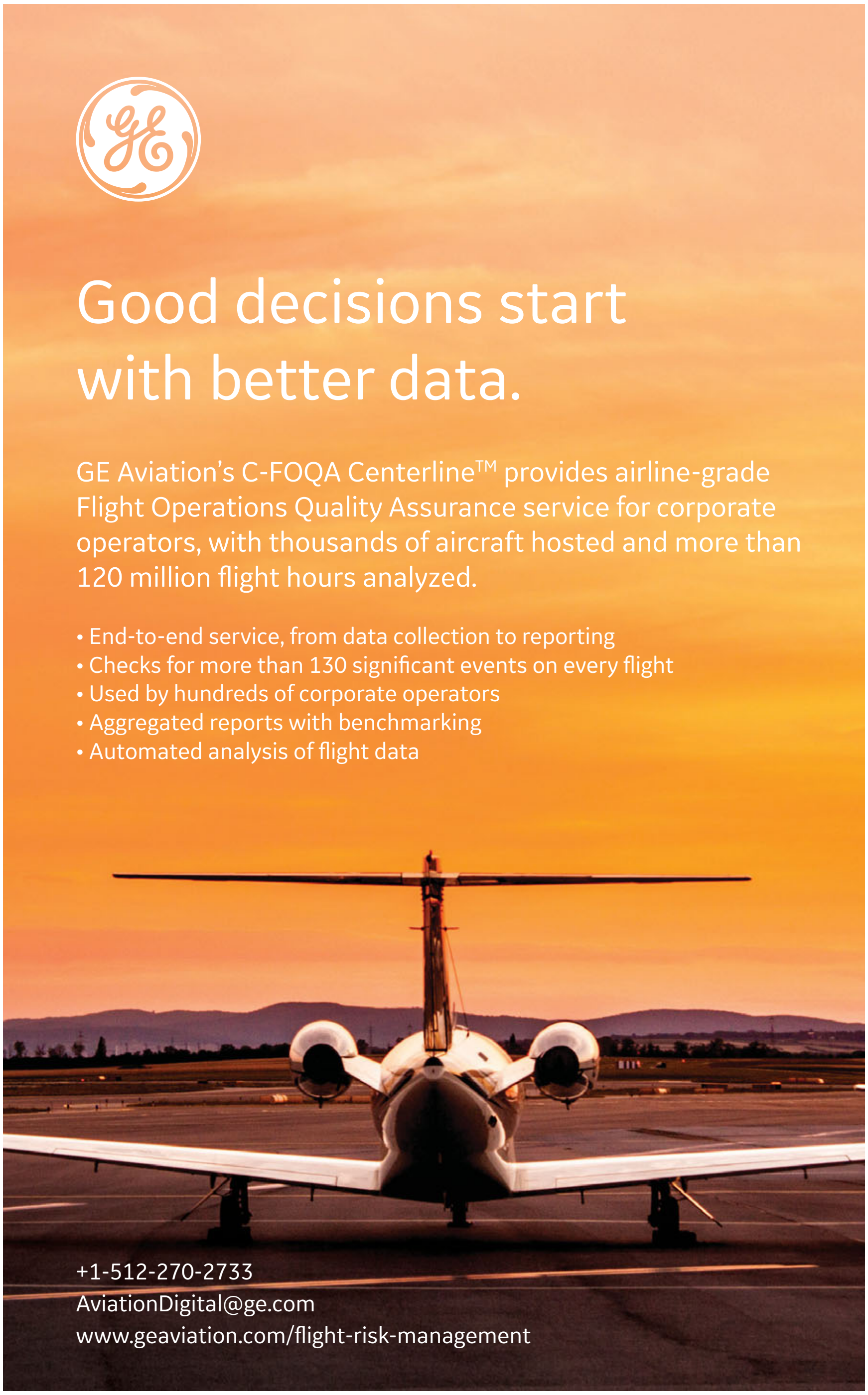
loses the trust of other team members for whatever reason, the manager needs to step in immediately. If a technician is not performing to standard, the entire organization feels the pain and discontent begins to build. Emotions become heated quickly when unfairness, or favoritism, is suspected and real trouble can ensue. To preclude this, the manager's best move may be to remove the source of the problem.

As any manager who has been through it knows, firing an employee is one of the most unpleasant of all managerial tasks. It is emotionally draining and there is an additional administrative burden involved to ensure that laws and company policies are followed in the process, adding further difficulty to the move.

Obviously, the experience for the person being terminated is even more emotionally stressful, even devastating. Accordingly, the manager must proceed with compassion, respecting the person's dignity, and try to help the individual move on and perhaps improve their situation going forward.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Legal Matters

Before taking any steps to terminate, a manager needs to understand how that person was hired and under what type of arrangement. Most employees are hired "at will", which essentially means that they can be fired for no reason. However, if your hangar crew is part of a union or works under a contract, the manager must know the terms of the agreement and what specific processes need to be followed. Since as a practical matter each contract is different, the focus here will be on the "at will" employee.

While such a worker can be terminated without reason, there is a catch. No employee can be fired for reasons of discrimination, for their role as a whistle-blower, or for exercising their legal rights such as taking leave for military service or jury duty.

Even though as a manager you do not need to provide a reason for firing an "at will" worker, it is best to have a carefully documented company policy in place along with a process to ensure that the termination does not violate any law. This is where having a company legal and human resources team comes in handy. If you as a manager do not have access to such staff, consider getting advice from outside specialists to ensure that your actions are compliant.

The best way to defend against legal action by the person being terminated is to have carefully documented your motivation for the firing.

"Make certain you have a paper trail that documents the reasons for terminating the individual, particularly if you are terminating them for cause," advised Bill Quinn, president and CEO of Portsmouth, New Hampshire-based Aviation Management Systems Inc., an aviation consulting firm with extensive experience in providing assistance in the aircraft acquisition process, as well as a wide variety of aircraft management solutions. These should include notes in the employee file with dates and times of your discussions, warning notices of poor performance, absentee notices and probationary notices.

"If you do not have a paper trail," Quinn continued, "I would highly recommend building one before you terminate the employee. While this may take some time, it will help to avoid a wrongful termination suit."

Know that the actual termination discussion will be hard for everyone. The person being fired may lash out verbally or even physically; there could be tears, anger and threats, but you, the manager, must remain cool, resolute and professional but understanding and sympathetic.

And "When the actual day comes," Quinn advised, "you want to have a witness with you. Do not do this alone."

If you have HR and legal staff, they should be present, if possible. And once you've delivered the hard news, be sure to collect the fired employee's badges, keys, company tools or computer gear and cancel any network and email access.

Time to Go

While firing someone is extremely difficult, postponing the decision can hurt both your team and your career. Your managers and your subordinates are watching and taking measure. If a team member's performance is affecting the organization in a negative way, rest assured everyone notices it. Other technicians will resent having to pick up the slack, and scuttlebutt in the break room travels faster than light. The longer you, as a manager, delay, the more your leadership will be questioned.

"A lot of managers procrastinate, hoping that the person will change, but they are taking a big chance that the whole organization will be harmed," said Bob Hobbi, founder, president and CEO of ServiceElements International Inc. Located in Scottsdale, Arizona, the company specializes in organizational development, helping customers achieve higher results, better leadership and professionalism in bringing more value through better service delivery.

As a leader, your team needs to trust your judgment and ability to fix a broken situation. You don't want people to lose confidence in you.

"If you have one person who is causing problems, the people who they affect are going to question your leadership ability," said Hobbi. "Be very cognizant of how people see you do this because we all know, when this kind of thing happens, everybody's watching — your managers above you, and the folks that are reporting to you. So it is critical that you have a high level of confidence, and speed."

Once the decision to terminate is made, act quickly but discretely. You may have to coordinate with other departments or resources, and there is a chance that the word will get out to the person affected through the wrong channels.

"People may know that you may be thinking about taking an action and terminating them," Hobbi noted, adding, "Once they find out, they may create more challenges."

Finally, after the terminating event has concluded, it is important that you clearly communicate with your team what just took place.

"A good leader, after terminating an employee or team member, immediately needs to engage the rest of the team, explain what just went on, because you can easily quell any kind of rumors, any kind of innuendos and any kind of drama," Hobbi advised. "There is no need to explain every detail of the situation, and you have to be cognizant of legal restrictions. But don't miss the leadership opportunity to really put a message out there that we are not going to tolerate people who are not positively contributing to our organization."

Firing someone is tough, especially if you regarded that person as a colleague and friend. Regardless, it's a burden you need to bear because your first obligation as a manager is to the team and its well-being.

To help avoid that burden, make sure your employees know what is expected of them and communicate this frequently. But have a plan in place so if the time comes to let someone go, you can execute it with professionalism and compassion. **BCA**

Government Guidance on Termination

Terminating an employee is stressful on both sides, but for the person being let go, there are many questions that will need answers. The Department of Labor has a helpful website at **https://www.dol.gov/dol/topic/termination/index.htm**

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Two Chances Lost

Pilot and mechanic **both miss** aileron hook-up error

BY **RICHARD N. AARONS** bcasafety@gmail.com

Arguably, among the most challenging and potentially hazardous flights a pilot undertakes are post-maintenance test flights. The NTSB database contains dozens of incidents in which post-maintenance flights ended up tragically, often because the preflight chores were rushed or carelessly executed. This month, we'll look at an incident that took the lives of two pilots, one of them an experienced U.S. Air Force-trained test pilot.

Piper PA 46-350P, N962DA, crashed into the Spokane River on May 7, 2015, at 1604 PDT following an attempted landing at Felts Field Airport in Spokane, Washington. The commercial pilot and pilot-rated passenger were killed and the airplane was destroyed during the impact sequence. The local flight departed Felts Field at 1553 in VMC.

Both the pilot and passenger were employees of Rocket Engineering, where company personnel had just completed several maintenance tasks including an annual inspection. The accident flight was to be a post-maintenance test flight, and was expected to take about 40 min.

Weather conditions were good at Spokane: winds from 020 deg. at 7 kt., 10-mi. visibility with few clouds at 7,000 ft. The temperature was 71F, the dew point was 26F, and the altimeter pressure was 29.93.

Felts Field had an operating tower (0600-2000 local) and two runways. The pilot specifically requested to depart from the longer (4,999-ft.) Runway 4L. Eleven minutes after making the initial call to ATC, the airplane began the takeoff roll. Almost immediately after takeoff, the aircraft began a climbing turn, 10 deg. to the right, as recorded by radar. After flying on that heading for about 1.5 mi., the airplane began a more aggressive turn to the right, reaching 1,000 ft. AGL while on a southbound heading.

The tower controller heard labored breathing over the frequency and asked the Piper crew if everything was OK, to which the pilot responded, "That's negative."

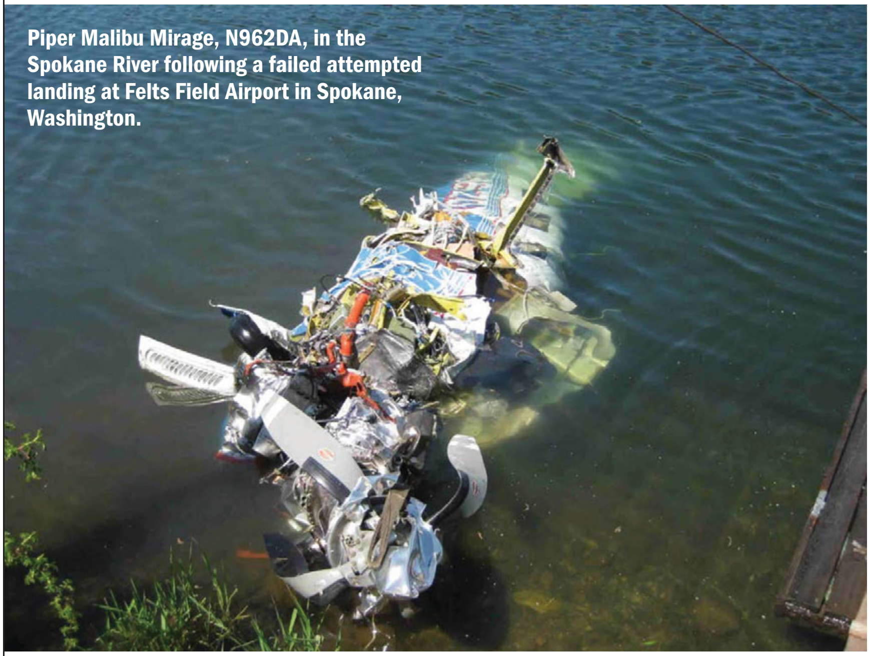
The airplane's turn radius then tightened to about 700 ft., and within 45 sec. it completed almost two spiraling turns, while descending about 700 ft. Control tower personnel later told investigators that during this period the airplane was banking about 90 deg. to the right and descending, and they assumed that it was about to crash. However, moments later the bank angle began to reduce, and the airplane appeared to recover.

The airplane then began a meandering climb to the east, and about 2.5 min. later the pilot reported, "We are trying to get under control here, be back with you."

The Piper eventually overflew the town of Newman Lake, about 11 mi. east of the airport, having climbed to about 5,600 ft. MSL (4,000 ft. AGL), and the pilot reported, "things seem to be stabilizing." When asked his intentions by the tower controller he replied, "We are going to stay out here for a little while and play with things a little bit, and see if we can get back."

The airplane began a gradual left turn, and the pilot requested and was approved for a straight-in landing for Runway 22R. The airplane became aligned with the runway about 7 mi. east of the airport, and a short time later the controller asked the pilot the nature of the emergency, to which he responded, "We have a control emergency there, a hard right aileron." The flight progressed, and a few minutes later the pilot reported that the airplane was on a 3-mi. final. The Piper remained closely aligned with the runway centerline throughout the remaining descent, and control tower personnel observed that it appeared to be flying in a 20-deg., right-wing-low attitude as it neared the runway threshold.

A tower controller later reported that as the still-airborne airplane passed Taxiway D, the engine sound changed, as if the pilot were attempting to perform a go-around. Suddenly, the airplane began a sharp roll to the right and crashed into the river just north of the airport.



Piper Malibu Mirage, N962DA, in the Spokane River following a failed attempted landing at Felts Field Airport in Spokane, Washington.

NTSB

Rescue operations began immediately; however, they quickly turned into recovery operations. The river was about 25 ft. deep at the accident site, and all major airframe components sank within a few minutes of impact. The airplane was recovered by a dive team from the Spokane County Sheriff's office over a two-day period during the week following the accident.

The fuselage sustained crush damage and fragmentation from the firewall through to the right-side emergency exit door. The engine remained attached to the firewall, and the propeller hub with all four blades remained attached to the engine gearbox. All blades were bent about 90 deg. aft, 8 to 12 in. from their roots. Both wings had separated from the airframe at their roots, with the right wing separating into two sections outboard of the main landing gear. The horizontal stabilizer had detached from the tailcone.

The pilot and pilot-rated passenger had died of blunt force trauma. No drugs or persisting conditions were involved.

The Pilot

The 64-year-old pilot-in-command, who was seated in the left front seat, held a commercial certificate with ratings for airplane single-engine land, multi-engine land, rotorcraft-helicopter, and instrument airplane and helicopter, along with a flight instructor certificate for airplane single-engine land. He also held a repairman, experimental builder certificate, and was rated in the Bell 212 helicopter and Lockheed L-382 (C-130 Hercules) airplane.

His most recent FAA medical certificate was second class, and dated May 17, 2013, with the limitation that he must have available glasses for near vision. He was a retired Air Force Lieutenant Colonel, with 20 years of active service as a test pilot, instructor, and search and rescue pilot.

The pilot was employed as an engineer for Rocket Engineering, and was the primary liaison with the FAA's Flight Standards and Certification divisions. He also typically performed post-conversion, post-maintenance and customer familiarization flights for the company. (Rocket Engineering did the turboprop conversion on the accident airplane.)

The pilot had accumulated about 5,800 hr. of total PIC flight time, 950 of which were in the accident make and model. He had flown about 20 hr. in the accident make and model during the 30-day period prior to the accident.

Representatives from Rocket Engineering told investigators the pilot had an appointment for his FAA medical examination at 0800 on the morning following the accident, and therefore chose to do the flight test that evening instead of the following day (Friday). The pilot's wife also stated that he typically did not work on Fridays but would do so if the work schedule required it.

The pilot-rated passenger held a private pilot certificate with an airplane single-engine land rating, issued in 2010. He had accumulated a total of about 122 hr. of pilot-in-command flight experience. He was employed at Rocket Engineering as a customer service and sales representative.

The Airplane

The accident aircraft was originally manufactured by Piper in 1996 as a PA-46-350P equipped with a Lycoming TIO-540-AE2A 350-hp turbocharged piston engine. It was modified by Rocket Engineering in 2007 under a JetProp LLC STC, which included the installation of a 560-hp Pratt & Whitney Canada PT6A-35 turboprop engine.

The airplane was brought to the facilities of Rocket Engineering on April 17 for an annual inspection. During the period leading up to the accident, routine maintenance was performed, along with the replacement of the four aileron cables in the wings and an aft elevator cable. The mechanic who performed the work stated that the aileron and elevator cables were replaced during the three-day period leading up to the accident.

The airplane's owner also had arranged for another maintenance facility on the field to perform an avionics upgrade concurrent with the inspection being done at the Rocket Engineering facilities. The avionics shop president told investigators the owner made multiple requests to add additional items to the work scope as the upgrade progressed. Due to time constraints, not all of his requests could be accommodated.


NTSB

(Left wing aileron cable) The aileron remained attached at the inboard hinge, and partially attached at the outboard hinge where the tip had become bent upwards. The aileron control cable remained attached to upper portion of the control sector wheel, and had looped back through the lower balance cable rib pass-through hole.

The owner reported that he had decided to pick up the airplane on May 5; however as the work progressed, he was informed that the airplane would not be ready in time, and the date was pushed back to May 7 (accident day) and then May 8. He had made plans to travel from Los Angeles the afternoon of May 7, and was en route via a commercial airline when the accident happened.

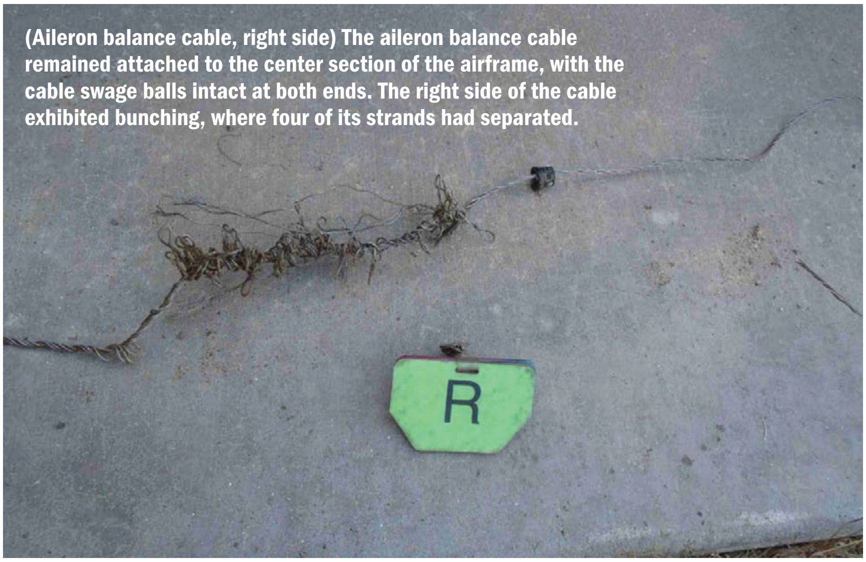
The airplane's primary flight controls are conventional, and operated by dual control wheels and rudder pedals through a closed-circuit cable system. The ailerons and rudder are interconnected through a spring system located under the main cabin.

An aileron is mounted on the

outboard trailing-edge section of each wing via a series of hinges. Movement of each aileron is controlled through a yoke and pin assembly that interfaces with a sector wheel mounted in each wing forward of each aileron. Each sector wheel is connected to, and driven by, one aileron drive cable and one balance cable. In each wing, both the balance and drive cables are terminated with identical ball swage fittings, and each swage fitting inserts into one of two identically sized receptacles in the sector wheel. Both cables are approximately the same length outboard of the pressure vessel seals, which are located about 1 in. apart vertically at the wing root.

In each wing, both cables are routed to the fuselage along the wing trailing edge, and pass through their respective pressure vessel seals in the wing root. Inboard of the pressure vessel seals, the left and right balance cables connect to one another after passing through a center pulley, while the drive cables are routed forward via pulleys to the control wheel assembly in the cockpit. The balance and drive cables are aligned vertically at the pressure vessel seals and diverge about 3 in. laterally at their respective pulley positions. The sector wheel design is unique within the Piper fleet to the PA-46.

The NTSB said that four aileron cables were replaced during the maintenance operation. "Post-accident examination of the airplane revealed that the aileron balance and drive cables in the right wing had been misrouted and interchanged at the wing root. Under this condition, both the left and right ailerons would have deflected in the same direction rather than differentially. Therefore, once airborne, the pilot was effectively operating with minimal and most likely unpredictable lateral control, which would have been exacerbated by wind gusts and



(Aileron balance cable, right side) The aileron balance cable remained attached to the center section of the airframe, with the cable swage balls intact at both ends. The right side of the cable exhibited bunching, where four of its strands had separated.

NTSB

Accidents in Brief

Edited by Jessica A. Salerno

Selected Accidents and Incidents in March 2017. The following NTSB information is preliminary.

▶ **March 13 — About 1530 CDT, a** Cessna 182, N6330B, crashed following a loss of control while taxiing for departure from the Skiatook Municipal Airport (2F6), Skiatook, Oklahoma. The commercial pilot, who was the sole occupant, was not injured, but the airplane sustained substantial damage to the left horizontal stabilizer. It was VFR at the time of the accident, and a flight plan was not filed. The local flight was originating at the time of the accident. The pilot stated that while he was taxiing the airplane for departure to Runway 36, the airplane suddenly veered to the right. He attempted to correct the right turn by applying the left brake, however, the attempt was unsuccessful and the airplane entered a drainage ditch.

▶ **March 11 — About 1515 PST, a** Piper Aerostar, N301FW, landed with a retracted left main landing gear at Reno/Tahoe International Airport (RNO), Reno, Nevada. The pilot, the sole occupant, was not injured; the airplane was heavily damaged. The Aerostar was registered to and operated by the pilot. VFR conditions prevailed for the cross-country flight, which operated on an IFR flight plan. The flight originated from Sandpoint Airport (SZT), Sandpoint, Idaho at 1100 with an intended destination of Minden-Tahoe Airport (MEV), Minden, Nevada. The pilot reported that, during landing checks at MEV, the left main landing gear did not extend. However, the nose and the right main landing gear extended. The pilot elected to divert to RNO to land. Upon touchdown, the left main landing gear was still retracted. The airplane slid down the runway, which resulted in a substantial damage to the left wing.

▶ **March 8 — About 1452 EST,** Ameristar Air Cargo Inc. Flight 9363, a Boeing MD-83, N786TW, ran off the end of Runway 23L after executing a rejected takeoff at Willow Run Airport (YIP), Ypsilanti, Michigan. All 109 passengers and 7 crewmembers evacuated the airplane via emergency escape slides. One passenger was reported to have received a minor injury. The airplane sustained substantial damage (no post-crash fire occurred). The airplane, which had been flown into YIP two days before the accident, was operating under the provisions of Part 121 as an on-demand charter flight and was destined for Washington Dulles International Airport (IAD), Dulles, Virginia. Daytime visual meteorological conditions prevailed at the time of the accident.

▶ **March 8 — About 1340 CST, a Grob** Aircraft AG G120TP-A, N196TP, was heavily damaged during a forced landing while maneuvering at Abbeville Municipal Airport (0J0), Abbeville, Alabama. The flight instructor and a pilot receiving instruction sustained serious injuries, and the airplane was substantially damaged.

propeller torque and airflow effects."

The sections of the two interchanged cables within the wing were about equal lengths, used the same style and size of termination swages, and were installed into two same-shape and -size receptacles in the aileron sector wheel. "In combination, this design most likely permitted the inadvertent interchange of the cables, without any obvious visual cues to maintenance personnel to suggest a misrouting. The maintenance manual contained specific and bold warnings concerning the potential for cable reversal," said the Safety Board.

"Although the misrouting error should have been obvious during the required post-maintenance aileron rigging or function checks," said the Safety Board, "the error was not detected by the installing mechanic. Although the installing mechanic reported that he had another mechanic verify the aileron functionality, that other mechanic denied that he was asked or that he conducted such a check. The mechanic who performed the work also signed off on the inspection; this is allowed per federal regulations, which do not require an independent inspection by someone who did not perform the maintenance."

The pilot did perform a preflight check; the preflight checklist included confirmation of "proper operation" of the primary flight controls from within the cockpit. "Although the low-wing airplane did not easily allow for a differential check of the ailerons during the walk-around," said the Safety Board, "both ailerons could be seen from the pilot's seat; therefore, the pilot should have been able to recognize that the ailerons were not operating differentially."

In analyzing the circumstances of the accident, the Safety Board observed that the accident occurred at the end of the business day, and the airplane had been undergoing maintenance for a longer-than-anticipated period. The airplane's owner was flying in from another part of the country via a commercial airline to pick up the airplane the following morning. The accident pilot, who was an engineer at the company and typically flew post-maintenance test flights, was assisting with returning the airplane to service. He also had an appointment with an FAA medical examiner the next morning (Friday), and he typically did not work on Fridays. "It is likely that the mechanic and pilot felt some pressure to be finished that day so the owner could depart in the morning and the pilot could attend his appointment."

The Safety Board determined the probable cause(s) of this accident to be: "The mechanic's incorrect installation of two aileron cables and the subsequent inadequate functional checks of the aileron system before flight by both the mechanic and the pilot, which prevented proper roll control from the cockpit, resulting in the pilot's subsequent loss of control during flight. Contributing to the accident was the mechanic's and the pilot's self-induced pressure to complete the work that day."

Unfortunately, the significant causal factors involved in this accident are repeated several times each year. Pressure to get the job done; inspection/installation-unfriendly designs; and rushed preflight inspections are all potential killers. The record shows that post-maintenance flights should never be considered "routine." They are fraught with hazards that can kill the unwary crew. **BCA**

The airplane was registered to and operated by CAE USA, under Part 91 as an instructional flight. VFR prevailed at the time and a company VFR flight plan was filed and activated. The local flight originated about 1304 from Dothan Regional Airport, Dothan, Alabama. The flight instructor stated that a preflight inspection was performed and no discrepancies were reported. The flight departed with about one-half capacity fuel load and flew near Lake Eufaula where in accordance with the operator's upset recovery training checklist, the crew awareness system circuit breaker was pulled. The pilot receiving instruction performed the maneuvers, and at the conclusion, the flight instructor took the controls and flew to 0J0, where he intended to demonstrate a practice power off procedure terminating with a low pass. The flight instructor entered the maneuver (high key) at 2,400 ft., with the power lever at flight idle and the condition (propeller) control at low, and maintained 100 kt. while turning crosswind and downwind. He lowered the landing gear and at the low key position (abeam the landing threshold), the airplane was 1,200 ft. AGL. The pilot receiving instruction stated that he smelled fuel, and the flight instructor turned onto the base leg of the traffic pattern, though he did not smell fuel at that time. They both then noted a vapor from the right side of the engine, followed by a puff of white smoke. The flight instructor noted a total loss of engine power, with a resulting 10 kt. decrease in airspeed and corresponding increase in descent rate, though there was no audible annunciation. The pilot receiving instruction attempted to restart the engine and he advanced the power and condition levers full forward, but the engine did not respond. While over trees unable to reach the runway, the flight instructor maintained controlled flight until the airplane collided with trees, then the ground. Both pilots exited the airplane, and after notifying the operator of the accident, they walked to the airport and were taken to a hospital for treatment. The wreckage was secured for further examination. In addition, onboard devices that recorded flight and engine related data were retained and forwarded to the NTSB Vehicle Recorders Laboratory for read-out.

▶ **March 5 — About 2223 Alaska** standard time, a wheel-equipped Cessna 172K airplane, N736AS, sustained heavy damage during an impact with sea ice in Norton Sound about 10 mi. east of Nome, Alaska. The private pilot and sole occupant received fatal injuries. The airplane was registered to and operated by the pilot as a VFR cross-country personal flight under the provisions of Part 91, when the accident occurred. VMC prevailed along the route of flight, and IMC prevailed at the destination. No flight plan was filed. The flight departed the Wasilla Airport, Wasilla, Alaska at 1710 destined for Nome City Field Airport (94Z), Nome.During an interview with the NTSB investigator-in-charge on March 7, the pilot's fiancé said that the pilot was going to visit friends in Nome and that he was time limited by his work schedule. She said that at about 1700 she witnessed him fueling the airplane and two fuel containers, for a total of 35.3 gal., per the

Accidents in Brief

fuel company records. She said that the pilot flew this route often, maybe 20 times before, but usually in summer. During an interview with the NTSB on March 8, a friend of the pilot in Nome said that she was expecting him that night by 2130 and he was planning to land at Nome City Field. The airplane arrived in the Nome area at 2141 and she and the pilot texted back and forth for the remainder of the flight. Prior to making any approaches, the friend texted the weather to be "10 miles 600 over." The pilot texted back "OK I think I can sneak in," then he proceeded to make four visual approaches to City Field runway 21, as well as circling maneuvers in the area. He texted "one more try" and after he couldn't land, he texted "one more OK" before his last attempt. At 2214 he texted "not happening" and departed the area. During an interview with the NTSB on March 7, a witness who lives near City Airport saw the airplane making multiple approaches and depart to the east. He also heard a transmission on the common traffic advisory frequency (CTAF) of 123.6 MHz that sounded like "no, no, no" sometime after the airplane departed the area. The concerned witness then listened on 121.5 MHz for an emergency locator transmitter (ELT) signal, but did not hear one. The pilot's fiancé reported the airplane overdue at about 0530 on March 6. At about 0959 a Nome Search and Rescue crew located the airplane wreckage about 10 miles east of Nome, on sea ice, near Hastings Creek. The wreckage consisted of the entire airplane in a vertical nose down attitude. The Garmin GPSMAP 296 device was recovered and downloaded by the NTSB. The Garmin GPS data indicates that the airplane took off from Wasilla at 1710 and made no en route stops. The data shows an airplane track that included four approaches to Nome City Airport Runway 21, some maneuvering in the area, then a departure to the east. The total GPS distance flown was 596 statute miles and total GPS time 5.3 hr. The last data point was at time 2223 and indicated the airplane at a groundspeed of 42 mph and 373 ft. GPS altitude near the wreckage location. The pilot held a current FAA Third Class Medical Certificate that stated the restriction "not valid for night flying or by color signal control." The closest weather reporting facility is Nome Airport, Nome, Alaska, about 11 mi. west of the accident site. At 2204, an aviation special weather report (SPECI) from the Nome Airport was reporting in part: Wind calm; sky condition, overcast 400 ft.; visibility, 10 sm; temperature -21 C; dewpoint -22C; altimeter, 30.49 in. Official sunset was 1933.

▶ **March 4 — About 0023 EST, a** Cessna 421B, N421KL, was heavily damaged after a collision with a powerline and terrain in Canton, Georgia. The commercial pilot was killed in the accident. Night VFR conditions prevailed at the time and no flight plan was filed for the personal flight. The flight departed from the Richard Lloyd Jones Jr. Airport (RVS), Tulsa, Oklahoma at 1930 EST. According to personnel at Southwest Aviation & Brokerage, the pilot purchased the airplane on March 2, 2017. A flight instructor who flew with the pilot on March 1, 2017, said he flew for a 1 1/2 hr. to go over the various systems of the Cessna 421. On March 2, 2017, the flight instructor flew with the pilot again for 45 min. conducting pattern work. He said that the pilot told him that he had owned two Cessna 421Cs in past and was a little "rusty." The pilot went on to say that he hasn't flown a 421 since 1984. The instructor acknowledged that overall the pilot was knowledgeable of the operation of airplane. The flight instructor also recalled that the pilot departed with sufficient fuel for the cross-country flight. Preliminary radar data obtained from the FAA revealed that the pilot was in contact with air traffic control and was receiving VFR flight following services while inbound to Cherokee County Airport (CNI), Canton, Georgia, and cancelled flight following when he had the airport in sight. Witnesses observed the airplane flying extremely low, before noticing a "ball of fire" erupt near the airport. According to the airport manager, video footage of the airplane approaching Runway 5 was captured by the airport surveillance system. She went on to say that the video showed that as the airplane got closer to the airport, it banked to the right side of the runway before descending into a ravine. Examination of the accident site revealed that the airplane came to rest in a retention pond located about 420 ft. east of the runway centerline. There were powerlines entangled on the right main landing gear strut and right wing of the airplane. The nose and cockpit were crushed aft and the windscreen on the left side was broken away from the fuselage. The wreckage was retained for reexamination at a later date.

▶ **March 4 — About 1330 EST, a** Beech B-60, N39AG, was destroyed by impact and a post-crash fire following an uncontrolled descent in Duette, Florida. The private pilot/owner and the flight instructor were killed in the accident. VFR prevailed, and no flight plan was filed for the instructional flight. According to friends and representatives of the pilot's family, the pilot recently purchased the airplane, and the purpose of the flight was to complete ground and flight training in the airplane to meet insurance requirements. The airplane departed Sarasota-Bradenton International Airport (SRQ) about 1240, and cancelled flight following services with ATC about 10 min. later. With a model of an airplane in his hand, one witness demonstrated an airplane in straight and level flight, going "kind of slow," as the nose gradually pitched up. He then demonstrated the airplane suddenly banking to one side, and entering a spiraling descent. He said the engine sound was smooth and continuous throughout, and the engine sound increased throughout the airplane's descent, until it disappeared from his view and he heard the sounds of impact. The witness added that as the airplane disappeared behind the trees and out of view, he "heard him give it gas," and described an engine sound increasing to very high rpm. **BCA**

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Approach Impossible

“Chair Flying” to **minimums** or **not at all**

Pilot Jon Cain “chair flies” an arrival before leaving the ground.

BY **JAMES ALBRIGHT** james@code7700.com

Much of flying is an “act of faith.” You are placing your trust in those who designed and built the aircraft, in those who maintain it, and in those who trained you to defy gravity for a living. Your act of faith goes even further than you may realize, however.

Who, for example, ensures the instrument approach you are about to fly can be safely flown down to minimums without breaking anything? We assume the approach was designed correctly, tested in real world conditions, and has the seal of approval from the aviation authority of the host nation. In most cases, all of that is true.

A Jeppesen approach plate will often have the term “TERPS” or “PANS-OPS” printed on one side. In the first case, the approach was designed in accordance with the U.S. Standard for Terminal Instrument Procedures (TERPS), an FAA Order (currently numbered 8260.3C) in a constant state of revision. In the second case, the guidance came from the International Civil Aviation Organization (ICAO) Procedures for Air Navigation Services, Aircraft Operations (PANS-OPS), also known as ICAO Document 8168. With the TERPS or PANS-OPS “seal of approval,” you know the approach plate has been vetted. But in either case, can you assume the instrument approach is flyable down to minimums exactly as published?

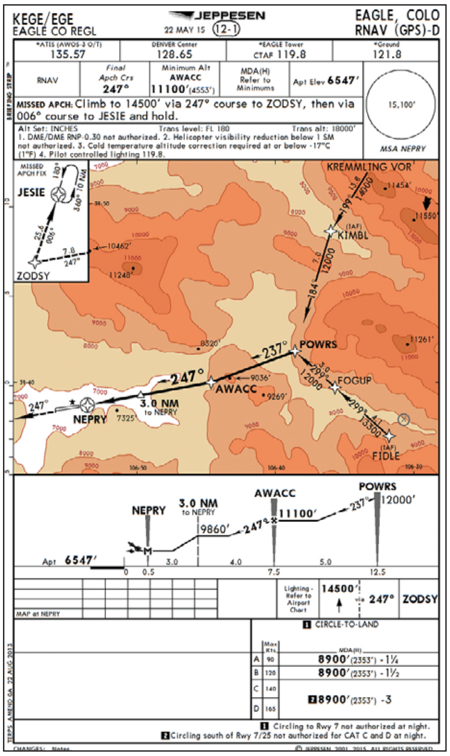
Unfortunately, the answer is no. There are cases when the approach, while legal, is improbable because the terrain makes the required descent angles unsafe. Other approaches, while perfectly safe, are impractical due to airspace design or airport congestion. Finally, some approaches are impossible to fly because of poor design and will guarantee the need to execute a missed approach if attempted down to minimums. You can, however, discover these improbable, impractical and impossible approaches before leaving the ground. And that knowledge can help you come up with a “Plan B.”

The key is to “chair-fly” the approach by visualizing each step of the procedure while considering terrain, country-specific and other local restrictions, and aircraft descent and turning performance. In many cases advanced trigonometry is helpful but not required; a few basic math rules of thumb and a pocket calculator will suffice.

Mountainous Terrain — The Improbable Approach

If you’ve never flown into Eagle County, Colorado, Regional Airport (KEGE) and had only the publicly available instrument approaches available, you might think the published RNAV (GPS)-D

Eagle, Colorado RNAV(GPS)-D, Jeppesen KEGE page 12-1



KEGE/EGE
EAGLE CO REGL

JEPPESEN
22 MAY 15 (12-1)

EAGLE, COLO
RNAV (GPS)-D

*ATIS (AWOS-3 O/T)	DENVER Center	*EAGLE Tower	*Ground
135.57	128.65	CTAF 119.8	121.8

RNAV	Final Apch Crs	Minimum Alt AWACC	MDA(H)	Apt Elev
	247°	11100′(4553′)	Refer to Minimums	6547′

MISSED APCH: Climb to 14500′ via 247° course to ZODSY, then via 006° course to JESIE and hold.

Alt Set: INCHES Trans level: FL 180 Trans alt: 18000′
1. DME/DME RNP-0.30 not authorized. 2. Helicopter visibility reduction below 1 SM not authorized. 3. Cold temperature altitude correction required at or below -17°C (1°F) 4. Pilot controlled lighting 119.8.

1 CIRCLE-TO-LAND

	Max Kts	MDA(H)
A	90	8900′(2353′) - 1¼
B	120	8900′(2353′) - 1½
C	140	2 8900′(2353′) -3
D	165	

1 Circling to Rwy 7 not authorized at night.
2 Circling south of Rwy 7/25 not authorized for CAT C and D at night.

CHANGES: Notes

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weather minimums of 2,353 ft. and 3 sm would allow a comfortable and safe arrival with weather just above those figures. But that would be wrong thinking. There are special approach procedures requiring operator approval and specific training for EGE, but the RNAV (GPS)-D can be flown by any RNAV-capable aircraft and instrument rated pilot. Easy, right?

Pilots with at least one approach into this airport know that flying north of the procedure course down a valley in visual conditions is the better choice. They only begin the approach if they can spot the airport from waypoint POWRS at 12,000 ft. MSL, nearly 6,000 ft. above the runway. They have basically doubled the weather minimums. But what if you've never flown into Eagle and don't know anyone who has?

Descent Angle

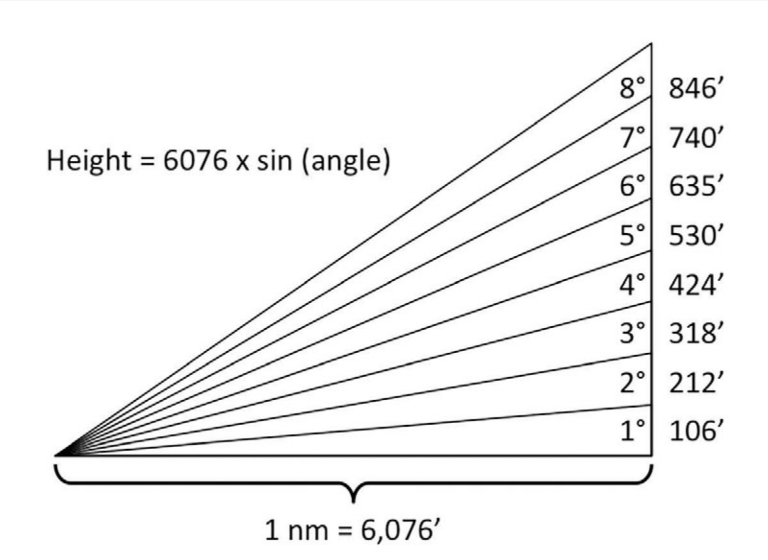
As a rule of thumb, most jets descend easily at a 3-deg. angle but require extraordinary measures at higher angles. You can use a calculator to solve the trigonometry: The height of an airplane 1 nm away from a point is equal to 6,076 ft. times the sine of the angle. For example, a 3-deg. angle leaves an airplane at 318 ft. when 1 nm away. But you don't really want to add a scientific calculator to your flight bag, do you? If you figure the descent angles from 1 to 8 deg. you will notice a strange coincidence: The angle approximates the height loss in hundreds of feet. You can use that coincidence to coin a rule of thumb:

$$\text{Descent Angle} = \frac{\text{Altitude to Lose (Hundreds of Feet)}}{\text{Distance to go (nm)}}$$

And:

A normal 3-deg. descent requires 318 ft. of altitude for every 1 nm traveled.

So, let's say you are at 10,000 ft. and need to descend to an airport with a 1,000-ft. elevation, which means you are losing 90 hundreds of feet. If you had 30 mi. to do that you are in great shape, with a textbook perfect 90 ÷ 30 = 3-deg. descent. But what if ATC delayed you until 15 mi.? Now you are looking at a 90 ÷ 15 = 6-deg. descent. You are in "slam dunk" territory!



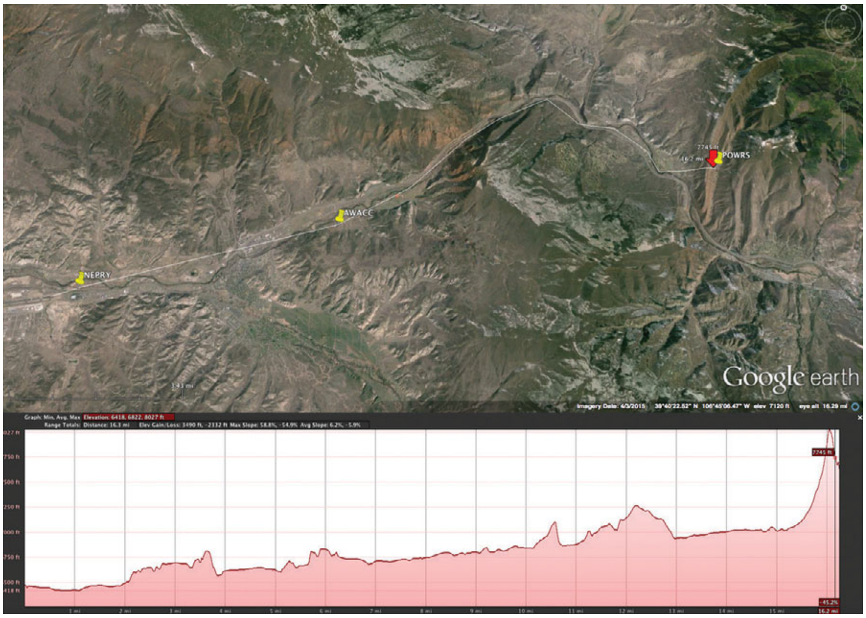
Typical heights versus vertical path angles

Imagine yourself flying the approach in Instrument Meteorological Conditions (IMC) after successfully making the descent to 9,860 ft., your last step-down altitude prior to the missed approach point. While you began the day with a bit of concern, you breathed a sigh of relief when the ATIS reported the weather was 3,000 ft. and 4 sm. You still have a mile before you can leave the step-down altitude but start to make out what has to be the runway. You spot it! But then it hits you that even though the runway is 4 mi. away, you are still over 3,000 ft. above the landing surface. Too high! Now what? Can you circle? The surrounding Rocky Mountain terrain discourages that thought immediately. You have no choice but to go missed approach and think of a new way to get your passengers to their Vail ski chalet.

Thankfully, Garfield County Regional Airport in Rifle, Colorado (RIL) is just over 30 nm to the west and can fit you in on their crowded ramp. The FBO was out of rental cars and any available hangar space was already taken. As your passengers wait for their ground transportation to catch up, you are forced to revisit the decision-making that brought you to this point.

The Eagle County weather was well above minimums, but landing from the approach in that weather would have required a wildly unstable approach and been unsafe. It appears the Garfield ramp had already been consumed by other crews who knew better than to attempt an approach to Eagle with a 3,000-ft. ceiling and "only" 4 sm visibility. The more seasoned pilots unveil the Eagle County secret. "If I don't see the runway before POWRS," one pilot tells you, "I'm not descending any farther." He goes on to tell you that even on a clear day, flying with the needles centered leaves you too high to land. "You have to fly down the valley to the north, otherwise you aren't landing." Well, now you know better! But how could you have known this without previous experience?

The key to flying an unfamiliar instrument approach correctly the first time is to mentally put yourself on the approach before you have to do it for real. You can do this from your dining room table, hence the seasoned veteran's technique of "chair-flying," but you need to be methodical about it. You



Terrain elevation along the valley north of the KEGE RNAV(GPS)-D approach, from Google-earth

need to think about the airplane's ability to descend and turn along each segment of the approach.

Looking back at our RNAV (GPS)-D approach into Eagle County we understand immediately that the terrain imposes descent restrictions until at least the 9,860-ft. step-down altitude located 3.5 mi. from the runway. If the weather was good enough to spot the runway from this distance, what kind of descent rate is needed? We need to descend 9,860 – 6,547 = 3,313 feet, or 33 hundreds of feet. Using our descent rule of thumb, we find that our required descent rate will be 33 ÷ 3.5 = 9 deg. Under TERPS, the maximum glidepath angle for a precision approach is 3.1 deg. for Category D and E aircraft, 3.6 deg. for a Category C aircraft and 4.2 deg. for a Category B aircraft. While those numbers don't restrict how you fly this non-precision approach, they offer you a good idea of what can be done safely. The 9-deg. descent angle is simply too steep.

Our chair-flying exercise reveals that flying this approach with the needles centered leaves you too high to make a stable approach to landing from instrument minimums. The terrain depiction on the instrument chart reveals a valley to the north of the approach course that would allow you to descend earlier and provides the added benefit of lengthening your flight path to give you more distance to descend. But will it be enough?

The first time I flew into Eagle, I took a paper terrain map and plotted a hypothetical ground track to determine the distance flown. These days there are free internet applications that can automate the process. Using a terrain mapping application such as Google Earth shows the valley route from waypoint POWRS to the runway is 16 nm long. Beginning our descent from POWRS means we have to lose 12,000 – 6,547 = 5,453 ft., just over 54 hundreds of feet. That reduces the required descent gradient to 54 ÷ 16 = 3.4 deg.

The terrain at many airports in mountainous areas makes landing from instrument approaches improbable because the required descent rates are too high while remaining precisely on course. Other approaches can be impractical because of national rules, air traffic density or other unusual circumstances.

Unusual Circumstances — The Impractical Approach

ICAO course reversal entry procedures are different than U.S. procedure turn entry rules and the difference can get you in trouble. The international procedures do a better job of ensuring you begin the approach on course but often require extra maneuvering prior to starting the approach.

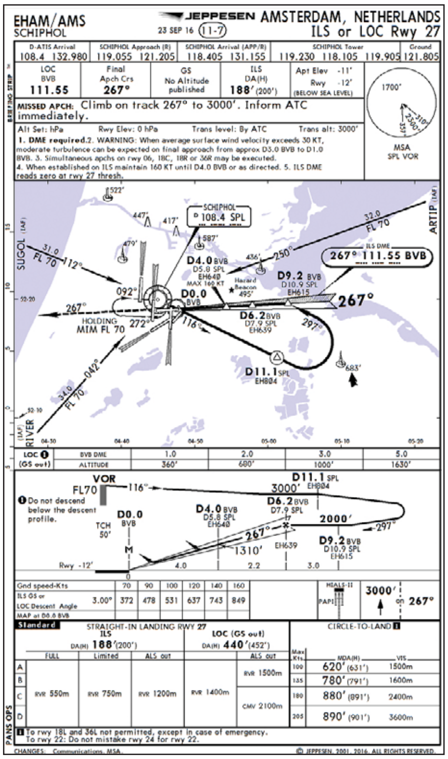
Some airports can compound this confusion with local procedures needed to deal with high-density traffic. These local procedures are rarely published where a visiting international pilot can be forewarned.

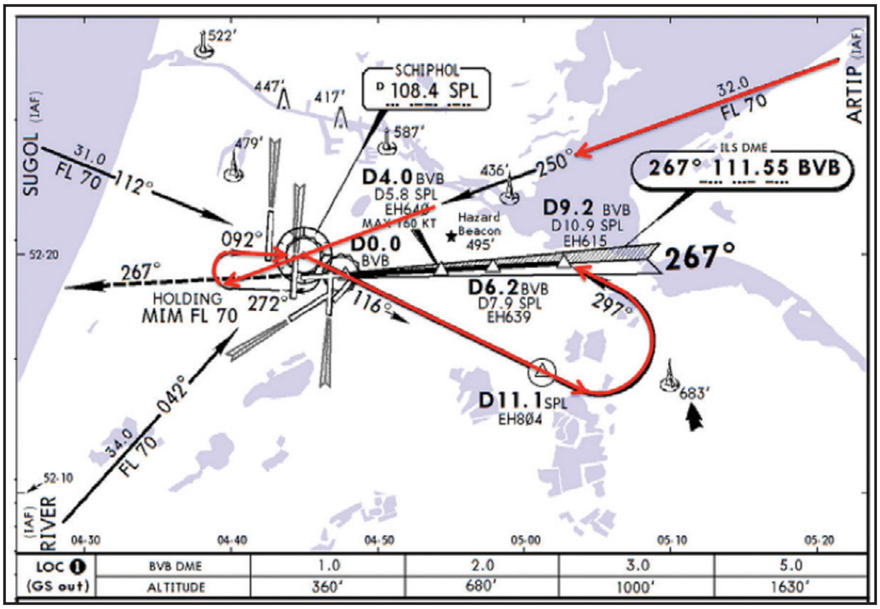
The ILS or LOC Rwy 27 to Schiphol Airport (EHAM) in Amsterdam provides a classic example. Under PANS-OPS this type of course reversal is known as a base turn and must be begun from a specific entry sector. The entry sector is generally within 30 deg. of the outbound course. If outside the entry sector, the holding pattern must be used to get within that sector before starting the approach.

Our Schiphol example approach has two initial approach fixes for aircraft arriving from the west and one from the east. Only pilots entering from SUGOL are permitted to immediately begin the outbound segment of the approach. Pilots arriving from ARTIP and RIVER are expected to execute a turn in holding at the Schiphol VOR.

About a year ago I was arriving from the west and got the clearance, "cleared ARTIP ILS Runway 27." Under U.S. procedures I could fly from ARTIP to SPL and then turn left to intercept the 116-deg. outbound radial. This would have earned me a violation

Schiphol ILS or Loc Rwy 27, Jeppesen EHAM page 11-7





LOC ❶ (GS out)	BVB DME	1.0	2.0	3.0	5.0
	ALTITUDE	360'	680'	1000'	1630'

Schiphol ILS or Loc Rwy 27 "Double" course reversal

under ICAO rules.

Because we chair-flew the arrivals into Schiphol as a crew, we were fully prepared to deal with having to reverse course twice. This "double" course reversal hardly makes sense for one of the world's busiest airports, but these are the rules as published under ICAO PANS-OPS. If we had lost communications or air traffic control had lost radar, we would expect to fly the arrival precisely this way. But we knew it couldn't end up this way since Schiphol is far too busy. Our chair-flying exercise included other options to arrive at each runway. There was also a VOR approach to Runway 27, though it is hardly anyone's first choice of a procedure to use in actual instrument conditions.

The Jeppesen airport arrival briefing pages spelled out the lost communications scenario that included the double course reversal. But those pages also noted, "navigation in the initial and intermediate approach segment is primarily based on radar vectors by ATC."

As we neared the airport our first clearance was "cleared ARTIP, ILS Runway 27." We realized our hypothetical double course reversal was really possible but suspected a vector might shorten things considerably, so we began configuring early. Shortly after passing ARTIP we got a new clearance, "Direct Papa Alpha Mike, cleared the ILS Runway 27."

Now we could have had a new problem: Where is Papa Alpha Mike? Fortunately, we had also reviewed the VOR Runway 27 approach, which is flown off of the PAM VOR.

There is no doubt the ICAO double course reversal can be impractical at times, but it also serves to remind us that many U.S. procedures are exceptions to ICAO PANS-OPS. We need to know the rules of the host country and keep a level of situational awareness to make an impractical approach usable.

Sometimes an approach can seem straightforward and quite practical, but a simple design error will make landing at the published minimums impossible.

Poor Design — The Impossible Approach

Approaches with specific tracks to fly can seem deceptively easy: You just need to follow the heavy black line. But these approaches can be built for the approach designer's convenience, not the pilot's. Chair-flying these approaches ahead of time can reveal minimums that are set too low.

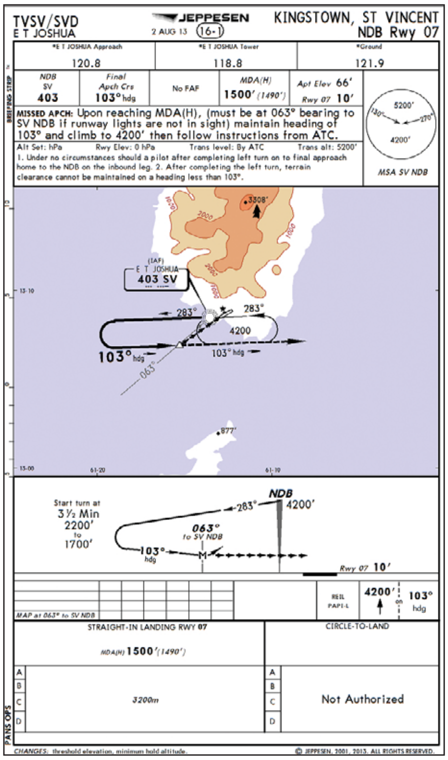
The NDB Runway 07 into E. T. Joshua Airport, Kingstown, St. Vincent (TVSV) looks straightforward at first glance. You pick up a 283 deg. course for 3.5 min., turn left, and then turn left again when on runway centerline. The MDA is at 1,500 ft. and the minimums are 3,200 meters, about 2 sm (1.73 nm).

I first flew this approach in a Gulfstream V with a ragged ceiling between 1,500 and 2,000 ft. but good visibility outside the clouds. Our approach speed was just under 120 kt. and we planned on flying the entire procedure fully configured at that speed. We didn't spot the runway until right on an extended centerline and by then we were too high to land. Fortunately, on the second try, the ragged ceiling allowed us to spot the runway earlier and descend comfortably to land. Our postflight critique began with one thought: "Why were we too high on the first try?"

Had we chair-flown the approach ahead of time, we would have realized landing at minimums would have been impossible. The distance needed to descend from the 1,500-ft. MDA to the near sea level runway exceeded the distance available along the 063-deg. extended runway centerline or within the distance of the visibility minimum. But you cannot predict your distance from the runway on that extended centerline without knowing your aircraft's turn radius.

Since we flew the entire procedure

E.T. Joshua NDB Rwy 07, Jeppesen TVSV page 16-1


TVSV/SVD
E T JOSHUA
JEPPESEN
2 AUG 13 (16-1)
KINGSTOWN, ST VINCENT
NDB Rwy 07

*E T JOSHUA Approach	*E T JOSHUA Tower	*Ground
120.8	118.8	121.9

NDB SV 403	Final Apch Crs 103° hdg	No FAF	MDA(H) 1500' (1490')	Apt Elev 66' Rwy 07 10'

MISSED APCH: Upon reaching MDA(H), (must be at 063° bearing to SV NDB if runway lights are not in sight) maintain heading of 103° and climb to 4200' then follow instructions from ATC.

Alt Set: hPa Rwy Elev: 0 hPa Trans level: By ATC Trans alt: 5200'

1. Under no circumstances should a pilot after completing left turn on to final approach home to the NDB on the inbound leg. 2. After completing the left turn, terrain clearance cannot be maintained on a heading less than 103°.

STRAIGHT-IN LANDING RWY 07		CIRCLE-TO-LAND	
MDA(H) 1500' (1490')			
A B C D	3200m	A B C D	Not Authorized

CHANGES: threshold elevation, minimum hold altitude.

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Measuring course distances with a hand drawn ruler

at 120 kt., we were doing 2 nm per minute. (120 nm per hour divided by 60 min. in an hour.) That gave us a turn radius of 0.6 nm. Doubling that gives us our turn diameter and the answer to the question, how far south of the runway is the 103-deg. course? Answer: 1.3 nm.

But we will be flying the diagonal 063-deg. line, which gives us more distance to descend. But how much more distance? At this point, we have two options on determining the distance: Armed with our turn radius, we can plot our ground track on the approach chart or we can do the same mathematically.

The heavy black line on the approach plate may or may not be an accurate representation of the aircraft's actual ground track, depending on the aircraft's speed and environmental conditions. We can construct our own hand-drawn ruler by transferring the scale on the left of the Jeppesen chart onto the edge of an index card or other straight-edged paper. Using this makeshift ruler, we discover that the heavy black line traces an eastbound course that is about 1.5 nm south of the westbound course. Because we know our turn diameter will be 1.3 nm, we know our aircraft will actually fly inside the depicted track but will be close.

We then measure the distance from the eastbound track to the runway and see we will have less than 2.5 nm, because we will be inside the depicted course.

With a little knowledge about right triangles and a scientific calculator, we can find the distance between our turn to final and the runway more precisely. Instrument approaches are often made up of straight lines and semicircles that can be further broken down to a series of triangles. In the case of our Joshua NDB approach, the distance to descend along the 063-deg. course line is the hypotenuse of a right triangle for which we know the smallest angle because we turn left from 103 to 063 deg., a difference of 40 deg.

Our right triangle lengths decoder tells us the length of the (c) leg is equal to the length of the (a) leg divided by the sine of the angle (A). A calculator makes quick work of this: c = 1.33 ÷ sine (35) = 2.1 nm.

Whether you use the hand-drawn ruler or a scientific calculator, the chair-flying exercise reveals that we have less than 2.5 nm to descend 1,500 ft. Our earlier rule of thumb tells us that this will require a 15 ÷ 2.5 = 6-deg. descent rate. No wonder we were too high to land!

So the next question would be how much distance do you need to make that descent? Remembering that a 3-deg. glidepath takes 318 ft. per nm, our answer is 1,500 ÷ 318 = 4.7 nm. In terms of visibility, that equates to 5.4 sm.

Now we know the approach minimum of 3,200 meters (2 sm) does not provide enough distance to descend in a safe, stabilized manner. We had future trips to St. Vincent and realized we would need Visual Meteorological Conditions (VMC) to safely land.

Low Altitude Turn Radius

An airplane's turn performance at a constant altitude can be derived by combining formulas for centrifugal force, load factor and the trigonometry of a circle. The resulting math is precise, but not cockpit friendly:

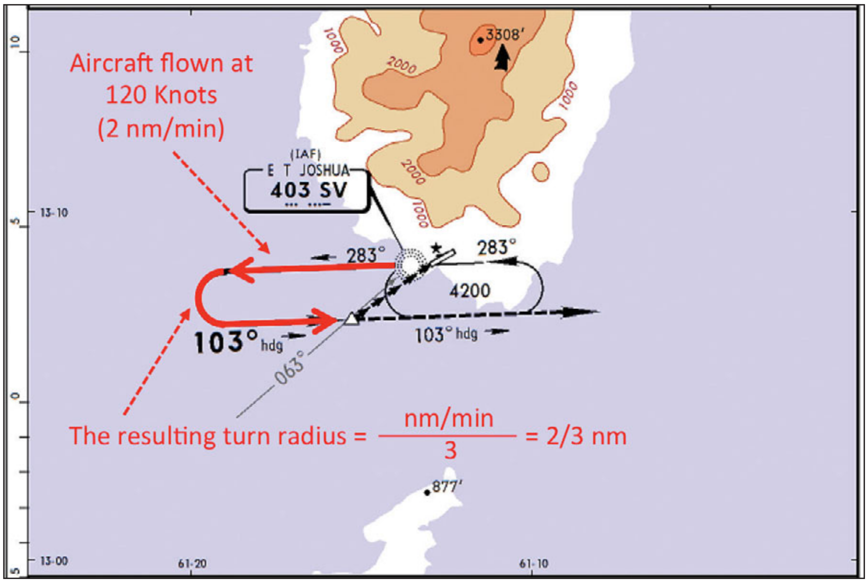
$$\text{Radius of Turn (ft)} = \frac{V^2}{11.26 \tan \Theta}$$

V is the true airspeed (in knots), tan is the trigonometric tangent function, and (the Greek symbol "theta") is the bank angle (in degrees).

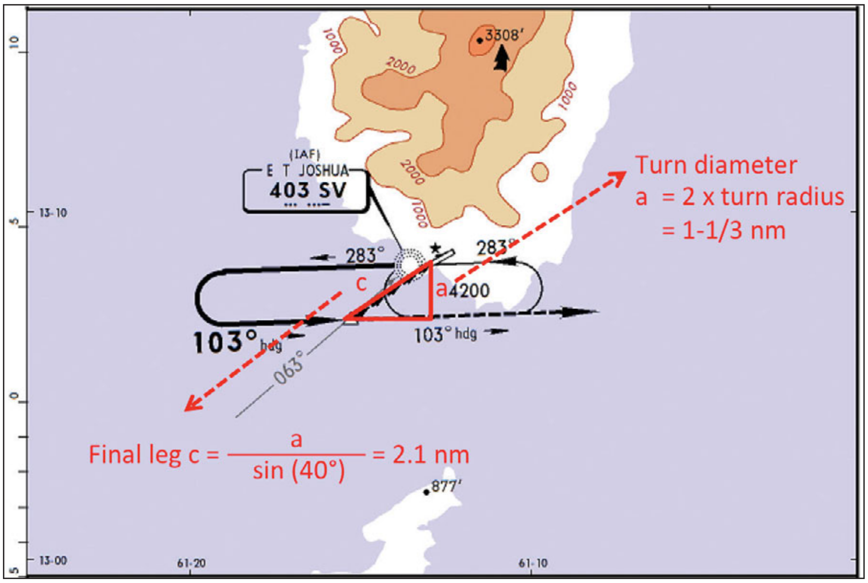
By converting knots to nautical miles per minute and assuming a 25-deg. angle of bank turn, we can greatly simplify the formula:

$$\text{Radius of Turn (nm)} = \frac{\underline{(\text{nm/min})}}{3}$$

This has an acceptable accuracy up to 170 kt.



Determining turn radius

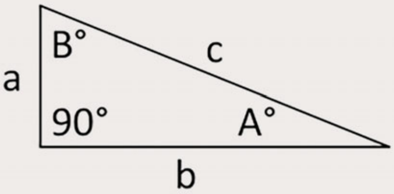


Approach geometry

An Instrument Approach Chair-Flown at 0 Kt.

If an instrument approach looks unusual at first glance, it will be worth a second or third examination. But analyzing an unusual instrument approach just minutes prior to beginning your descent doesn't leave you a lot of time to consider if the approach is improbable, impractical or perhaps impossible. Chair-flying the approach before you leave the ground gives you the time to come up with other options, including not going in the first place.

The only real math skill needed is knowing how much airspace your airplane needs to turn. With a few rules of thumb, an approach plate drawn to scale and a sharp pencil, you can accurately predict your flight path and find out if you are looking at an impossible approach before you are committed to flying it. **BCA**



Typical right triangle

Right Triangle Length Decoder

When dealing with right triangles, you only need to know the length of two sides or the length of one side and one of the smaller angles to determine the length of the remaining side or sides. The sides are typically labeled with lower case letters: a, b and c. The opposite angles are given the same letters in upper case: A, B and C.

For example, if you know the length (c) and the angle (A), you can find the length (a) with a scientific calculator by entering (A), pressing the sine key (typically labeled "sin") and multiplying that by the lengh (c).

$a = (c) \sin(A)$

$a = (c) \cos(B)$

$a = (b) \tan(A)$

$a = b / \tan(B)$

$a = c / \sec(B)$

$a = c / \csc(A)$

$b = (c) \sin(B)$

$b = (c) \cos(A)$

$b = a / \tan(A)$

$b = (a) \tan(B)$

$b = c / \sec(A)$

$b = c / \csc(B)$

$c = a / \sin(A)$

$c = b / \sin(B)$

$c = b / \cos(A)$

$c = a / \cos(B)$

$c = (b) \sec(A)$

$c = (a) \sec(B)$

$c = (a) \csc(A)$

$c = (b) \csc(B)$

GE Honda Aero Engines

FL450
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SILENT
TOUGH
EFFICIENT
RELIABLE

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TOUGH: Setting new standards for durability and efficiency, superalloys used in the hot section permit a higher operating temperature with extended parts life. All HF120s are monitored closely via proven large aircraft engine proactive diagnostic systems to minimize downtime and enable longer uninterrupted service.

EFFICIENT: Using innovative aerodynamic designs, the HF120 delivers greater cycle efficiency while optimizing operability. Unique airblast fuel nozzles provide better fuel atomization yielding superior fuel-to-air combustion to minimize fuel burn. Laser drilled combustor liner holes ensure minimum pressure drop across the combustor, enabling optimum transfer of compressor energy to the turbine side. This unique design offers outstanding overall environmental benefits, including low NOx, CO, and HC emissions.

RELIABLE: All of these amazing features combine to create an engine that redefines dependability. Extensive testing in excess of 23,000 cycles and simulated 5,000 flight cycles run on a single engine reveal proven reliability and readiness for longer uninterrupted operation.

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The Heir Apparent

Bell hopes to regain **light-turbine glory** with the Model 505

BY **AARON SMITH**

Bell Helicopter has returned to the five-seat light-turbine market once dominated by its 206B Jet Ranger, of which some 8,500 civil and military variants were delivered. But since production of that model ended in 2010, other marques and models — notably the Robinson R66 — have come to the fore. Now, with the new Model 505 Jet Ranger X, a more powerful and sophisticated successor to the 206, with new propulsion, avionics, systems and airframe but the same transmission and rotors, the Textron subsidiary hopes to reclaim its crown.

The 505 was certified in December 2016 and deliveries began in March. A former U.S. Army aviator — my training at Fort Rucker began in the TH-67, the service's version of the Jet Ranger — and an MD 520N pilot for the Prince George's County, Maryland, Police Department, I traveled to Dallas to evaluate Bell's latest.

According to Chuck Evans, Bell's director of marketing and sales, the company's targets for the new aircraft included equipping it with a powerful turboshaft with full-authority digital engine controls (FADEC), a modern digital cockpit, a true five-place cabin and marketing it for about $1 million.

Our evaluation flight was to depart from the Vertiport, Dallas' downtown elevated heliport, hard by the city's convention center. There I met Randall Parent, Bell's senior demonstration pilot. As we walked on to the deck after our preflight briefing, the winds were out of the south at 25 kt., with gusts to over 33 kt. Some maneuvers would not be advisable in sustained winds with such a gust spread. Parent and I discussed the flight maneuvers I felt would best give an idea of the Jet Ranger X's abilities. We were flying a demonstration aircraft that was not equipped with skid shoes for touchdown autorotations or run-on landings. We would have to terminate all autorotations with power.

During the walk-around, I found that everything I needed to

Evaluation pilot Aaron Smith (left) finds integration of the helicopter's systems with the Garmin G1000 displays to be seamless. Randall Parent, Bell's senior demonstration pilot, is in the right seat.

TONY OSBORNE/AW&ST

check — sight gauges, engine inlets, avionics bay — was easy to access. Dzus fasteners secure all access doors, making them easy to manipulate. Climbing on the aircraft to inspect the rotor head and engine also was relatively easy; however, it would have been helpful to have a right-side handhold, like the one on the left, to aid the ascent.

Up top, the dual-spool hydraulic actuators constitute a slight change from the 206. The major difference between the predecessor aircraft and its descendant, however, is the latter's Turbomeca Arrius 2R engine, rated at 504 shp for takeoff and 457 shp continuous. That represents a major increase from the 206B's 420-shp Rolls-Royce 250-C20B. However, Bell's main reason for choosing the French engine was its FADEC.

SHELDON COHEN/COHEN PICTURES

Behind the cabin is a luggage compartment big enough for four sets of golf clubs or 250 lb. of gear. Meanwhile, the electronic power supply unit contains everything needed to manage the generator, battery monitoring and charging, and power distribution to the aircraft's various systems. Notably, there are no cockpit circuit-breakers within reach of the pilot since Bell wants to wean pilots from using them as switches or resetting those indicating a problem — a position I endorse.

The tail boom remains a classic monocoque design, and the tail rotor and its gearbox are legacies of the 206. The main rotor and transmission are also proven components from the 206, with minor design changes for installation. All the lighting is LED, and a night-vision-goggle-compliant version of all lighting and displays will be available.

The main windscreen descends level to the floor with no obstructions. Doors and seats were easy to manipulate. No doors-off configurations have been specified but should be soon — likely with a speed restriction of 90 kt., as with the 206.

Behind the left cockpit door is a smaller reverse-opening door to help access the rear cabin. The area in the rear is remarkably spacious and can easily accommodate three adults.

Entering the aircraft, it would have been helpful to have a strap to grab to assist with front-seat boarding. The forward seats are comfortable but not adjustable; they must be locked forward in the "fly" position. To adjust for pilot height, anti-torque pedals must be moved to one of eight positions, a somewhat cumbersome task.

The checklist is a simple, single sheet taken directly from the pilot operating handbook (POH). Parent turned on the switch to the small lithium-ion battery in the avionics bay. At that point the Garmin G1000 displays and standby indicators came alive. Integration of engine, transmission and systems with the G1000 appeared seamless. Warning, caution and advisory lights are all displayed clearly. The limiting engine or transmission indication is enlarged, with information presented in dial format so pilots can readily monitor trends. For startup, Turbomeca's limiting indication is measured gas temperature (MGT).

Parent switched to a nifty weight-and-balance display page that is clearly laid out as a top-down view of the aircraft. He entered our weights and that of the fuel and instantly the display showed our weight of 3,150 lb., or 530 lb. below maximum gross, along with our longitudinal and lateral center of gravity.

There's a two-position switch labeled IDLE and FLY on the collective-lever head, easily manipulated by thumb. After confirming both switches were set to IDLE, I reached to the center instrument panel controls, pushed the selector to START/RUN and that was it. We watched as MGT, Nr (rotor speed) and Np (power turbine speed) came alive, and Ng (gas turbine speed) was at about 63%. I have thousands of hours in FADEC-equipped aircraft, but none in a single-engine rotorcraft in the 505's price range.

After setting up the G1000's PFD and MFD, Parent placed his throttle (switch) to FLY and we were ready to go. We taxied out, lifted off and headed to Dallas Executive Airport (RBD, the former Redbird), about 8 nm to the southwest, to conduct maneuvers. Parent had me switch my throttle to FLY, and the aircraft let us know we were in "dual-FLY" mode. The 505 was remarkably smooth given the winds. I had no problems finding a straight and level attitude at 100 kt. The collective control was also staying right where I put it, and so it continued throughout the flight.

I set up a 70-kt. base leg then reduced to 60 kt. indicated airspeed on final and shot my approach to the departure end of Runway 17. Into the wind it was difficult to detect the 25-35-kt. wind. On the way to RBD I did notice that, similar to the 206, you have to make a conscious effort to maintain coordinated flight and keep the aircraft in trim. I have flown a number of aircraft without automated flight controls that do not require as much footwork, but it was no different from the 206. On short final, a voice alert told me I was at 50 ft.

At the departure end of Runway 17 we sidestepped to the large sod area where Parent let me conduct a number of hovering maneuvers, including sideward and rearward flight. I was easily able to get the aircraft to move in either direction smoothly, with relatively little pedal input to keep the tail behind the aircraft. I was easily able to reach 17-18 kt. Parent demonstrated speeds closer to the 25-kt. sideward and rearward limits with no issues. Turns around the mast were smooth, and the aircraft required less torque than I thought to get the tail through the 30-kt. wind while maintaining a relatively constant rate of turn.

After in-ground-effect hovering maneuvers, I asked Parent to get to an out-of-ground-effect (OGE) altitude of about 100 ft. AGL to demonstrate pedal turns — a maneuver I would not have been as comfortable doing in the 206 given the winds. I noted about 78% as the highest torque value — good power remaining considering winds and weight.

As previously mentioned the aircraft was not equipped with skid shoes for touchdown autorotations or run-on landings. Consequently, we had to terminate all autorotations with power. After the OGE hover work, I asked Parent to demonstrate a hovering autorotation. He went with the published

TONY OSBORNE/AW&ST

Bell's 505 Jet Ranger X retains the Model 206B's proven main and tail rotors and gearboxes.

zero-ground-speed bottom side of the height-velocity diagram limit of 5 ft., switched to IDLE and the 505 settled much like the 206, with about 2-3 in. of right pedal input. Then it was my turn. I took the controls, placed the throttle to FLY and the FADEC smartly brought rotor rpm back to flight speed. Once again, for my hovering rotation the aircraft was exactly like a 206.

Next, when Parent demonstrated a minimum-rate autorotation, 50 kt. gave us 1,400 fpm, and a max glide speed of 70 kt. gave us 1,850 fpm. He used the middle of the green arc for Nr, or 100% — at the center of the 90-111% range. Descent rates were as expected for the high inertia of the relatively large and lengthy blades of Bell's semi-rigid underslung rotor design. It feels like you have lots of time. Compared to some aircraft, you do — just don't let Nr go below the green. Getting rpm back on a decayed high-inertia rotor system is not fun, if not impossible.

On one autorotation, Parent went as far as the flare before cushioning (where energy in the rotor system is used to soften the landing) and then switched the throttle back to FLY. He slowed the descent to 5 ft. AGL and then placed the throttle switch back to FLY and almost simultaneously pulled collective, asking for power. The Arrius 2R responded rapidly with little yaw to the right as power increased.

It was my turn to fly with the hydraulics off. This requires some effort, but the rates and movements are predictable. In the 206 with hydraulics off to simulate a failure, it is standard to search for a suitable landing area such as a runway to execute a run-on landing. Parent told me to perform a normal landing from a hover. My experience flying the CH-47D with the automatic flight control system off helped, but any pilot with good stick-and-rudder skills would do well.

At this point, it made sense to demonstrate run-on landings, but because of the winds we chose to put the hydraulics back on. Even though the aircraft lacked skid shoes, we were able to conduct a run-on landing to a grass area. Touching down above effective translational lift speed (16-24 kt. — where the rotor system is more efficient and drag from downwash starts to reduce), I was easily transitioned and maintained control to a complete stop.

Then it was Parent's turn to demonstrate a max-performance takeoff using about 95% of continuous power available, or about 85% torque. The result was about 1,750 fpm as we climbed to 2,000 ft. At the top we planned to reduce collective to enter a vortex ring state, but with zero ground speed and a 35-kt. wind across the nose, we were not going to be able to enter a settling-with-power condition.

Next, I began a series of standard airborne law-enforcement maneuvers. I used a highway on downwind so I could look across where my tactical flight officer would sit. The windscreen and doors provide good visibility. But the location where an operator would mount a computer or video monitor could hinder the spot I use to view a fleeing vehicle. This is where a chin window can make a difference.

When conducting steep, 360-deg. turns in both directions — as when pursuing a fleeing car — the aircraft was smooth, and I was able to roll the 505 to a 60-deg. bank without any adverse yaw and little additional vibration from the rotor system. Next, I focused on a tennis court to serve as a simulated target location. I initially flew 1,000-ft. AGL orbits at 60 kt., a typical infrared-camera search altitude and speed. I then reduced altitude to 600 ft. AGL and airspeed to 40 kt., a common visual search combination. In both cases the aircraft was predictable and did not display any unusual characteristics. The 600-ft. AGL orbit was high enough above the Dead Man's curve to gain the airspeed required to make a successful autorotation to landing. By this time, the sustained winds and gust spread was so high, neither Parent nor I felt it prudent to demonstrate autorotation from a hover at the top of the height-velocity diagram. At that point, we headed back to the Vertiport.

The 505 holds about 550 lb. of fuel and, at a consumption of about 200 lb./hr., you can expect about 2.5 hr. of flight, and with a cruise speed of 105-110 kt., you can plan a range of about 250 nm. Bell predicts DOCs of about $420 per hour. Some components are life-limited to 500 hr. pending fatigue testing. The goal is for all major components to have at least a 3,000-hr. time between overhauls.

The 505 Jet Ranger X meets Bell's targets and is an able successor to the iconic Model 206. While I would prefer it being fitted with a fully articulated rotor, that would have caused it to exceed its target price. And with a base of about $1.2 million, the 505 should prove to be a popular competitor in the entry-level, light-turbine helicopter market — a market its predecessor helped create. **BCA**

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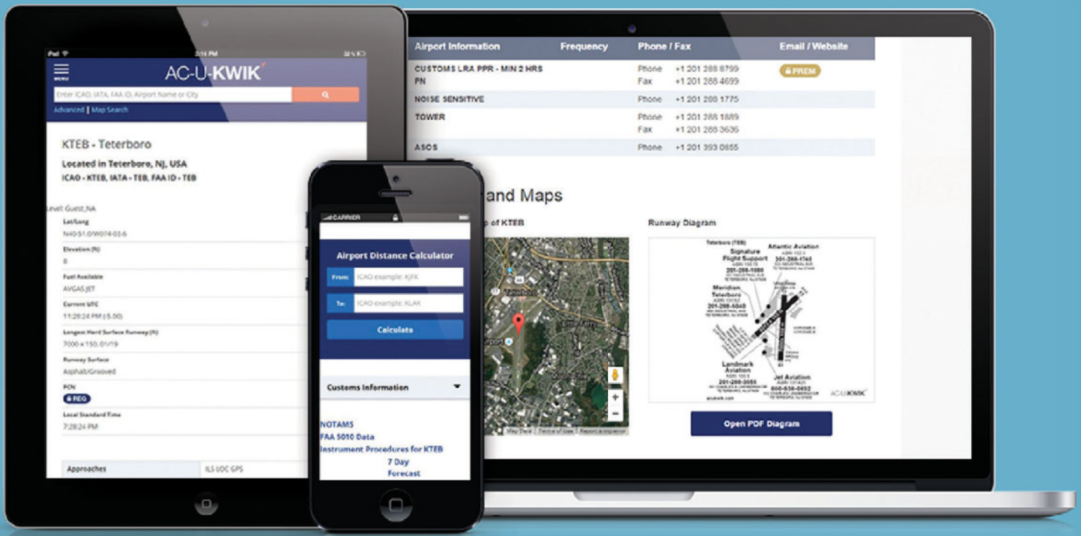

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Lighting Up

LEDs are **changing our view** of things aviation

BY **KIRBY HARRISON** kirbyjh12@hotmail.com

Few innovations have brightened the future of business aviation like light-emitting diode (LED) technology, and its uses continue to light the way, quite literally, from cabin interiors to landing lights to airport runways.

Barely a dozen years ago, LEDs were just making their way into aircraft cabins; initially as digital displays on cabin control devices, and on the faces of passengers' digital wristwatches.

Today, that technology is seemingly everywhere within cabins, from overhead wash-lights to reading lamps to emergency signage. They're in the cockpit; across the instrument panel, down the center console and across the overhead. And they are fast becoming common on the aircraft exterior and as part of airport infrastructure.

Across the board, LEDs are for the most part, superior in almost every way to every other lighting technology — incandescent, fluorescent, tungsten-halogen, compact fluorescent lamps (CFLs), T8 bulbs and high-intensity discharge.

They have a longer lifespan than other forms of lighting; on average, LED bulbs last 20 years longer than incandescent bulbs and might well outlive the aircraft in which they are installed. They are so efficient they can save as much as 80% in energy costs over incandescent bulbs and they are far less prone to breakage.

While LED technology itself continues to be refined, the applications are also expanding (pardon the predictable pun, please) at nearly the speed of light.

Robert Fogarin, a senior sales engineer at Jet Aviation's Basel, Switzerland, operation, said the business aviation industry has seen a number of recent advancements in packaging of LED units for specific applications. Among these is the accommodation of very accurate lighting details within cabinetry, while integrating them so well that the LED units are completely hidden in the construction.

AEROLEDS

In addition to reducing the size of the LED units, improvements in flexibility have helped accommodate 3-D curves and long, continuous light runs around the cabin. Fogarin admitted, however, that, "Consistency in brightness with some details remains a challenge."

At B/E Aerospace Lighting and Integrated Systems, engineers have pushed the boundaries still further with their new VIU flexible LED system. The RGBW (red, green, blue and white) lighting package comes in fully calibrated color points, is available in lengths from 3 in. to 90 in. and has a bend radius of just 2 in. Moreover, it is encapsulated and waterproof, and operates on standard 28-volt DC current.

"It brings full RGBW light to places never thought possible," said Stephan Scover, B/E Cabin Systems Group general manager. "It has the flexibility to conform to monuments, the intensity needed for wash lighting, and the durability necessary for toe-kicks and pathways."

In 2016's prestigious Crystal Cabin Awards competition in Hamburg, the VIU system won first place in the Cabin Systems category.

Working from the concept of LED lighting as an integral part of the overall business jet cabin ambiance, Bombardier Business Aircraft designers are using LEDs to emphasize design elements, such as a textured bulkhead on the new Global 7000.

With an increase in the size of its Global business jet windows, ambient light has been increased and window shades are considered part of a common system to manage cabin ambient light in coordination with the LED lighting. This is particularly important in aircraft such as the long-range Global 5000, 6000 and 7000 models and the Challenger 650, in which passengers are frequently crossing multiple time zones, requiring a darkened cabin to facilitate the shift in normal sleep patterns.

Bombardier's LED cabin lighting includes direct application such as dome lights, table lights and reading lights, providing simulated daylight brightness when boarding the airplane or when eating, reading or working. Indirect light complements direct light and creates diffused cabin lighting when the interior is configured in sleeping and night mode. There are also LED toe-kick lights to illuminate the pathway aisle, allowing passengers to move safely through the cabin during low-luminosity levels.

The Canadian company's mood lighting is available only in its Global aircraft line. It is controlled by using preset colors available through the cabin management system. Color settings are measured in light temperature gradients. The color spectrum ranges between all variations of whites (warm to cold). The cabin passenger mood can also be influenced by other color settings, from yellow to orange shades, or even shifting from pink all the way to red.

Among the more interesting cabin lighting designs at Associated Air Center in Dallas are multiple ceiling domes on a head-of-state widebody aircraft. One of the three customized domes employs specialized LED programming that features the night sky as it appeared on that country's day of independence. Other night sky simulations were created to represent significant events in the country's history.

Many Associated Air Center customers have recognized the advantages and capabilities of LEDs and expressed a desire to get the maximum experience, recalled Chip Fichtner, vice president of business development. "The system enhancements go well beyond just sunrises and sunsets, [and] many of our clients required custom programming for individuals as well as for specific rooms."

How LEDs Work

Light-emitting diodes, better known as LEDs, are quite simply electronic components with two electrodes called the anode and the cathode. They might be considered miniature equivalents of a common light bulb. When an electric current passes through it, the diode emits visible light, or infrared energy. The material used in the semi-conducting element of the LED determines the color produced. Digital programming allows an infinite choice of colors through blending and timing.

Another VIP completion required development of a custom boarding display for the aircraft, using the LED color spectrum, providing geometric shapes and personalized branding for guests as well as the owner.

If any single aircraft manufacturer is representative of the growth of LEDs in business aviation, it might be Gulfstream. Today's G650ER, for example, has LEDs throughout the cockpit and cabin, and notes "all external lighting is based on LED technology."

In the cabin, said Heidi Fedak, director of corporate communications, "The emerging trend is to use the latest lighting technology for mood enhancement, which allows passengers to relax and provides a comfortable environment during their travel.

"The light conditions can be customized very easily to enhance the activities being performed by the passengers, including dining, sleeping or entertainment."

Shervin Rezaie, general manager of LED distributor and manufacturer Aircraft Lighting International (ALI), points out that LEDs can play a role in relieving the apprehension that some passengers may have with merely the idea of flight. "Imagine the difference between a bumpy ride on a stormy night in a dark room, and that same ride in a warm, well-lighted cabin," he suggested.

At times, the LED innovation can seem minor but results in considerable improvement. Such is the case at Beadlight Aerospace, which claims to have designed the "first ever" LED reading light in 1997. Over the past 15 years, the Witney, U.K.-based supplier has become a major player in the field. Its most recent contribution is "beadlight diffusion" — a reading lamp that takes into consideration light spread, light intensity, LED color temperature, glare and lamp positioning.

While more recent and current production aircraft are typically LED from front to back, the retrofit market is perhaps more active, consisting of thousands of aircraft still outfitted with old and unreliable incandescent and fluorescent lighting. In short, the LED retrofit market is strong.

Retrofit Is the Name of the Game

ALI has been manufacturing aircraft interior lighting systems since 1998 and today is a major supplier in LED retrofitting activity, said Rezaie.

The Hauppauge, N.Y.-based company's LEDs are 100% interchangeable with the existing 12mm series

A Beechcraft 400A with flourescent lighting (left) and with Aircraft Lighting International (ALI) LED lighting on the right.

ALI (2)

Measuring LED Light Output

In the rapidly receding world of incandescent light bulbs, light produced is simply measured in watts. Today, LEDs are becoming the standard, but a number of other bulbs have appeared, with advantages and disadvantages. This expansion required a new means of measuring light, with the lumen (from Latin, meaning "light") emerging from a coalition of more than 40 organizations.

In "geek-speak," a lumen is a unit of luminous flex in the International System of Units that is equal to the amount of light given out through a solid angle by a source of 1 candela intensity radiating equally in all directions.

More to the point, lumens equal brightness, while watts measure energy use, not light output.

A light bulb producing 450 lumens and a color temperature of 5,000 to 6,500 Kelvin is, for example, a good choice for a reading lamp. This would be equal to a 40- to 60-watt incandescent bulb, a 10- to 15-watt compact fluorescent lamp (CFL) bulb or an 8- to 12-watt LED bulb.

For those still wandering about in the "dark" ages of incandescent lighting, the following is a conversion guide from watts to lumens. **BCA**

INCANDESCENT BULB (WATTS)	FLUORESCENT/LED (WATTS)	LUMENS
40	10	600
60	15	900
75	18.75	1,125
100	25	1,500

fluorescent lamps and require no rewiring, nor new lamp holders, new connectors, new dimmers or new controllers. ALI also carries the latest 28-volt DC kit, which incorporates the LED lamp and ballast as one unit.

There is also an LED replacement reading light bulb that, according to Rezaie, requires "absolutely no change or modification to the reading light fixture, and like other products, it is in stock and can be delivered the next day."

ALI also recently launched its own mood lighting, giving passengers the ability to easily dim or brighten the lighting ambiance and create special effects. And the company expects to introduce a 115-volt, alternating current, self-ballasted, drop-in LED suitable for Bombardier's Global Express. "We hope to have it available this summer," said Rezaie.

As a reflection of the strength of the retrofit business, ALI expanded last year into a new, 18,000-sq.-ft. facility on Long Island. "We currently have more space than necessary," Rezaie said, "but we expect to use it in the future and to be adding manufacturing jobs in the U.S. for years to come."

When Luma Technologies got into the LED retrofit market a decade ago, its first target was the 5,000+ legacy King Air fleet fitted with 50 to 60 master caution display lights with two problematic incandescent bulbs each. Today, the company has that market "pretty much cornered," said Luma President Bruce Maxwell.

"That's our bread and butter," he told *BCA*. "We have AML/STC [approved model list/ supplementary type certificate] approvals for the King Air 90, 200, 300 and 350i, and the replacement process takes only a half day. It's simple: Unscrew, remove, disconnect, put in the new LED panel, reconnect and test. And there's no wiring changes or flight tests involved."

LUMA Technologies LT-4000 Series integrated LED displays and caution/ warning systems.

Prices range from $13,500 for a baseline King Air C90 panel, to $16,000 to $20,000 for the larger 200, 300 or B300 models. The price includes all the STC data, lifetime license and a five-year full coverage warranty.

Two years ago, Maxwell said, Luma shipped 20 sets to the FAA for installation in the agency's King Air 300 fleet, "and not one of them has failed."

There are also Luma replacement panels available for the Cessna 208 Caravan and Bell 206, 206L, 214ST and 412 helicopters, a three-panel suite for the Beechjet 400A, XP and XPR, and, according to Maxwell, there are "other projects in the wings."

Along with its focus on caution display LEDs, Luma offers other LED retrofit products, including low-profile push-button switches and annunciators targeted at the large global fleet of Russian-built helicopters.

And Luma recently introduced an LED light kit for King Airs to replace the clusters of blue-booted incandescent lamps under the glareshield.

Exterior Lights Growing

AeroLED is also big-time into the retrofit market, most recently with its Polaris, all-LED direct replacement for the existing 7412-12 series reflector type navigation light.

"We've had people asking for it for quite a while," said Nat Calvin, president and CEO of the Boise, Idaho, company. "There had been attempts to address that [nav light] market, but there are challenges as it has to re-create the light pattern of the old incandescent bulb; a very common part."

The Polaris light draws 9 watts, compared to 40 watts for incandescent lights. While the LED bulb is priced at $200 and the old bulbs are in the $50 range, Calvin argued that the long-term savings make the switch worthwhile. To illustrate, he pointed to the charter industry.

"When a charter aircraft is down, it isn't making money," he said. "It's a matter of $1,000-a-day in income put on hold by a $50 part that failed."

Meanwhile, Honeywell Aerospace is touting its new LED Searchlight for helicopters, the function of which is to visually identify the landing zone and objects near the helicopter using either visible light or the infrared mode. The unit is a drop-in LED light-head replacement for Honeywell's current searchlight and will be available for delivery in fourth quarter 2017.

The company says that while other searchlights require the use of an external dimmer, the LED Searchlight features an innovative microprocessor that allows for internal dimming of both the visible and infrared light sources, saving both weight and power, while reducing maintenance costs.

According to Honeywell, development of the LED Searchlight was in response to the limitations of halogen lights and laser diodes. It offers the fully integrated, dual mode and infrared LED modules to boost the infrared performance to an unprecedented 90 NI.

Honeywell is also the supplier of LED exterior lights for Boeing's 787 Dreamliner. And its LED nav lights are also now standard on new production Airbus ACJ318, 319, 320 and 321 models. They are also available as retrofit items for the ACJ320 with no requirement for aircraft modification.

The company also offers wingtip warning lights as a retrofit, drop-in item for the ACJ320 family. And it's pursuing other aftermarket LED retrofit, modification and upgrade lights, and will be introducing a "Qik-Plug" LED drop-in upgrade for legacy VIP 737 variant nav lights later this year.

On the new BBJ 737 Max, Honeywell provides LED landing, taxi, runway turnoff and anti-collision lights and cockpit lighting.

While the initial rush to LED lighting occurred in and on aircraft, aviation is rapidly finding other uses for the technology in runway edge, threshold, barricade, taxiway and helipad lighting.

Solar-Powered Lights

Taking LEDs to a new level, Carmanah, a Victoria, B.C.-based company, is busy producing solar-powered LED lights for a variety of aviation applications from airports to forward operating bases and for a wide array of customers from the general aviation sector to the military.

Most recently, the company introduced solar-powered runway lights with three peak intensities — 250, 500 and 750 candelas. The lower-intensity lighting is for remote or temporary runways, while medium-intensity units are common at most airport runways. The high-intensity lighting is for operators needing increased visibility, particularly for military use.

According to Cory Brigham, manager of Carmanah's Airfield Lighting Business Development, solar-powered LED lighting is ideal for remote locations where power is in short supply. "Is costs less, it's easier to install, and there is no need for transformers and other electrical equipment," he noted.

It takes less than 10 min. to install one light, he added. They automatically go on at dusk and off at dawn, and they can be turned on and off at any time by wireless control. "Operators can expect about 20 years of use before the LEDs begin to dim," he said, "and the lifespan of the high-volume batteries is roughly seven years."


CARMANAH

Carmanah's airfield lighting at Yakubu Gowon Airport, Nigeria

Carmanah also has infrared LEDs that are compatible with night-vision goggles. "We have an excellent solution for military customers, as well as a growing global market for civilian airports," said Brigham.

OLEDs and Lasers Coming

It's estimated that well over 90% of the new aircraft being delivered have LED interior lighting, and an LED presence on their exteriors is steadily expanding. So what is the next wave of lighting technology?

Organic LEDs, or simply OLEDs, are already commonplace in the retail television market with such innovations as OLED ultra-HD and curved screens.

OLED light is generated when electricity passes through layers of

High Points in the History of LEDs

LED technology first found a market in smaller products, such as watch and clock faces. In a sense, aerospace provided a platform for worldwide recognition of LEDs when film director Stanley Kubrick teamed with watchmaker Hamilton to create a clock with glowing red digital numerals for his 1968 film, "2001: A Space Odyssey."

To provide proper context for the growth of the technology, the first use of LED lights in the Times Square New Year's Eve Ball was in 2007 and called for 9,576 LED bulbs capable of producing more than 200 colors. Today, the ball comprises 2,688 Waterford Crystal triangles lighted by 32,256 Philips Luxeon Rebel LED lights capable of producing a palate of more than 16 million colors.

LED applications in business aviation only began some 12 years ago when Shuji Nakamura, a researcher at Nichia Chemical Industries in Japan, invented the blue LED, and soon after, the white LED.

In 2017, virtually every business jet delivered comes with full LED lighting, from up- and down-wash to the cockpit, and including many exterior applications such as navigation and landing lights.

And on the ground, airport runways are now being outlined with solar-powered LEDs. LED technology is even finding its way into heliport infrastructure. LEDs are the future, and the future is now. BCA

Rockwell Collins Moves Into Aircraft Lighting

With a vote on March 9 by their respective stockholders regarding the proposed acquisition of B/E Aerospace, Rockwell Collins moved a step closer to establishing a major presence in the field of aircraft lighting.

The Cedar Rapids, Iowa, aerospace company is a major producer of aircraft communications, control, navigation, cabin management and entertainment systems, and provides a variety of flight services. Its acquisition of B/E Aerospace will add to that an extensive competence in cabin lighting and systems integration, as well as seating, food and beverage preparation, galley systems, cabin reconfiguration, program management and certification.

The "definitive agreement" under which Rockwell Collins will acquire B/E Aerospace includes approximately $6.4 billion in cash and stock, plus the assumption of $1.9 billion in net debt. Finalization of the deal is expected this summer. **BCA**

ALI (2)

Aircraft Lighting International lights up Globals, Challengers and Falcons with retrofits.

The organic layers of OLEDs are thinner, lighter and more flexile, however they are easily damaged by moisture.

organic semiconductor material mounted on a transparent base. Less energy is required for it than for LEDs or liquid crystal displays (LCDs). They also emit very little heat and are lighter in weight. The latest iterations are flexible and only slightly thicker than a credit card.

Actually, OLED technology has long played a minor role in business jets, being used in the screens of cabin control devices, as well as personal electronic devices (PEDs) such as smartphones, tablets and laptop computers. But it has yet to find its way into business aviation on the scale of LEDs. The advantages of OLED over LED are, however, manifold.

▶ The organic layers of OLEDs are thinner, lighter and more flexible.

▶ OLEDs are brighter than LEDs because the organic layers are much thinner than the inorganic crystal layers of LEDs.

▶ OLEDs generate their own light, rather than selectively blocking areas of LED backlight.

▶ OLEDs are easier to produce and can be made in virtually any size.

▶ There are disadvantages, albeit minimal, to OLEDs, however.

▶ While red and green OLED films have longer lifetimes — 46,000 to 230,000 hr. — blue organics last only about 1,400 hr.

▶ OLEDs are easily damaged by moisture.

▶ Current manufacturing processes are expensive.

▶ Early development of OLEDs was led by Kodak. It, along with other companies, holds patents on the technology, and for commercial development it is often necessary to acquire a license from the patent holders.

According to Jet Aviation's Fogarin, OLEDs' ability to conform, even to curved surfaces, is almost without limit and thus offers new design possibilities. "For very specific applications, OLED lighting offers a lot of ability to customize the end result, though the technology is new and remains cost prohibitive in larger quantities."

Fogarin added that OLEDs will only really take off when a manufacturer invests in scale production and certification, opening the door to spin-off products for cabin interiors.

Laser technology is also gaining as a lighting source. Once seen as a technology looking for a problem, lasers today are used for myriad technologies — CD and DVD players, precision tooling, digital communications and the lowly bar code scanners at the local supermarket.

Laser's practical use as a light source is already here. In 2014, BMW introduced the first production automobile with laser headlights, the BMW i8. It is now an option on other in-production cars. The result are headlights that are 1,000 times as bright as LED headlights, consume just two-thirds the energy and result in less eye fatigue.

LEDs are the future spelled large in the business aviation sky. Meanwhile, OLEDs' widespread adoption could take another decade, with laser lighting close by. Welcome to the bright and shining new world of aviation, where light can find its heretofore darkest reaches. **BCA**

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New Concepts in Charter, Part Two

How innovative commercial operators are **redefining business aviation charter**

BY **DAVID ESLER** david.esler@comcast.net

A Gulfstream G550 operated by one of Bliss Jet's contractors on the N.Y.-London service under a DOT Part 380 approval.

BLISS JET

If business aviation is to grow in the new economy, it has to be expanded to a larger demographic of users beyond blue-chip flight departments and high-net-worth individuals.

This is the premise business aviation analysts have agreed the industry must accept as it contemplates a future fraught with change. As we'll see in Part 2 of BCA's examination of innovative concepts in marketing charter, forward-looking operators are bringing the principles of the so-called "shared economy" to private aviation, broadening it to a wider class of users. These new business models are emerging to replace or augment the traditional business aircraft ownership and charter/management models since the 2008 recession and its aftermath, one lingering effect being flat sales of new business jets and a glut of relatively young used ones.

While fractional ownership brought a new class of users to the benefits of business aviation — albeit in parsed-out shares — many participants ultimately left the programs when their shares were devalued as a result of fractional providers running up hours and cycles of their customers' aircraft with chartering and card schemes. Now these former fractional owners are themselves turning to charter and membership programs to continue exploiting the advantages of business aviation without the burdens of whole aircraft ownership.

Pointing out that in 2015, two million people worldwide accessed business aviation in comparison to 800 million traveling via the airlines, Embraer has hypothesized an intriguing business model that could further enlarge the population of business aviation users as well as stimulate new aircraft sales. Put forth by the former CEO of the company's Executive Jets division, Marco Tulio Pellegrini, who departed Embraer in April to head Industria Aeronautica de Portugal (owned 65% by Embraer), the proposal suggests formation of alliances between manufacturers and leasing companies, the latter which would buy new aircraft, subsequently leasing them to charter providers for scheduled operations between city pairs offering robust business traffic.

The alliances would identify key markets that could support a premium level of service based on convenience and, especially, time savings when compared to legacy airline service. Operating between general aviation terminals or executive FBOs, these services could streamline passenger processing and security clearance as well as offer luxury onboard comfort, catering and curb-to-curb accommodations akin to traditional business aviation operations. Furthermore, specific customer groups could be targeted in alignment with business centers, *e.g.*, finance and legal, and the model would be based on providing direct point-to-point service as opposed to the airlines' hub-and-spoke distribution system.

In Pellegrini's example, ideal stage lengths for the scheme would average 1 to no more than 2 hr. duration, and to attract lessors to the concept, relatively high utilization of the business aircraft employed would be a necessity to reduce operating costs and premium fares.

An objective of the concept would be to alter perception of business aviation from an indulgence of the wealthy to premium air transportation for business leaders. According to an informed source within Embraer, the concept is still active but

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CAE

The Bliss Jet team: (left to right) Chief Operating Officer Omar Diaz; Executive Vice President Toni Drummond; and President and Chief Executive Officer David Rimmer.

awaiting completion of a reorganization of the Executive Jets division in the wake of Pellegrini's departure.

One That's Trying It

Now, an attempt to implement a scheme very much like Pellegrini's concept but on a transoceanic basis officially began operations April 16 between New York's LaGuardia Airport (KLGA) and London Stansted Airport (EGSS) using Gulfstream business jets. This is Bliss Jet, the creation of David Rimmer and Omar Diaz, both with extensive backgrounds in business aviation: Rimmer formerly ran Alerion and Excel Aire charter/management companies and began his aviation career as a *BCA* associate editor, while Diaz, currently a consultant, has worked in the private jet and helicopter industries for two decades.

The two conceived Bliss Jet after market research revealed that many business jet owners were flying commercially across the Atlantic to do business rather than adding cycles and hours to their airplanes and paying high fuel costs. Still, they wanted to avoid the time-wasting hassle of airline travel and security processing. As part of that research, Diaz told *BCA,* the pair studied most-traveled international city pairs, finding New York/London (not surprisingly) topping the list, with more than 800,000 people flying the route in first class every year.

"For the concept we visualized," he said, "we needed to capture 1,000 of them annually. These people are paying $8,000 to $12,000 one way on British Airways, depending on when they book their flights, since having to reserve at the last minute, you will pay through the nose. What could we offer that the airlines couldn't? The answer, primarily, was time savings."

This became the "anchor" for the service. "Commercially, you have to arrive 2 hr. before the flight and go through the whole process of checking in, checking your bag, going through the TSA security check with all that entails, and getting to the boarding lounge," Diaz said. "For our service, we ask passengers to arrive 30 min. before the scheduled flight at the Marine Air Terminal at LaGuardia where they get out at the curb, take 25 steps into the lounge, get the security screening from a professional company owned by a former FBI agent, get ushered to a van and driven right to the airplane. Over at the airline terminal, at 30 min., you've just checked your bag.

"On one of our Gulfstreams," he continued, "the passenger is already one-third of the way to London by the time you board your airline flight. On the other end, at London-Stansted, customs comes on board and clears the passengers, then everyone gets deplaned to a private terminal in the Inflite Jet Centre FBO."

In bringing the concept on line, Diaz and Rimmer relied on their mutual experience and contacts in business aviation. The concept was to use long-range business jets operated by contracted FAR Part 135-certificated operators to make scheduled transoceanic flights from FBO to FBO under the Department of Transportation Part 380 public charter regulation. "We got the approval in November 2016 and struck deals in mid-February with operators and FBOs," Diaz said.

Following that, the new company embarked on a testing, or route-proving, program, carrying out a series of revenue flights, averaging six passengers per flight. At that time, operators signed included White Cloud Charter out of White Plains, New York, Jet Access Aviation at Palm Beach and Journey Aviation at Fort Lauderdale, Florida. At press time, discussions were underway with a fourth. "Under the public charter allowance, we must specify to the DOT who we are going to use for a particular schedule," Diaz said.

The test flights involved Sunday night departures from LGA with arrivals the following morning at Stansted. Return flights left Thursday afternoon and, depending on the winds, arrived Friday before midnight or Saturday after. Aircraft used for the trips were Gulfstream IV-SP, V and 550 types. "The seating varies between 12 and 14," Diaz explained, "but we are capping it at 10 passengers per flight. Under provisions of Part 380, none of [the passengers] need to know one another. There's no membership fee — our commitment is to get them to London and back with a private experience. The fares are always the same no matter when you reserve and are priced at $9,995 one way."

Time Is $$$$

"It ain't cheap," Diaz admitted, "but the [high-worth individuals] will pay for it to save the time, and you can't buy time. The average business jet owner has bought the aircraft for time savings, so this saves them $70,000 to $90,000 a flight on a trip to Europe in their own plane. So to avoid that, they fly domestically to New York on their own aircraft and then transfer to an airline. Now they can do it with us, saving them lots of time. We're bearing the cost of operating the flight. And a last-minute booking saves them $3,000 to $4,000 [rather] than doing it on British Airways."

The other advantage, Diaz claimed, is using the private terminals. "Others have tried a pseudo-version of it using airliners but were confined to having to access airline passenger terminals. We cut all of that out. It's expensive to use a gate — they charge by the minute. We are limited to 22 souls on board or we have to use a gate, so with only 10 on board [13 total with crew], we can use the private terminal. We pay one ramp fee between $800 and $1,000."

After six moths of operations, Bliss Jet plans to add a second round trip per week and possible expansion to other destinations, e.g., Dubai, Beijing, São Paulo and the Caribbean.

"We've been feeling 'the invisible hand' of the airlines and regulators," Diaz said. "'Are you an illegal airline?' But once we explain it, they disappear. We would want to become the ultra-first-class service for the airlines, and we look forward to a time when cooperating airlines might actually book some of their high-end passengers on Bliss Jet."

Another attempt aimed at pulling passengers off of the airlines and inviting them into chartered business aircraft is Overland, Kansas-based MemberJets. Intended "to break the gap between commercial and private aviation and the lack of service on the former and high prices on the latter," MemberJets was founded three years ago by Ty Carter, who previously plied careers in investment banking, aviation insurance and risk management. (A private pilot, he reports having logged 8,000 hr. of total flight time, 6,000 of them in a Pilatus PC-12.) "We wanted to open it up to a new demographic, the middle market — more than the 'One Percent' say, the 'Five to Ten Percent,'" Carter told *BCA*.

Like Bliss Jet, MemberJets is licensed by the DOT as a Part 380 indirect air carrier. "What they are doing is empowering operators to set up their own shuttle operations on a per-seat basis rather than selling charters to a single client," explained Jeff Reis, a consultant who assisted Carter in setting up MemberJets. "Previously it wasn't possible to do that, so MemberJets becomes the indirect air carrier using the service of these operators."

The two assembled a team to compose a software suite allowing operators to be inserted into a system for on-demand charters and advertise scheduled routes on a per-seat basis. Tapping into the shared economy, a second feature enables individual customers to crowd-source flights to destinations of their choice. "It allows indirect carriers to hold themselves out to offer scheduled air travel on a per-seat basis, an important distinction between a Part 121 air carrier that does it directly," Reis said.


BLISS JET

Typical interior treatment of a Gulfsteam operated on behalf of Bliss Jet's LaGuardia-Stansted serice for $9,995 per seat one way.

The company currently has eight Part 135 operators on the platform, collectively representing 150 business jets. Carter identified half of the operator group as International Jet and Mountain Aviation, both of Denver; Kansas City Aviation Center, Kansas City, Missouri; and Jet Linx, Omaha, Nebraska.

"We vet them all for safety compliance based on Wyvern and Argus [audits] and through Greg Feith, a former NTSB investigator who assists in safety compliance," he said. "Under Part 380, you have to float a bond, hold all fares and related money in escrow, and post a notice of all flights to the DOT." (See Part 1, *BCA,* April, page 52.)

Meanwhile, members sign up with the program and pay a $250 annual fee, allowing them access to the marketplace and flights posted in the system. "You log onto the platform, which is mobile friendly," Carter said. Four types of flights are listed: scheduled with origins and destinations, *i.e.,* shuttles, where the customer can book a seat; flights to special events; on-demand charters; and crowd-sourcing, where the traveler can request a flight, and the operator will "build the trip out," with a minimum number of seats that have to be sold. The operator dictates price per seat and minimum seat fulfillment to ensure profitability.

B-to-B Advantages

The concept also focuses on charter brokers, where, according to Reis, most contemporary tools focus on business-to-consumer, that is, "a company trying to directly empower operators to be connected with the travel client or a membership." But the business-to-business link that is missing is "offering a service to the broker who has the client and allowing him or her to purchase individual seats on the aircraft. In the conventional charter model, the broker cannot purchase seats on an airplane, only the entire aircraft. Our platform allows them to purchase individual seats, and MemberJets aggregates the seats and then finds operators who can fly them. From the operator's perspective, they are fulfilling a charter for MemberJets, and from the broker's perspective, they are completing a seat fulfillment through MemberJets' Part 380 certificate."

MemberJets protects its operators' profitability by honoring retail rates for the service, which Carter claimed is unique. "Operators want to get a fair charter price, so MemberJets is allowing the operator to sell the charter at the full retail price. So using an eight-passenger business jet as an example, the individual fare would be one-eighth the retail cost of the charter. The operator doesn't see that — only the overall cost of the charter. Customers receive discounts from operators on every flight because we can provide them [the operators] with the volume to absorb that."

The software platform was in development for two years. "It's an enabling technology," Carter said. "It's about changing how people fly, giving business travelers another option. There are a lot of players in the space, but no one empowers the operators the way we do through our software platform and the ability to access Part 380, enabling them to market their aircraft in a way that

MEMBERJETS

MemberJets founder Ty Carter claims "a passion to share more aviation with more people."

they were unable to do before."

MemberJets currently supports a dozen employees. Offering the service only domestically, as of the end of March, the company had signed more than 200 members while its operator group had performed approximately 130 flights since starting from zero in January.

"We are encouraged by what were seeing from the market," Carter observed. "Everyone is trying to go directly to the consumer, but we are trying to add value to the charter brokering industry and the operators. It pays off with higher utilization for the aircraft, maintains margin and profitability on every flight, and brings in an entirely new user base. We just signed a deal with [executive search firm] ExecRank that will be offering our service to its 10,000 active members and partner companies. This is among a portfolio of services through strategic partnerships we offer our customers."

Pointing out that in 2015, Part 135 revenues totaled $15 billion, while the airline industry showed a net profit of $25 billion, Carter believes this disparity presents "a huge opportunity to expand private aviation and bring the efficiencies of jet travel to a demographic for which it has been previously unattainable. We are trying to alleviate the inefficiencies and hassle of flying on the airlines by offering an alternative that also benefits the operators and brokers. That's the premise of how we're doing it and why we're here — a passion to share more aviation with more people."

'Democratizing' Private Aviation

Alliances between online brokerages/aggregators and operators are all the rage in the crowd-sourced air charter-verse these days, and another one that has received considerable attention in the business press is the XOJET/JetSmarter partnership formed in 2015. In this case, it's like a marriage between two elephants, as XOJET claims to be the third-largest private jet services company in North America behind NetJets and Flexjet and the largest offering on-demand charter, while JetSmarter bills itself as "the world's largest mobile marketplace for private jets."

According to XOJET CEO and Chairman Brad Stewart, the company has "morphed" quite a bit over the past 10 years since its inception when it was primarily a fractional ownership program.

"We define ourselves not by fleet size," he said, "but by the number of clients we serve and broker — 7,000 since inception. Every year we serve about 3,000 to 4,000 and have 1,500 in membership programs."

XOJET's 165 pilots fly the operation's core fleet an average of 45,000 hr. per month, while a separate shuttle operated independently for an unnamed client racks up an additional "several thousand" hours a month. Additionally, XOJET claims it logs several thousand more hours through its on-demand brokerage business. The operation's core fleet, which "floats," consists of 24 Cessna Citation Xs and 17 Bombardier Challenger 300s.

The company's fleet operations headquarters is located in Sacramento, California, at the former McClellan Air Force Base, while executive offices are sited in Brisbane, south of San Francisco, with sales offices in New York and Los Angeles. Employees number between 400 and 500, including pilots. The dedicated shuttle, an FAR Part 125 scheduled operation wholly owned by XOJET, operates six Embraer ERJs throughout the Western U.S., employs 50 pilots and is overseen by its own CEO.

JetSmarter was launched in 2013 by Sergey Petrossov, a Russian émigré raised in Florida, to offer custom charters and sell unused seats and empty legs. Operating out of Fort Lauderdale, the booking company claims it has lowered the cost of entry into private aviation using a software platform based on algorithms, artificial intelligence ("AI") and "mobile distribution" that optimizes inventory to drive down pricing.

Under the partnership, the platform powers an XOJET-branded mobile app allowing XOJET's clients to book charters on the operator's Citations and Challengers. The payoff to JetSmarter is real-time availability of XOJET's aircraft

Xojet 's 165 pilots fly the operation's core fleet an average of 45,000 hr. per month. JetSmarter members have access to the aircraft at discounted rates.

XOJET

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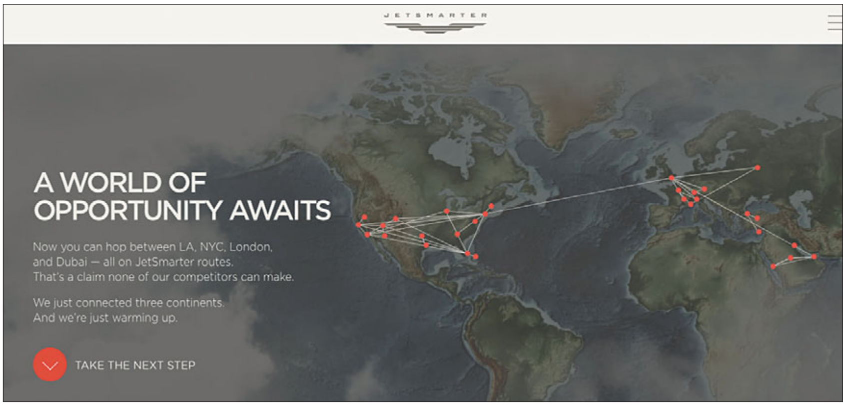

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and discounted pricing equal to XOJET's Preferred and Elite Access programs. Further, XOJET clients are able to book shared charter flights and shuttles by seat and harvest last-minute deals on other operators' aircraft through the branded app portal to JetSmarter's listings.

Memberships in JetSmarter (independent of XOJETS) range from $7,000 to $11,000 per annum (plus a $4,000 initiation fee) and yield a panoply of benefits including cut-rate prices on crowd-shared charters. More than 7,000 members have been signed, and since non-members can use the booking service, as well, sans bennies, Petrossov claims 300,000-plus users have booked flights on his mobile app over the last two years. Since inception, Petrossov has raised $157 million from a variety of investors against a $1.6 billion valuation of his startup.

The JetSmarter mobile app lists three categories of service:

- JetShuttle, or shared private flights, where members can search for and book a seat on a scheduled flight. Routes include New York to Boston, Washington, Atlanta, Chicago, Las Vegas, Miami, Palm Beach, San Francisco, Los Angeles and London.
- JetCharter is perhaps the most creative service. It enables members to initiate and customize their own shuttles, either by chartering a jet for themselves and sharing the cost with their friends, or purchasing individual seats and throwing the subsequent charter onto the JetShuttle page of the app, creating a shared flight available to other

"Embracing Change" in the U.K.

No, we're not talking about Brexit, although it looks like there's going to be lots of change for Brits to embrace when the U.K. abandons the European Union. Here, we're addressing the theme — "Embracing Change" — of the British Business and General Aviation Association's annual conference held in March.

Keynote of the BBGAA gathering was a panel discussion on "new/disruptor markets." One of the speakers was CEO Simon Talling-Smith of California-based SurfAir (see main text) who briefed the conference on SurfAir's impending move into the European market (via a partnership with TAG Aviation to operate its crowd-shared charters) with its short-haul upscale private airline scheme. He claimed that in the California operation, some 85% of the company's 3,000 members came over from riding the major airlines. SurfAir is targeting 5% of the Euro short-haul market, and Talling-Smith speculated that airline users will be willing to pay more for better service "where there is now little difference in the product offering between British Airways and the low-cost carriers."

Refuting concerns about the impact of the so-called "disruptor model," Carol Cork, cofounder and sales/marketing director of British-based private jet broker PrivateFly, said that instead of fomenting a price war with the airlines, the disruptors needed to show corporate travelers the convenience and "affordability" — presumably when compared to first-class fares on the biggies — of using business aviation.

Also addressing the conference was European Business Aviation Association president Brian Humphries, who welcomed the emergence of the disruptors, seeing them not as a threat to the status quo but as harbingers of a new vehicle for bringing more users to business aviation. "We are quite pleased in the extension of the market and making more options available to users," Humphries told *BCA* in a post-conference interview.

"At EBAA, we are about to embark on 'Face to Face,' a public information program like the NBAA's 'No Plane, No Gain,' and one of the themes is freedom of choice," he said. "Whether you want to start off with a single-engine turboprop, a twin turboprop, a light jet or a Gulfstream 650, the more choice people have the better."

Opening More Fields to All-Weather Operations

All this ties in "critically" to establishing LPV (localizer performance with vertical guidance) approaches, or satellite-based navigation, at more British airfields. Humphries sees the confluence of single-engine IFR approval in Europe, the crowd-sharing charter movement and the need for more all-weather airports in the U.K. as potentially a good thing. "We've got the capability here for Cat I to any airfield, but the approval process is very slow and bureaucratic," he said. "But the single engines can get into any airfield, are very well equipped, and some even have synthetic vision. So combining this with LPV could open up a lot of fields to [a new form of] business aviation."

The LPV approach is "perfect," Humphries, who flew business jets for Shell Oil in his earlier career, believes, but the difficulty in obtaining blessings from U.K. CAA for their installation galls him. "LPV is absolutely crucial to access at reliever airports and also to address the capacity crunch, as we are


SURFAIR

SurfAir will have 15 Pilatus PC-12s in its California fleet with an option for 50 more, implying ambitious growth plans.

members.

▶ JetDeals, or exclusive one-ways (i.e., repositioning, or deadhead, inventory) on private jets, where members can book flights to new destination cities on a daily basis.

“One of today’s trends is the ‘democratization’ of private aviation,” XOJET’s Stewart said. “One approach is private airlines like SurfAir and another is the digital brokerage: plane sharing and booking full charters via a digital app. JetSmarter is positioned to be the winner in that second vertical. We entered into a five-year partnership where they are our exclusive distribution channel. On top of that, they purchase repositioning inventory from us for their clients.”

JetSmarter is the fastest growing charter brokerage in the U.S., Stewart pointed out, “offering many benefits to their customers. We are exclusive to them in terms of distribution, but they are also using other fleets — for example, Delta Private Jets, Jet Suite, Travel Management Company and Jet Edge. They specialize in repositioning inventory, shared shuttles and digital brokerage of whole aircraft. Ride sharing saves money. Customers get the same pricing our retail clients get.”

The ‘Anti-Airline’

And speaking of SurfAir . . . this Los Angeles-based private airline was founded during 2012 and 2013 by Wade Eyerly, a frequent traveler whom it is claimed developed it in response to the “pain points” of commercial aviation. “He put a team together to use business aviation

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short of all-weather airfields. People are flying non-precision approaches to get into them, and these procedures are known to kill people. So if we can have more precision approaches, not only do they improve capacity, they also improve safety — so it’s a win-win solution.”

So important is this to business aviation — it addresses access, after all — the EBAA has ranked it as its No. 1 issue in aviation strategy. “We’ve signed an MOU with the GNSS satellite control people and are working with the directorate to prosecute it and identify the airports where we most want to have LPV approaches.”

Today, “if we’re lucky,” Humphries pointed out, there are 500 business jet movements a year at Heathrow (EGLL), whereas 20 years ago, the total was 22,000, “so the hubs are simply not available to us.” But at London-Luton Airport (EGGW), business aviation represents 24% of the traffic. “Everyone recognizes the capacity crunch,” Humphries said, “so keep the mixed-mode airport like Luton, but make greater use of the underutilized airports for all-weather operations.”

The EBAA has conducted a “perception study” of what the rule-makers at the European Aviation Safety Agency (EASA) think of business aviation, and Humphries revealed that the outcome was better than expected. However, the regulators:

▶ Generally questioned that business aviation genuinely provides connectivity, “that is, whether we really are connecting the long, thin routes.”

▶ Cited business aviation’s impact on the environment, “even though we represent only 7% of the traffic.”

▶ Generally view business aviation as elitist and not extending downward, “and that addresses the connectivity issue.”

So the Face-to-Face information program is important, Humphries maintains. “We have to make sure we have the right reputation to bring people in. We have to show we are an important part of the infrastructure. We have the budget set for the program and have a contractor lined up, and it will run for five years, focusing on policymakers, young people and potential users. It’s about growing the market — there are a lot of people out there who could use business aviation but don’t due to the perception that it’s not affordable. So the new platforms [like SurfAir, et al.] can all help to grow this market.”

Business Sense

The BBGAA and the EBAA have “gotten closer together with a merging of membership such that if you’re a member of one you’re a member of the other,” Humphries said, “so we are working closely on U.K. issues and European issues.” [How the U.K.’s exit from the EU, with its implied animosity toward the Continent, will affect this remains to be seen. — Ed.]

But are the new web-based charter platforms going to work in the heavily regulated Euro environment? “Yes, but more work needs to be done,” Humphries answered. “In terms of making people think they can afford business aviation, we are also working on a ‘business sense’ tool like the NBAA’s ‘TravelSense,’ which could be useful in helping people make the best decision for a particular travel situation. It targets image, access and choice — and the dreadful experience now of flying on the airlines. The growth of business aviation averaged 4% over the last four months, the first time since 2008 that we’ve had four consecutive months of growth.” **BCA** in a shared-use model,” Jim Sullivan, SurfAir’s senior vice president for operations, said. The start-up inaugurated in-state operations in June 2013, servicing Burbank, Santa Barbara and San Carlos markets. Today, SurfAir serves 13 destinations, all in California, from an operations center at Hawthorne that houses dispatch, operations and maintenance functions. “We operate under a provision in FAR Part 135 for commuter airlines operating aircraft of nine passenger seats or less,” Sullivan explained.

What distinguishes SurfAir from its commercial airline competition, Sullivan claimed, “is that we operate on a point-to-point schedule between FBOs. So you show up, and we take you to your destination on a schedule, sharing the flight with seven other folks on a Pilatus PC-12 turboprop. That, combined with the way we market it, is a one-price membership club: You pay one fee per month and have access to the scheduled flights — you are not assessed a fare, just the monthly membership fee.” SurfAir markets three levels of membership: $1,950, $2,450 and $2,950 per month.

Using the entry level as an example, the customer receives two reservations to use at any given time during the month; as the price point goes up, the customer is accorded more reservations up to a maximum of eight. “You can use them over and over through the month, but you can’t hold more than two, or whatever level you’ve purchased,” Sullivan said. “In understanding this, think of Netflix, where you can’t hold more than three DVDs at a time.”

The company operates about 65 flights a day Monday through Friday. “We are the anti-airline in that we fly mostly during the work week,” Sullivan said, “with only a handful of flights on the weekends.” The founders reportedly chose the PC-12 because of its quality, robustness and economics.

According to Sullivan, “It’s very comfortable for the customer, has state-of-the-art avionics, and is easy to maintain and own. Currently, we have a fleet of 12 leased aircraft — in other words, owned by the company and leased back under a sale/leaseback scheme.” The company’s initial order with Pilatus was for 15 aircraft, with three more expected this year. Upon delivery, SurfAir will then exercise an option with Pilatus for 50 more aircraft, implying a robust growth plan.

Strictly an intrastate airline at this time, Sullivan confirmed SurfAir anticipates filing for DOT economic authority to become an interstate air carrier. “So expansion is in the future. We’ve talked publicly about extending the route structure to Nevada and Arizona. Our sweet spot is 90 min. or less [with the PC-12], but we can stretch it out to 2.5 hr., or 350 sm. Part of the model is that you need to produce seats during the peak times of the day, so if you’re tying the airplane up for 2.5 hr., you can’t produce more seats. It’s a fairly short-haul model. We are constantly looking at other platforms [*i.e.,* aircraft].” Demand tends to be “very peaky,” Sullivan explained. “It’s 90% business travel, so

Glut of Used Aircraft Could Feed New Charter Concepts

The flow of relatively young, high-time business jets exiting the fleets of fractional ownership companies could allow whole ownership for first-time buyers while supporting a vigorous charter business that could nearly cover the cost of ownership.

So maintains business aviation consultant Mike Riegel of Aviation IQ in Carson City, Nevada. Ten years ago, Riegel and his consultancy began seeing “good used aircraft with attractive prices” being shed by fractional ownership operations and ripe for purchase. He began brokering deals for whole ownership that included leasebacks to commercial operators and even some fractional providers to assist new owners in covering the costs of their own flying.

“These are used aircraft, 10 to 15 years old, purchased in an agreement where you’re leasing hours to commercial operators and fractional ownership companies,” he elaborated. “It’s a popular option and completely legal. You can put a lot of hours on the aircraft — up to 100 hr. a month on charter — and actually cover the owner’s costs.”

As an example, Riegel cited one client who purchased a 12-year-old Bombardier Challenger 300 for $6.95 million, refurbished the cabin and arranged a leaseback with an FAR Part 135 company that guaranteed charter utilization on the aircraft of 40 hr. a month. That covered the customer’s own utilization of 100-200 hr. a year, bringing operating cost down to $3,000 an hour, according to Riegel.

“That particular aircraft type was designed for high-utilization fractional ownership, and even in used condition, the maintainability and reliability is as good as a new one,” he said. “You can get the utilization up and over 600 hr. a year with this aircraft.”

“Used aircraft values are dropping at incredible rates,” Riegel continued, “and when you plug into modern designs like the Challenger 300 and 605, the Lear 45, Cessna Sovereigns, and so forth, with low operating costs and good reliability, hourly operating costs are a fraction of what they would be with a new aircraft.”

He also said relatively low time, 10-year-old models “are terrific values — the Falcon 7X, G550, Globals, and so forth.” Many are half that age with less than 1,200 hr. total time.

Then there is what Riegel terms the “ghost inventory,” aircraft not listed for sale but for which there might be a “tell” that “the owner needs cash, that there’s recoursed financing, that the owner’s waiting for the book value to match the market value, and so forth. He said he’s “identified 1,000 aircraft that fell into this category” and they are likely candidates for the charter/leaseback scheme.

“The important point here is that I don’t believe that the used inventory will see a wholesale recovery,” he speculated. “The changes we have seen are structural because the fractional industry will be periodically purchasing hundreds of new aircraft that eventually will be dumped into the market. The last 10 years should have taught us that the market cannot absorb that number of used airplanes. They’re lowering values on a wholesale basis.” **BCA** the demand is in the early mornings and evenings.”

Replicating Private Aviation

Under the SurfAir business model, the company strives to offer the “private aviation experience” and is constantly studying airplanes that could fit that template and price point. While the traditional airline model is to cram as many seats into the airplane as possible to reap the highest number of fares, surprisingly, Sullivan claims SurfAir actually doesn’t want its aircraft to be full in order to give its members the “private aviation feel” and flexibility to get onto a flight on short notice. Average load factor is 60%.

“So we are always looking for business-type aircraft with not too many seats, something we can operate from an FBO rather than a passenger terminal.” FBOs used include Atlantic Aviation, Signature and Jet Center LA. At Santa Barbara and San Carlos, SurfAir uses its own facilities and is supported on the ramps by, respectively, Atlantic and Rabbit Aviation.

While SurfAir currently operates under Part 135, Sullivan emphasized that the company views it “as the floor rather than the standard. We operate to a Part 121 standard wherever it is practical, so we adopt the best practices for safety because 121 promotes the highest level of safety.” The company’s Hawthorne dispatch center is staffed with licensed dispatchers and duty managers to process flight releases and conduct dispatch functions and flight following.

“We file and fly IFR, always with two pilots, and our captains are all ATP-certificated even though Part 135 doesn’t require that for this class of airplane,” he said. “Additionally, we do full-flight Level D simulator training at FlightSafety International’s DFW facility in the only Pilatus PC-12 full-motion-base simulator in the country.”

Total employees number a little over 200, 70 of whom are pilots. The company reports having signed just under 3,000 members in the program, up from a few hundred at startup. “We are close to breaking even and will be profitable shortly,” Sullivan said. “We do a little on-demand charter for the members who request it. We fly the aircraft an average of 200 hr. a month, so there is not a lot of room for on-demand work.”

Earlier this year, SurfAir management announced a European program in partnership with TAG Aviation and has advertised it on its website. “While the E.U. has approved single-engine turbines for IFR night ops, there is a jet product there at a longer stage length and higher price point,” Sullivan said, “however, we have not made a fleet decision on Europe at this time.” One thing that has been decided is that the Euro operation will be set up as a separate endeavor under the umbrella of a holding company.

“We believe this brand and model has a worldwide potential,” Sullivan said, “as there are a lot of city pairs with the right stage lengths. I expect we’ll see something emerge in the second or third quarter of 2017.”

What *BCA* has described here is just the beginning. Alternative, disruptive business aviation charter options are popping up everywhere, exploiting obscure corners of the regulations and challenging the status quo. It’s a new web-driven world that may totally recast private air transportation. Fasten your seat belts, raise your tray tables to their full and upright position . . . and hang on. **BCA**

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BY **MAL GORMLEY** mgormley@gmail.com

According to the Aircraft Electronics Association's (AEA) year-end market report, total worldwide business and general aviation electronics sales for 2016 amounted to some $2.2 billion, which was down 6.4% from 2015 figures. That was the lowest annual total since 2012, the first year the association began tracking sales. A little more than half of last year's billings came from "forward fit," that is installations in new production aircraft. And new aircraft deliveries were down in every category with the exception of an ever-so-slight uptick in turboprops.

By contrast, avionics retrofit sales reached new heights in 2016, continuing a positive four-year trend. Roughly two-thirds of all avionics were sold in North America.

So, although overall sales of new business and general aviation aircraft are soft, operators are finding plenty of new technology reasons to retrofit their fleets. The following summary of news and developments among avionics manufacturers provides a surfeit of examples of why this is so.

Aspen Avionics

Albuquerque, New Mexico-based Aspen Avionics has earned a supplemental type certificate (STC) to interface its Evolution primary and multifunction displays (PFDs and MFDs) with Garmin's GTX 345 all-in-one transponder. Installing the GTX 345 with an Aspen EFD1000 PFD will allow aircraft owners to take full advantage of viewing ADS-B weather and traffic information directly in their line of sight, which is a good thing.

The 1090 MHz ADS-B Out feature provides users with access to dual-band ADS-B In traffic and subscription-free weather on Aspen Avionics' PFDs and MFDs, and combines a Mode S Extended Squitter (ES) transponder with an optional WAAS/GPS position source. The $795 upgrade can be installed by any Aspen Avionics authorized dealer.

Aspen has also earned certification to interface its Evolution 1000 Pro PFD with the System 55X autopilot by Genesys Aerosystems. The STC will cover hundreds of light-single and twin-piston aircraft. When installed, multiple altimeter setting adjustments are no longer required. The upgrade replaces separate monochrome displays, push buttons and panel knobs with a full-color display directly in the pilot's line of sight, saves panel space and can provide smooth, automatic level-offs with no altitude overshoot — just set the desired vertical speed and altitude on the PFD.

Integrating the System 55X autopilot with Aspen displays requires a software unlock and Analog Converter Unit 2 (ACU2). The software unlock is priced at $1,995 for customers who already have an ACU2 installed. For those customers who require the unit, bundled pricing for the ACU2 and System 55X unlock is $2,995.

Astronautics Corporation

Last year, the FAA selected Astronautics Corporation of America to research and develop a comprehensive approach to identify and assess potential cybersecurity threats as they relate to aircraft certification and continued operational

Astronautics Roadrunner

safety. The contract covers research to improve ways to identify and resolve such cyberthreats.

The project will include the development of an efficient process that identifies system security vulnerabilities and safety risks, including risk-mitigation information. The researched approach will support the FAA's development of aviation policies, regulations and training requirements to ensure flight safety and secure aircraft network systems from cyberattacks.

Astronautics will adapt its preexisting cybersecurity processes to support the implementation of the FAA aircraft system information security/protection and safety risk assessment (SRA) framework. That framework will then be used to model aircraft communications addressing and reporting systems (ACARS), a digital data-link for transmission of short messages between aircraft and ground stations via air-band radio or satellite.

All work will be performed at the Astronautics headquarters in Milwaukee, using systems and software engineers from the current cyber team and in-house development and cybersecurity labs.

As part of the process, Astronautics will collaborate with the FAA, FAA-designated organizations, and aviation and information security partners with whom the company has established relationships.

The company's product areas include electronic PFDs, engine displays, mission computers, electronic flight bags (EFBs) and servers for airborne applications.

Astronics Max-Viz

East Aurora, New York-based Astronics Corp., through its subsidiary Astronics Max-Viz, recently announced that its Max-Viz 1200 EVS (enhanced vision system) for fixed- and rotary-wing aircraft has been certified to DO-160G environmental testing standards by the Radio Technical Commission for Aeronautics (RTCA).

The solid-state $9,000 Max-Viz 1200 EVS requires no routine maintenance and features a low-power, uncooled thermal camera. The sensor image can be presented on any video-capable display that accepts composite video (RS-170) NTSC or PAL/analog signals. The 1.2-lb. unit is compatible with a variety of display systems including Garmin's G500, 600 and 1000; Avidyne's R9; Bendix King's KMD-850; AvMap's EKP-V; Flight Displays' Flipper; various Rosen monitors; and EFBs.

Astronics Max-Viz 1200 EVS

With its infrared enhanced-vision thermal imaging system, the EVS enables pilots to see when flying day or night in smoke, haze and light fog. The EVS can work as an alternative to, or in tandem with, light-based night-vision goggle (NVG) technologies.

The Max-Viz 1200 EVS complements synthetic-vision displays, allowing pilots to see transient obstructions, like wildlife and construction barriers not in synthetic-vision databases. The system gives real-time confirmation of the operating environment, as well as supporting the approach-to-landing transition from IFR to VFR in marginal visual conditions. Astronics Max-Viz is an EVS supplier to aircraft manufacturers and to the retrofit market with over 40 STCs in fixed- and rotary-wing aircraft.

Avidyne

Melbourne, Florida-based Avidyne has been granted an Approved Model List-Supplemental Type Certificate (AML-STC) for its new IFD550 Navigator with integrated Attitude Reference Sensor (ARS).

The certification also includes FAA approval of Release 10.2 software that includes a host of new features including synthetic vision and two-way wireless connectivity with Avidyne's new IFD100 iPad app. Avidyne has also received approval for its new IFD545, IFD510 and IFD410 FMS/GPS systems.

The IFD550 is a full-featured FMS/GPS/Nav/Com with all the same functionality of Avidyne's current IFD540 but with the addition of an integrated ARS. This detects pitch-and-roll motion and enables the display of dynamic synthetic vision with full-motion 3-D "out-the-window" views as well as exocentric "in-trail" views of the aircraft and nearby terrain, obstacles and traffic. The IFD550 also gives pilots the ability to toggle synthetic vision off and view a traditional blue-over-brown attitude display, as well as an overlay of horizontal and vertical deviation indicators, a total velocity vector (TVV)/flight path marker, and adjustable field of regard. The IFD550 has a list price starting at $21,999.

Avidyne's Release 10.2 software is available as a field-loadable upgrade for existing IFD540 and IFD440 systems, giving these customers the ability to display synthetic vision views of the host aircraft, along with overlay of flight-plan, color-contoured terrain, obstacles, full-color 3-D traffic and terrain warnings. R10.2 also includes two-way wireless connection to Avidyne's IFD100 iPad app, wireless flight-plan transfer into the IFD, non-TSO TAWS functionality and support for European VFR (Bottlang) charts. In addition, it enables a 16-watt power output option on the IFD440, incorporates improvements to Australian Published Holds, orbit-around-a-point circular holds, software enablement for the RDR2000 radar display on the IFD 5-Series, and more.

Avidyne IFD550

All new-production IFD 5-series and 4-series models are available now and will begin shipping immediately with R10.2 functionality. The 10.2 software upgrade for existing IFD540 and IFD440 units is available for download directly from the Avidyne website at no charge. Optionally, the software is available on a USB memory stick for $150 from Avidyne. Costs do not include dealer labor to upgrade existing systems. Pricing for IFD models with synthetic vision starts at $9,499.

Esterline CMC Electronics

Esterline Corp.'s latest cockpit avionics displays include a new overhead panel with touch-screen technology for the Gulfstream G500/G600 — the first of its kind— as well as Mason primary and secondary flight controls.

The Montreal-based company's utility control system touch-screen display technology is part of the Korry line of cockpit controls and displays, and is the first touch-screen control for overhead panels in civilian aviation. It replaces a number of separate display and switching components, while increasing flexibility and reliability. After pioneering this application for the business jet market, Esterline is making the technology available in a format easily adapted to a wider range of aircraft.

Meanwhile, Esterline's new CMA-6024 GPS sensor is a satellite-based augmentation system and ground-based augmentation system (SBAS/GBAS) CAT-I/II/III precision approach system. The sensor is an upgrade to the existing CMA-5024, with an embedded VHF data broadcast (VDB) receiver. It is also fully compliant with ADS-B and required navigation performance (RNP).

Moreover, according to CMC, the CMA-6024 is a plug-and-play, standalone unit requiring no specialized installation or integration support. It's available for forward-fit installation or as a retrofit, occupying the same space as the CMA-5024 it replaces.

The company's new PilotView CMA-1310 EFB and compact CMA-1525 aircraft information server work with CMC's new CMA-1310 or other tablets to secure connectivity with aircraft systems and wireless and satcom aircraft-ground communications. It's a tool that bridges the aircraft and the outside world.

The PilotView is offered as a standard option on the Bombardier Challenger 600 series; Dassault Falcon 900, 2000, 7X and 8X; Embraer Legacy 600/650; and Boeing Next-Generation 737s and BBJs.

FreeFlight Systems

CMD Flight Solutions, an engineering and certification company, recently obtained European Aviation Safety Agency (EASA) validation of FreeFlight Systems' AML-STC for the integration of the Waco, Texas, manufacturer's 1203C SBAS/GNSS sensor paired with Rockwell Collins TDR-94/94D transponders. The pairing is a cost-effective way to help aircraft owners meet any ADS-B mandate worldwide.

Freeflight AML-STC

Meanwhile, Signature TECHNICAir has purchased FreeFlight's ADS-B STC for turboprops for ADS-B compliance on Beechcraft King Air C90 models. This transfer of ownership will allow TECHNICAir to modify and enhance the STC to meet the diverse needs of the King Air fleet while also expanding the offering to include the light jet market. The STC provides a fully compliant ADS-B solution to C90 operators.

Garmin G500H

Garmin International

The G1000 NXi, Garmin's successor to its popular G1000 integrated flight deck, features wireless cockpit connectivity, wireless aviation database updates using Garmin Flight Stream, enhanced situational awareness with SurfaceWatch, visual approaches and map overlay on the horizontal situation indicator (HSI). The FAA has granted STC approval for the G1000 NXi in the King Air 200 and 300/350. EASA approval is expected later this year.

Building on the G1000's success — some 16,000 are in use worldwide — the G1000 NXi is a faster, modernized and lighter avionics suite with expanded capabilities.

On the surface, the G1000 NXi's physical enhancements and display advancements incorporate faster processing power to support faster map rendering and smoother panning throughout the displays. The Olathe, Kansas, manufacturer says the displays initialize within seconds after start-up, providing immediate access to frequencies, flight-plan data and more. The system also incorporates contemporary animations and modernized design for improved readability. New LED backlighting increases display brightness and clarity, reduces power consumption and has improved dimming performance.

Garmin's Connext wireless cockpit connectivity unlocks more capabilities. Available as an option, Flight Stream 510 enables Database Concierge, the wireless transfer of aviation databases from the Garmin Pilot app on a mobile device to the G1000 NXi system. Flight Stream 510 also supports two-way flight

Garmin 5000 in Citation Longitude

Garmin G1000 NXi Hero

plan transfer — the sharing of traffic, weather, GPS information, backup attitude information and more — between the G1000 NXi and compatible mobile devices running Garmin Pilot or ForeFlight mobile. Garmin's D2 Bravo and D2 Bravo Titanium aviator watches even sync with the app.

G1000 NXi equipped-aircraft are rule-compliant to meet FAA and EASA ADS-B requirements. The G1000 NXi also supports the display of various ADS-B In benefits, including traffic and subscription-free weather. FIS-B weather products include: NEXRAD, METARs, TAFs, PIREPs, winds, temps, NOTAMs, AIRMETs and SIGMETs, as well as exclusive traffic features such as Garmin's patented TargetTrend and TerminalTraffic features, and many more.

For new installations, the G1000 NXi is estimated to provide a weight savings of 250 lb. or more in King Air aircraft. New G1000 NXi installations also utilize a new, fully integrated and lightweight air data and attitude heading reference system (ADAHRS), streamlining the upgrade process. Garmin reports that King Air operators with an existing G1000 system can upgrade to the G1000 NXi with minimal aircraft downtime and disruption of the panel as the displays preserve the same footprint and connector, so panel modifications are not required. New G1000 NXi installations and display upgrades all come with a two-year warranty.

Genesys Aerosystems

MD Helicopters has selected Genesys' Integrated Display Units (IDUs) for three of its new helicopter models, the MD 902 Explorer, the MD 530G Scout Attack Helicopter and the all-new MD 6XX concept aircraft.

Genesys IDU 680 (left) and IDU450 PFD (below)

Meanwhile, the Mineral Wells, Texas, avionics manufacturer also joined with its Russian distributor, Heliatica, to announce validation by the Aviation Register of the Russian Federation for its FAA STC to install the Genesys HeliSAS stability augmentation system and autopilot onboard the Robinson Helicopter R44 and R66, and the Airbus Helicopters H125 family.

In addition to that validation, Heliatica also announced that it had recently completed the first HeliSAS installation on an Airbus H1300 helicopter. This work was done in cooperation with Heliswiss Iberica, a maintenance provider based in Barcelona, Spain, and a Genesys Aerosystems authorized distributor and service center.

Meanwhile, customers who purchase a new Genesys Aerosystems S-TEC 2100 digital flight control system by June 30, 2017, will receive a free (installation separate) Lynx NGT-9000 ADS-B transponder as well. The limited-time offer is meant to encourage twin-piston and turboprop aircraft owners to upgrade to an advanced digital autopilot and meet the upcoming ADS-B mandate at the same time.

Popular with operators of high-performance twins and turboprops, the S-TEC 2100's features include a solid-state three-axis digital flight control system, control wheel steering, IAS hold, GPS steering, heading preselect and hold PFD integration, altitude preselect and hold with autotrim.

The Lynx NGT-9000 touch-screen 1090ES/ADS-B transponder's features include a 978/1090 MHz dual-band receiver, L3 Lynx Tail patented flight ID, aircraft type and ground speed of other ADS-B traffic, a full-color, resistive touch-screen interface, full-color moving maps including TFRs, airports and NOTAMs, full-color graphical and textual weather displays, and a built-in WAAS/GPS requiring no external GPS connections. An embedded NextGen Active Traffic option eliminates the need for a separate box.

Honeywell Aerospace

Operators of several major business jet types will soon have an opportunity to replace outdated Laseref II and III navigation systems with the all-digital Laseref IV ring laser gyro-based inertial reference system (IRS).

This is significant because Honeywell will soon be ending aftermarket product support for Laseref II and III, both of

Honeywell Primus Epic in Gulfstream G500

which have been out of production for several years.

Aircraft eligible for the upgrade include the Hawker 800, 800XP and 1000; Bombardier Challenger 600, 601-3A/-3R and Global Express; Cessna Citation X; Dassault Falcon 900A/B/C/EX; and Gulfstream GIV and GV.

The Phoenix manufacturer estimates that, depending on the platform, the upgrade will reduce aircraft weight by 25-75 lb. and mean time between failures (MTBFs) will show a 30% increase, thanks to Laseref IV's demonstrated 30,000 hr. This is the fourth-generation ring laser gyro-based IRS in the lightest 4 MCU rack-mountable package. Pricing for the replacement will be announced in the near future.

Meanwhile, the new Cessna Citation Hemisphere large-cabin business jet will feature Honeywell's Primus Epic integrated cockpit system. Honeywell says its transoceanic FMS, including SmartView for lower minimums, and precision inertial reference sensors should enable Hemisphere operators to reach destinations at reduced costs. In addition, the system will provide pilots with a conformal 3-D view of the outside world to improve situational awareness in any weather. And Honeywell's Connected Aircraft feature includes satcom connectivity as well as cockpit, cabin, and maintenance apps and services.

Other Primus Epic features for the Hemisphere include a SmartView synthetic vision system (SVS), IntuVue volumetric weather radar, airport 2-D and 3-D moving maps integrated with SmartView SVS for an "out-the-window, gate-to-gate" view of the airport, RNP, advanced LED large-format, high-resolution displays, touch-screen controls, and Aspire 300 satellite communications enabling simultaneous cockpit voice and data connectivity via the Iridium satellite system for safety services.

Optional JetWave cabin satellite communications deliver high-bandwidth global connectivity for passengers.

And Honeywell is offering the latest cockpit safety technologies to Gulfstream operators to modernize their aircraft and enhance safety. STCs for enhanced features were recently received from the FAA for Gulfstream PlaneDeck cockpits on the GIV and GV. The latest suite of upgrades will increase crew situational awareness through the integration of synthetic vision with charts and maps, video capability and the XM ground-based weather displayed on PlaneDeck LCDs.

The suite of upgrades also adds TCAS symbology and XM weather information to PlaneDeck SV's enhanced moving map display as an additional overlay improving the flight crew's situational awareness. The Gulfstream GIV and GV join the GIV-SP, which was certified earlier, to be eligible for the latest cockpit upgrades.

L3 Technologies

To better reflect the company's breadth of offerings and scale, L-3 Communications has changed its name to L3 Technologies Inc. As part of its name change, L3 changed its email and website to **http://www.L3T.com**

Headquartered in New York City, L3 employs some 38,000 people worldwide as a provider of communication and electronic systems and products used on military, homeland security and commercial platforms. The company is also a prime contractor in aerospace systems, security and detection systems, and pilot training. L3 reported 2015 sales of $10.5 billion.

L3 ACCS NXT

Meanwhile, ACSS, an L3 and Thales company, has developed the NXT-700, an ADS-B transponder for legacy corporate aircraft. This next-generation Mode S transponder will satisfy the DO-260B mandate for ADS-B on many legacy aircraft models. ACSS says it will reduce owner/operator costs, as well as downtime, because it is a 1/4 ATR short form-fit installation.

The NXT-700 is designed for use on the following legacy aircraft models: Hawker 125-400, -600 and -700, and Beechcraft Hawker 400 SP/Beechjet; Bombardier CL-601-3A and 3R; Cessna CitationJet, Ultra, V, VII and 550; Dassault Falcon 10, 20, 50, 200, 900 and 900B; Gulfstream IIB, III and V; IAI Westwind 1124; and Learjet 35, 35A, 36 and 36A.

The transponder's configuration is compatible with current retrofit TCAS II 7.1 systems and may be able to leverage the aircraft's existing mounting rack and connectors for quick installation. Since no additional control heads are needed, the cockpit configuration will remain the same.

Rockwell Collins

The Cedar Rapids, Iowa-based manufacturer reports a number of recent Pro Line Fusion-related developments, including FAA certification for upgrades to King Air B200 and 350, and Citation CJ3 cockpits.

The King Air B200 series upgrade provides turnkey compliance with airspace modernization deadlines and transforms the panel with the first touch-screen PFD to be certified for operational use, as well as the largest widescreen PFDs available. Rockwell Collins is promoting the upgrade as enhancing aircraft since it involves the same icon-based, touch-screen technology found on new-production King Airs.

Rockwell Collins Pro Line Fusion for B200

The avionics upgrade for King Air 350s has been expanded to include Rockwell Collins FMS navigation database updates and coverage under its Corporate Aircraft Service Program (CASP) at no additional charge for three years. Pro Line Fusion is designed to be easily updated with software upgrades, and to accommodate future technology enhancements, including the company's HGS-3500 head-up guidance system, EVS-3000 EVS and airport moving map.

Pro Line Fusion made its flying debut on the Citation CJ3 last August

Rockwell Collins Citation CJ3 flight deck

following implementation of the system in conjunction with Duncan Aviation. That upgrade also provides turnkey compliance with airspace modernization deadlines and transforms the panel with widescreen displays, high-resolution synthetic vision and touch-screen navigation.

The upgrades are FAA-certified and EASA-validated, and include ADS-B Out, synthetic vision, an updated FMS with localizer performance and approach procedures with vertical guidance (LPV/APV) and radius-to-fix (RF) legs, and the latest version of the Integrated Flight Information System (IFIS). Similar Pro Line 21 upgrade packages are in development for numerous other aircraft types, including Hawkers, Premiers and more.

Keys component of the Pro Line Fusion avionics system are the HGS-3500, the industry's first HGS developed for midsize and light business aircraft, and multi-spectral EVS-3000, which were certified on the Embraer Legacy 450 and Legacy 500 executive jets — the first such certification for both technologies. The systems bring transformative flight deck technology to the business aviation market segment to enhance pilot situational awareness and increased safety.

The HGS-3500 is designed with waveguide optics that couple with the Legacy 450's and 500's Pro Line Fusion avionics system. It comes standard with synthetic vision for even greater situational awareness, and can be upgraded with an enhanced vision option, enabled through the EVS-3000.

The manufacturer maintains that having synthetic and enhanced vision on the HGS sets the stage for a combined head-up vision system in the future, which will make for a full-time, augmented view of the outside world for enhanced situational awareness and approval for lower operating minima.

Universal Avionics

In an effort to help operators equip their aircraft for the FAA's NextGen mandate, Universal Avionics is extending three of its pricing incentive programs that had been set to expire at the end of 2016. The company's ADS-B Out incentive package program, and the SBAS-FMS upgrade incentive program for the Learjet 40/45/40XR/45XR and Citation Excel/XLS are now available through Dec. 31, 2017.

The ADS-B Out Incentive Package pairs Universal's SBAS-FMS with the Rockwell Collins TDR-94(D) Mode S transponder to meet the upcoming NextGen ADS-B Out mandate. Unlike other standalone solutions, Universal's solution includes a TSO C146c-certified FMS, allowing operators to gain LPV as well as provide the necessary sensor requirements to meet data-link mandates like FANS 1/A+, Link 2000+ and FAA Data Comm. The Tucson, Arizona, manufacturer says it has taken a "building-block" approach to meeting mandates while adding real, long-term value to the aircraft.

Universal family ADS-B

Universal Avionics forward-fit FMSes have been featured on Learjets for over 30 years and Citations for more than two decades. Now, those aircraft operators can trade-in their existing FMS for a significant credit toward the purchase of a new, advanced capability SBAS-FMS. SBAS approach procedures like LPV offer several benefits over traditional GPS or ILS procedures.

The NextGen SBAS-FMS upgrade incentive program provides trade-in credit for competitor FMS or GPS systems, and the technology is the foundation for PBN requirements and ADS-B Out compliance.

On the Horizon

Avionics sales may be off temporarily, but avionics makers continue to advance the art and science of their products. The capabilities of near- and long-term forthcoming avionics underscore breakthrough advances in technology. Some examples:

▶ Rockwell Collins sees combined synthetic-infrared vision, blending weather information, personalized information displays, voice recognition, even pilot posture recognition as almost foregone conclusions.

▶ The NTSB is examining which of the many parameters recorded by flight recorders might most usefully be streamed back via satellite to ATC and flight operations.

▶ Teledyne Controls and GE Aviation have signed a strategic partnership that should simplify the flow of flight data off aircraft, and expand its value through GE's cloud-based platform.

▶ EFBs are beginning to offer real-time updates of operational information.

▶ Thales sees the convergence of big data, machine learning and connectivity in industry on the near horizon. And there are plenty more examples out there.

As we detailed in last December's special report, "The Internet of Airborne Things," the interrelation and interactivity of the digital cabin, flight deck, service providers and ATC are steadily increasing. Still, all the gee-whizardry must be tempered with the realization that ultimately, the flight crew must be ready to demonstrate fundamental control under any circumstances because the "F" in MTBF is there for a reason. **BCA**

ACJ

Expertise at the right place

Our Service Centre Network*

Comlux America
HAECO Private Jet Solutions
Jet Aviation
Sabena technics
Sepang Aircraft Engineering
ST Aerospace in Singapore

*The ACJ Service Centre Network comes in addition to the Airbus worldwide support network

AIRBUS

VHF PANEL-MOUNT TRANSCEIVERS

Manufacturer	Model	Channels	Power Output (peak W)	Units/Weight (lb.)	Price	Remarks
	TSO	Channel Display	Power Required	Size (in.)		
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GTR 225**	760 w/25 kHz spacing; 2280 w/8.33 kHz spacing	10W or 16W	1/2.30	Not provided by OEM	
	C34e, C36e Class A; C40c, C128a, C169a Class 3, 4, 5, 6, C, E, H1, H2	LCD	9 - 33 V	6.25 x 1.65 x 10.4		
	GNC 255	760 w/25 kHz spacing; 2280 w/8.33 kHz spacing	10W or 16W	1/3.02	Not provided by OEM	
	C37c C38c	LCD	9 - 33 V	6.25 x 1.65 x 10.4		
Honeywell Aerospace BendixKing 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KY 196A**	760	16 nominal	1/3.2	$5,364	Active/standby frequency; stored channels; LED, 28 V.
	C37c C38c	LED	28 VDC	6.3 x 1.35 x 10.8		
	BendixKing KY 197A	760	10 nominal	1/3.2	$5,323	LED, NVM
	C37c C38c	LED; nvm	14 VDC	6.3 x 1.35 x 10.8		
	BendixKing KY 196B	2280	18 nominal	1/3.2	$7.298	Active/standby frequency; stored channels; LED 28 VDC.
	C37c C38c	LED; nvm	28 VDC	6.3 x 1.35 x 10.8		

VHF PANEL-MOUNT TRANSCEIVERS

Manufacturer	Model	Channels	Power Output (peak W)	Units/Weight (lb.)	Price	Remarks
	TSO	Channel Display	Power Required	Size (in.)		
Honeywell Aerospace **BendixKing** 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**						
	BendixKing KX 165-21	760 com; 200 nav	10 nominal	1/5.65	$6,214	Nav/Com/GS/VR/LC CV 14V 760 freq.
	C37b C38c	LCD; non-volitile	28 VDC	6.25 x 2.05 x 10.16		
	BendixKing KX 165A-01	760 com; 200 nav	10 nominal	1/4.0	$5,981	Nav/com, 25 kHz; 28V
	C37d; JTSO-2C37e; C38d; JTSO-2C38e	LCD; non-volitile	28 VDC	6.25 x 2.05 x 10.16		
	BendixKing KX 165A-02	760 com; 200 nav	10 nominal	1/4.0	$6,015	Nav/Com, 25 and 8.33 kHz; 28V
	C37d; JTSO-2C37E; C38d; JTSO-2C38e	LCD; non-volitile	28 VDC	6.25 x 2.05 x 10.16		

VHF REMOTE-MOUNT TRANSCEIVERS

Manufacturer	Model	Frequency Display	Xmit Power (W)	Units/Weight (lb.)	Price	Remarks
	TSO	Frequency Storage		Size or Form Factor	Power Required	
Aspen Avionics 5001 Indian School Rd. NE Albuquerque, NM 87110 (505) 856-5034 Fax: (505) 314-5440 **www.aspenavionics.com**	**ATX100**	978 MHz In/Out	10-40 VDC	0.95 lb.	$3,495	Includes installation kit; single-band; meets ADS-B mandate below 18,000 ft.; ADS-B transceiver provides an ADS-B solution for aircraft equipped with a Mode A/C transponder and a WAAS GPS nav receiver.
	TSO Rule Compliant ADS-B In/Out	—		5.0 x 5.75 x 1.7	—	
	ATX100G	978 MHz In/Out	10-40 VDC	0.95 lb.	N/A	Includes installation kit; single-band; meets ADS-B mandate below 18,000 ft.; ADS-B transceiver provides an ADS-B solution for aircraft equipped with a Mode A/C transponder without a WAAS GPS nav receiver.
	TSO Rule Compliant ADS-B In/Out	—		5.0 x 5.75 x 1.7	—	
Honeywell Aerospace BendixKing Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KTR 908**	gas discharge	20	2/4.3	$16,291	Does not include KFS 598 control head. 152 MHz and SECAL options available.
	C37c C38c	2 (9 channels); 118.0 - 151.975 MHz opt.		1.8 x 5.0 x 11.8	28 VDC	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**VHF-4000**	CTL-22 gas discharge	20	2/4.7	see remarks	Built-in diagnostics; compatible only with CSDB or ARINC 429 controls. Options: 001 baseline: includes CTL-22. 101 adds 8.33: includes CTL-22C. 201 adds Mode A/2 data; includes CTL-22. 301 adds 8.33 and Mode A/2 data: includes CTL-22C. Prices range from $13,976 to $21,892 (*BCA* estimate).
	C37d C38d	8 frequencies; nvm		2.5 MCU	28 VDC	
	VHF-4000E	CTL-22C gas discharge	20	2/4.7	$21,892-$26,264*	Built-in diagnostics; compatible only with CSDB or ARINC 429 controls. Options: 101 adds 118.0-151.975 + 8.33; includes CTL-22C. 301 adds Mode A/2 data; includes CTL-22C. **BCA* estimate.
	C37d C38d	8 frequencies; nvm		2.5 MCU	$21,892-$26,264*	
	VHF-4000 Transceiver	gas discharge	20	24.7	$68,620*	**BCA* estimate.
		8.33/25 kHz		2/5 MCU	N/A	

HF TRANSCEIVERS

Manufacturer	Model	Frequency Range	Xmit Power (W)	Units/Weight (lb.)	Price	Remarks
	TSO	Channels		Size or Form Factor	Power Required	
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.aerospace.honeywell.com**	**HF-1050**	2-29.999	200 PEP (SSB)	4/29.9	$77,680	Delivers 200 W PEP transmitter power and four squelch options. "Once tuned, always tuned" coupler capability provides <20 millisecond response. PS-440 controller provides 99 user-programmable channels, clarifier functional and coupler tune status.
	C31d C32d	280,000		KRX 1053 Receiver/Exciter: 5.56 lb; 10.8 x 3.1 x 5.0 KPA 1052 Power Amplifier: 6.67 lb; 12.7 x 7.2 x 1.8 KAC antenna coupler: 9.87 lb; 13.0 x 4.7 x 9.87	28 VDC	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**HF 9000 System**	2 - 29.9999 SSB/AM AM data	selectable power output 10.50, 175 PEP	3/27.5	$99,980*	Fiberoptic interface; rapid-tune antenna coupler (40 millisecond computer training); BITE. Includes HF receiver/transmitter antenna coupler and radio-tuning unit. *Special order price and delivery.
	C31d C32d	280,000; 99 operator programmable; 176 ITU r/t programmed		controller: 2.625 x 5.75 x 5.85 transceiver: 7.625 x 5.55 x 12.60 antenna coupler: 7.6 x 3.8 x 13.0	28 VDC	

HORIZONTAL SITUATION INDICATORS/COMPASS SYSTEMS

Manufacturer	Model	Gyro	Autopilot Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Slave Rate		Form Factor	Power Required	
Astronautics 4115 N.Teutonia Ave. Milwaukee, WI 53209-6731 (414) 449-4000 **www.astronautics.com**	Roadrunner Electronic Flight Instrument (EFI) /none	see remarks	N/A	1/ 8.0 lb. / 4.65 x 4.98 x 1.65 in. electronics unit, 5.0 x 9.67 x 6.96 in. display head —	— 28 VDC <50 Watts - optional 115 VAC 400 Hz primary power	Provides an upgrade for existing HSI/ADI primary flight instruments. Capable of displaying weather, synthetic vision, terrain awareness and traffic information. interfaces with ARINC 429 input and output, differential analog, discrete interfaces, RS232 (bi-directional), synchro and resolver, direct output for TAWS aural alerts. Options include ARINC 453 and ARINC 568 inputs, and connectors matching legacy instruments. TSO approvals are planned.
	N/A	N/A		N/A	N/A	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GI 106B**	—	14/28V	1/1.4	$2,599	Course deviation indicator (CDI) with needle and glideslope.
	TSO C34e, C36e, C40c	—		3.25/3.25/4.75	—	

HORIZONTAL SITUATION INDICATORS/COMPASS SYSTEMS

Manufacturer	Model	Gyro	Autopilot Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Slave Rate		Form Factor	Power Required	
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602-365-3343 (855) 250-7027 **www.aerospace.honeywell.com**	**KCS 55A Slaved Compass System**	remote/3-deg. per minute	magnetic heading	4/8	$27,937	Includes KG 102A directional gyro, KMT 112 flux valve and KA 51B slaving unit and installation kits.
				3.375 in. x 3.375 in.	14-28 VDC	
	KI 825 Color EHSI/MFD	remote	extensive outputs; GPS selected discretes, EHSI-ready discretes	1/3.0	$17,638	Integrated EHSI, AMLCD; arc mode; 360 mode; course map; interfaces with numerous navigation systems and WX500 Stormscope. Priced for a new installation and a KCM 100.
	C113, C6d, C34e, C36e, C40C, C11a	—		3 ATI	14 - 28 VDC	
Sandel Avionics 2401 Dogwood Way Vista, CA 92081 (877) 726-3357 (760) 727-4900 Fax: (760) 727-4899 **www.sandel.com**	**SN3500 Primary Navigation Display**	remote	N/A	1/2.9	$14,113	3-ATI Primary Navigation Display. Sunlight readable LED backlit display with 180 degree viewing angle and over 10,000 hour MTBF. Combines HSI, RMI, color moving map and other features. Accepts synchro, stepper motor and ARINC 429 gyro inputs. Designed to work with a wide variety of digital and analog NAV, GPS/WAAS, DME, ADF and marker beacon receivers. Built-in LNAV roll-steering interface. Compatible with the WX-500 Stormscope. TACAN interface available. Optional interfaces for traffic ($980), WSI datalink weather ($980), Reversionary Attitude ($980). High-vibration version $17,714. NVIS compatible version $21,895.
	C113, C6d, C34e, C35d, C36e, C40e, C41d, C118, C119B	N/A		3 ATI	11-33 VDC; 33 W	
	SN4500 Primary Navigation Display	remote	analog	1/3.5	$20,950	4-ATI Primary Navigation Display. Sunlight readable LED backlit display with 180 degree viewing angle and over 10,000 hour MTBF. Combines HSI, RMI, color moving map and other features. Accepts synchro, stepper motor and ARINC 429 gyro inputs. Designed to work with a wide variety of digital and analog NAV, GPS/WAAS, DME, ADF and marker beacon receivers. Built-in LNAV roll-steering interface. Compatible with the WX-500 Stormscope. TACAN interface available. Optional interfaces for traffic ($980), WSI datalink weather ($980), Reversionary Attitude ($980). High-vibration version $23,800. NVIS compatible version $27,050.
	C113, C6d, C34e, C36e, C40e, C41D, C118, C119B	N/A		4 ATI	22-33 VDC; 40 W	

AUTOMATIC DIRECTION FINDERS

Manufacturer	Model	Frequencies	Nav Outputs	Units/Weight (lb.)	Price	Remarks
		Frequency Storage				
	TSO	Display		Size or Form Factor	Power Required	
Honeywell Aerospace BendixKing 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**Bendix/King KR 87**	200-1799 kHz	analog	1/6.7 P/M	$5,395	Times flight and approaches; slaved indicator and RMIs available as options. Incudes KA 44B antenna.
		nvm				
	C41c	gas discharge		6.25 x 1.3 x 11.23	11-33 VDC	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**ADF-4000**	190-1799 kHz 2182 kHz emergency freq.	CSDB ARINC 429	3/6.4	$18,272*	Built-in diagnostics; compatible only with CSDB or ARINC 429 controls; digital signal processing; dual antenna optional. Includes ANT-462A. *Dual system, $36,728.
		6 frequencies; nvm				
	C41d	gas discharge		2 MCU	28 VDC	

NAVIGATION RECEIVERS (PANEL- AND REMOTE-MOUNT)

Manufacturer	Model	Channel Display	Nav Outputs	Units/Weight (lb)	Price	Remarks
	TSO	Channel Storage	GS/MB	Size or Form Factor	Power Required	
Honeywell Aerospace BendixKing Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KNR 634A**	gas discharge	ARINC 429 CDI, HSI, RMI	2/6.5	$42,317	Synchro-interface KNI 582 RMI optional. Digital display of active/standby frequencies.
	C40a, C36c, C34c, C35d	2 nav; nvm	—	3.0 x 5.0 x 10.0	28 VDC	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: ((913) 397-8282 **www.garmin.com**	**GNC 255**	LCD	ARINC 429	1/3.02	$4,495	10W or 16W comm and 200 channel nav with VOR/LOC and G/S receiver.
	C34e, C36e Class A; C40c, C128a, C169a Class 3, 4, 5, 6, C, E, H1, H2	Recall of frequency from database by facility name and type. Stores/recalls 15 user defined frequencies. Stores/recalls previous 20 frequencies used	CDI/HSI/EHSI/EFIS	6.25 x 1.65 x 10.4	9 - 33V	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**VIR-4000**	CTL-32 gas discharge	CSDB ARINC 429	2/3.9	See remarks	Special order item and pricing. Combines ADF and VOR/ILS/MKR receivers in a single package. Internal diagnostics capability.
	C34e, C36e, C40c, C35d	6 frequencies; nvm	NA	2.5 MCU	28 VDC	
	NAV-4500	CTL-32 gas discharge	CSDB ARINC 429	2/4.1	$23,560*	Built-in diagnostics; compatible only with CSDB or ARINC 429 controls; digital signal processing; includes CTL-32 ($4,904); meets Eurocontrol FM immunity standards only. RTU 4200, $23,880. **BCA* estimate.
	C34e, C36e, C40c, C35d	6 frequencies; nvm	NA	2.5 MCU	28 VDC	
	NAV-4000	CTL-32 gas discharge	CSDB ARINC 429	2/4.7	$32,532*	Built-in ADF; built-in diagnostics; compatible only with CSDB or ARINC 429 controls; digital signal processing; Eurocontrol FM immunity standards.*Configuration will determine price.
	C34e, C36e, C40c, C35d, C41d	6 frequencies; nvm	NA	2.5 MCU	28 VDC	

DISTANCE MEASURING EQUIPMENT

Manufacturer	Model	Channel Display	Nav Outputs	Units/Weight (lb.)	Price	Remarks
	TSO		Power Outputs (peak W)	Size or Form Factor	Power Required	
Honeywell Aerospace BendixKing Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KN62A**	gas discharge	serial data	1/2.6 P/M	$8,617	Includes antenna and installation kit; accepts remote channeling. Distance accuracy: ±0.1 nm nominal to 99 nm, ±1.0 nm, 100 to 389 nm.
	—		100	6.3 x 1.3 x 12.3	11-33 VDC	
	BendixKing KN63	gas discharge	serial data	2/3.6	$13,760	Includes KDI 572 indicator, optional slaved indicator. Distance accuracy: ±0.1 nm nominal to 99 nm, ±1.0 nm, 100 to 389 nm.
	C66a		100	6.5 x 1.1 x 11.55	11-33 VDC	
	BendixKing KDM 706A	gas discharge, slaved indicators	ARINC 429 ARINC 568	2/6.3	$24,093	Includes KDI 572 indicator; optional slaved indicator; kits/mounts not included.
	C66b		250	3.0 x 5.25 x 12.8	28 VDC	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**DME-4000**	gas discharge	CSDB ARINC 429	2/4.4	$20,100*	Tracks three channels simultaneously when linked to CTL-32, IND-42; decodes and displays station ident; digital signal processing; echo monitor; built-in diagnostics; includes IND-42. **BCA* estimate.
	C66c		300	2.5 MCU	28 VDC	

LONG-RANGE NAV/COMS

Manufacturer	Model	Inputs	Units/Weight (lb.)	Price	Remarks
	System Type				
	TSO	Outputs	Size or Form Factor	Power Required	
Avidyne 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 **www.avidyne.com**	**IFD 550**	VHF Com; VOR-LOC-ILS; GPS; SBAS-WAAS, Attitude, WiFi, Bluetooth	1/8.5	$21,999	FMS/GPS/NAV/COM system with integrated Attitude Reference Sensor (ARS). Egocentric and Exocentric Synthetic Vision capability. Designed a drop-in replacement for the GNS530/W series navigators, but with a larger display and touch-screen interface. 5.7-in. VGA (640 x 480) LED. 16 channel GPS/SBAS receiver with 1,000 user-defined waypoints/99 flightplans. Includes Forward Looking Terrain Alerting (FLTA), Includes built In Bluetooth/WiFi capability. Optional TAWS-B, $7,995; optional 16 W VHF transceiver, $4,995 (28vdc aircraft only). Optional RS-170 Video input ($1,499). Optional Wx Radar Interface -BendixKing RDR2000/2100 ($3,999). Release 10.2 Software Upgrade for existing IFD540 and IFD440 units is available for download directly from the Avidyne website at no charge. Optionally, the software is available on USB memory stick for $150 from Avidyne. Costs do not include dealer labor to upgrade existing systems. All new-production IFD 5-Series and 4-Series models are available now and will begin shipping immediately with R10.2 functionality.
	GPS receiver with WASS (SBAS) capability, VOR/ ILS/ LOC receiver, VHF com, ARS				
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	--	4.60 x 6.3 x 11.0	11-33 VDC 10-watt VHF Com (16- watt option available)	
	IFD545	GPS; SBAS-WAAS		$19,999	FMS/GPS Navigator with integrated Attitude Reference Sensor (ARS). Egocentric and Exocentric Synthetic Vision capability. Designed as a drop-in replacement for GNS500 navigators. 16 channel GPS/SBAS receiver with 1,000 user-defined waypoints/99 flightplans. Includes Forward Looking Terrain Alerting (FLTA). Includes built In Bluetooth/WiFi capability. Optional TAWS-B, $7,995; optional 16 W VHF transceiver, $4,995 (28vdc aircraft only).
	GPS receiver with WASS (SBAS) capability, VOR/ ILS/ LOC receiver , ARS				
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	--	2.66 x 6.3 x 11.0	11-33 VDC	
	IFD 540	VHF Com; VOR-LOC-ILS; GPS SBAS-WAAS	1/8.5	$15,999	FMS/GPS/NAV/COM system. Also designed as a drop-in replacement for the GNS530 and 530W navigators but with a larger display and touchscreen interface. 5.7-in. VGA (640 x 480) LED. 16-channel GPS/SBAS receiver with 1,000 user-defined waypoints/99 flight plans. Includes Forward Looking Terrain Alerting (FLTA) and built-In Bluetooth/Wi-Fi capability. Optional certified TAWS-B, $7,995; optional 16 W VHF transceiver, $4,995 (28VDC aircraft only).
	GPS receiver with WASS (SBAS) capability, VOR/ ILSs/LOC receiver, VHF com				
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	—	4.60 x 6.3 x 11.0	11-33 VDC 10W VHF Com (16W option available)	
	IFD 510	GPS; SBAS-WAAS	1/8.0	$15,995	FMS GPS Navigator. Also designed as a drop-in replacement for GNS500 navigators. 16-channel GPS/SBAS receiver with 1,000 user-defined waypoints/99 flight plans. Includes Forward Looking Terrain Alerting (FLTA) and built-In Bluetooth/Wi-Fi capability. Optional certified TAWS-B, $7,995; optional 16 W VHF transceiver, $4,995 (28VDC aircraft only).
	GPS receiver with WASS (SBAS) capability, VOR/ILS/LOC receiver				
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	—	2.66 x 6.3 x 11.0	11-33 VDC	

LONG-RANGE NAV/COMS

Manufacturer	Model System Type TSO	Inputs Outputs	Units/Weight (lb.) Size or Form Factor	Remarks
Avidyne 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 **www.avidyne.com**	**IFD 410**	GPS; SBAS-WAAS	1/6.0	FMS GPS Navigator. Also designed as a drop-in replacement for GNS400 navigators. 16-channel GPS/SBAS receiver with 1,000 user-defined waypoints/99 flightplans. Optional Blue-tooth and WiFi capability $1,300. Optional Forward-Looking Terrain Alerting (FLTA) $1,300 ($2,000 for both) Optional certified TAWS-B $7,995; optional 16 W VHF transceiver, $4,995 (28VDC aircraft only).
	GPS receiver with WASS (SBAS) capability, VOR/ILS/LOC receive	—	2.66 x 6.3 x 11.0	
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a			
Esterline CMC Electronics 600 Dr. Frederik Philips Blvd. Montreal, Quebec Canada H4M 2S9 (514) 748-3184 Fax: (514) 748-3100 **www.cmcelectronics.ca**	**CMA-5024**	ARINC 429 (complies with ARINC 743B/ ARINC 429)	1/5.5	Certified SBAS/LPV receiver, Certified SBAS/LPV receiver, fully compliant as an ADS-B and RNP navigation source; provides LP/LPV and SBAS LNAV/VNAV, growth to GBAS with built-in VDB currently in development, LPV/ GBAS stand-alone approach capability with CMA-5025 control head, Options include: Have Quick and Doppler velocity radar emulation, meets or exceeds all FAR Part 25 requirements, operation from -55c to +70C.
	GPS receiver with SBAS and LPV	ARINC 429	9.5 x 8.5 x 2.5	
	C145c Beta-3 C146c Delta-4			
	CMA-3024 GPS Receiver	ARINC 429	1/5.5	Low cost certified SBAS Receiver, fully compliant as an ADS-B and RNP navigation source. Extremely reliable, MTBF > 48,000 hrs. Meets and exceeds all Part 25 requirements.
	C145b Beta -3	ARINC 429	9.5 x 8.5 x 2.5	
Garmin 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: ((913) 397-8282 **www.garmin.com**	**GNC 255**	RS-232	1/3.02	10W or 16W com and 200 channel nav with VOR/Localizer and Guideslope receiver
	VOR/ILS/LOC receiver, VHF com	ARINC 429, RS-232	6.25 x 1.65 x 10.4	
	C34e, C36e Class A, C40c, C128a, C169a Class 3, 4 5, 6, C, E, H1, H2			
	GTN 750	HSDB, ARINC 429, ARINC 453/708, RS-232, RS-422	1/9.3	Fully integrated GPS/NAV/COM/ MFD system. The unit's 6-in. high touchscreen provides access to high-resolution terrain mapping, graphical flight planning, geo-referenced charting, traffic display, multiple weather options, connectivity and more.
	VOR/ILS/LOC receiver, VHF com	HSDB, ARINC 429, RS-232, RS-422	6.25 x 6.00 x 11.25	
	C34e, C35d Class A; C36e Class A, C40c, C63d Class BC, C74d Class A, C110a, C112c, C113 Class I, II, II, C118, C128a, C139, C146c Class 3, C147; among others			
	GTN 650	HSDB, ARNC 429, ARINC 453/708, RS-232, RS-422	1/7.0	Full integrated system combines GPS, COM and NAV functions with MFD capabilties.
	VOR/ILS/LOC receiver, VHF com	HSDB, ARINC 429	6.25 x 2.65 x 11.25	
	C34e, C36e Class A, C40c, C74d Class A, C110a, C112c, C113 Class I, II, III, C118, C128a, C146c Class 3, among others			
	GSR 56	RS-232	1/2.51	The GSR 56 gives access to on-demand global weather information and text/voice communication through the Iridium stellite network.
	Iridium weather datalink, text/voice communications	RS-232	2.08 x 6.96 x 12.96	TSO: 139

LONG-RANGE NAV/COMS

Manufacturer	Model System Type TSO	Inputs Outputs	Units/Weight (lb.) Size or Form Factor	Price Power Required	Remarks
Avidyne 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 **www.avidyne.com**	**IFD 440** GPS receiver with WASS (SBAS) capability, VOR/ILS/LOC receiver, VHF com C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	VHF com; VOR-LOC-ILS; GPS; SBAS-WAAS —	1/6.6 2.66 x 6.3 x 11.0	$11,999 11-33 VDC 10W VHF Com (16W option)	FMS/GPS/NAV/COM system. Also designed as a drop-in replacement for the GNS430 and 430W navigators but with a larger display and touchscreen interface. 16-channel GPS/SBAS receiver with 1,000 user-defined waypoints/99 flight plans. Optional Bluetooth and Wi-Fi capability $1,300. Optional Forward-Looking Terrain Alerting (FLTA), $1,300 ($2,000 for both). Optional certified TAWS-B $7,995. Optional 16 W VHF transceiver, $4,995 (28VDC aircraft only).
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**Laseref IV** Laser Gyro IRS C4c, C5e, C6d	ARINC 419/429 ARINC 429/ASCB	2/16.9 4.9 x 7.6 x 13.1	$265,361* 28 VDC or 115 VAC	All digital; 4 MCU, ARINC 704. *BCA estimate.
	Laseref VI Micro IRS Laser Gyro IRS C4c, C5e, C6d, C129a	ARINC 429 ARINC 429	2/3.2 6.5 x 6.4 6.4	$355,992* 28 VDC	Laseref VI Inertial Reference Unit with updated microprocessor, on-aircraft data load capability; HIGH Step II software for 100% available RNP. *BCA estimate.
	AH-1000 Attitude Header Reference Unit MEMS AHRS C3e, C4c, C5f, C6e (ETSO C3d, C4c, C5e, C6e)	ARINC 429 and discrete I/O ARINC 429	2/3.2 2.5 x 5.0 x7.8	$33, 334* 28 VDC	AH-1000 is a Microelectromechanical System (MEMS) attitude and heading reference system (AHRS) designed to serve as the AHRS for commercial aerospace primary and secondary attitude and heading systems. *BCA estimate.
	KTR 2280 Multi-Mode Digital Radio C37d, C38d, C40c, C36e, C34e, C41d	ARINC 429 Interface	— —	— 27.5 VDC	Functionality consists of a VHF communication transceiver that can monitor two frequencies simultaneously, a VHF navigation receiver and an ADF receiver is an option enabled via software.
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**NxtLink ICS-120A Satcom Terminal**	ARINC 429; audio tip/ring; audio 4 wire; RS-232; Discretes: RF, USB; mainenance port; remote SIM and configuration	Single 2 MCU rack/6.3 lb. 15.98 x 2.33 x 7.75	$38,022 28 VDC	Dual-transceiver device that combines a single channel of global voice and 2400 bps data service with a second Short Burst Data (SBD) channel in a single 2MCU LRU. The system provides the flight crew with an exclusive global voice channel and a dedicated data link channel to support ACARS, FANS messaging, ADS-C and CPDLC.
	NxtLink ICS-220A Satcom Terminal	ARINC 429; audio tip/ring; audio 4 wire; RS-232; Discretes: RF, USB; mainenance port; remote SIM and configuration	Single 2 MCU rack/6.3 lb. 15.98 x 2.33 x 7.75	$48,714 28 VC	Three-transceiver unit combines dual channels of global voice and 2400 bps data service with a third Short Burst Data (SBD) channel in a single 2MCU LRU. The system provides the flight crew with an exclusive global voice channel and a dedicated data link channel to support ACARS, FANS messaging, ADS-C and CPDLC.
	GPS-4000S GPS receiver w SBAS (WAAS) capability C145A Class Beta-3	ARINC 429 (complies with ARINC 743A) ARINC 429	N/A 2 MCU	$32,576* 28 VDC	*BCA estimate.

TRANSPONDERS

Manufacturer	Model	Modes	Units/Weight (lb.)	Price	Remarks
	TSO	Power Output (W)	Size or Form Factor	Power Required	
ACSS, an L3 and Thales Company 19810 N. 7th Ave. Phoenix. AZ 85027 (623) 445-7001 Fax: (623) 445-7000 **www.acss.com**	**Mode S RCZ-852**	TCAS/Mode S/Fit ID control panel; RMU (Primus II radios)	5.0	$78,409	Elementary and Enhanced Surveillance (ELS/EHS) and DO 260 compliant. Certified on many regional and business jets.
	C112	CTL92A/T/E	3.4 x 4.1 x 14.01	28 VDC	
	Mode S ATDL XS-950	TCAS/Mode S/Fit ID control panel; CTL92A/T/E	1/11.5	$99,474	DO-260B and DO-181E compliant. Elementary and enhanced surveilance (ELLS/EHS).
	C112		4 MCU	28 VDC	
	NTX-600 Mode S	TCAS/Mode S/Fit ID; control panel; RMU (Primus II radios)	1/5.0	$51,418	DO-260B and DO-181E compliant. Elementary and Enhanced Surveillance (ELS/EHS). Selected for the Bombardier Q400.
	C112d, C116b	115 VAC, 400 Hz or 28 VDC	3.4 x 4.1 14.01	NA	
	NXT-700	TCAS/Mode S/Fit ID; conrol panel	5.5	$38,975	DO-2608 compliant; Elementary and Enhanced surveillance (ELS/EHS)
	C112d, C166b	500w max, 250W min	1/2 ATR Short	N/A	
	NXT-800 Mode S	TCAS/Mode S/Fit ID; control panel	1/8.6 (AC); 7.8 lb. (DC)	$101,900	
	C112d, C166b	115 VAC, 400 Hz or 28 VDC	4 MCU	NA	
Avidyne Corp. 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 Info @avidyne.com **www.avidyne.com**	**AXP340**	Mode A/C/S with extended squitter; ADS-B OUT	1/2.98	N/A	Panel-mounted Class 1 Mode S Level 2 data-link transponder, with 1090 MHz Extended Squitter (ES). Meets requirements for Mode S elementary surveillance transponders. Slide-in replacement for existing KT76A/KT78A transponders. Designed to upgrade existing Mode A/C equipment to Mode S, while adding additional functionality such as direct-entry numeric keypad, pressure altitude and GPS Lat/Long readout, Flight ID entry, one-touch VFR code entry, a stop-watch timer/flight timer, and altitude alerter. Supports the latest Version 2 1090 MHz Automatic Dependent Surveillance Broadcast (ADS-B) Extended Squitter (ADS-B out).
	C166b, ETSO 2C112b, ETSO C166b	240	6.3 x 1.57 x 9.4	10 -33 VDC	
	AXP322	Remote-mounted Mode A/C/S with extended squitter; TIS & ADS-B OUT	1/0.97	$2,999	Remote-mounted Class 1 Mode S Level 2 data-link transponder, with 1090 MHz Extended Squitter (ES). Meets requirements for Mode S elementary surveillance transponders and supports legacy Traffic Information Service (TIS). Supports the latest Version 2 1090 MHz Automatic Dependent Surveillance Broadcast (ADS-B) Extended Squitter (ADS-B out). Designed to work with Avidyne's panel-mounted IFD540 & IFD440 panel-mounted FMS/GPS/NAV/COMs for display and control.
	ETSOC112b, ETSO C166a, FAA TSO C112c, C166b	250	2.68 x 1.90 x 6.30	10-33 VDC	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GTX 327**	A, C	1/3.1	$2,036	IFR-certified panel-mounted Mode C transponder.
	C74c Class 1A	200	6.25 x 1.65 x 8.73	11-33 VDC	
	GTX 330 ES	A, C, S, ES	1/4.2	$8,636	IFR-certified panel-mounted Mode C transponder with ADS-B compliant ES capability.
	C112d Level 2ens Class 1, C 166b Class B1S	250	6.25 x 1.65 x 11.25	11-22 VDC	
	GTX 3000	A, C, S, ES	1/5.2	$24,226	The GTX 3000 Mode S ES remote transponder features ADS-B OUT transmission and TCAS II/ACAS II compatibility.
	C112d Level 2adens, Class 1c, C166b Class B1	250 minimum, 300 nominal	2.58 x 6.47 x 10.94	14-28 VDC	

TRANSPONDERS

Manufacturer	Model	Modes	Units/Weight (lb.)	Price	Remarks
	TSO	Power Output (W)	Size or Form Factor	Power Required	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GTX 335**	A, C, S, ES	1/2.83	$2,995	IFR-certified 250W panel-mounted Mode S transponder with ADS-B compliant ES capability.
	TSO-C88b, TSO-C112e Level 2es Class 1	250	6.25 x 1.65 x 10.07	9-33V	
	GTX 335 w/GPS	A, C, S, ES	1/2.94	$3,795	IFR-certified 250W panel-mounted Mode S transponder with ADS-B compliant ES capability and built-in WAAS.
	TSO-C88b, TSO-C112e Level 2es Class 1, TSO-C145d Class B2	250	6.25x 1.65 x 10.07	9-33V	
	GTX 335R	A, C, S, ES	1/2.5	$2,995	IFR-certified 250W remote-mounted Mode S transponder with ADS-B compliant ES capability.
	TSO-C88b, TSO-C112e Level 2es Class 1	250	6.25 x 1.65 x 10.07	9-33V	
	GTX 335R w/GPS	A, C, S, ES	1/2.6	$3,795	IFR-certified 250W remote-mounted Mode S transponder with ADS-B compliant ES capability and built-in WAAS.
	TSO-C88b, TSO-C112e Level 2es Class 1, TSO-C145d Class B2	250	6.25 x 1.65 x 10.07	9-33V	
	GTX 345	A, C, S, ES	1/3.09	$4,995	IFR-certified 250W panel-mounted Mode S transponder with ADS-B compliant ES capability and ADS-B In benefits.
	TSO-C88b, TSO-C112e Level 2es Class 1, TSO-C154c Class A1S, TSO-C157a Class 1, TSO-C166b Class A1S/B1S, TSO-C195a Class C1, C2, C3, C4	250	6.25 x 1.65 x 10.07	9-33V	

TRANSPONDERS

Manufacturer	Model	Modes	Units/Weight (lb.)	Price	Remarks
	TSO	Power Output (W)	Size or Form Factor	Power Required	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GTX 345 w/GPS**	A, C, S, ES	1/3.20	$5,795	IFR-certified 250W panel-mounted Mode S transponder with ADS-B compliant ES capability, built-in WAAS and ADS-B in benefits.
	TSO-C88b, TSO-C112e Level 2es Class 1, TSO-C145d Class B2, TSO-C154c Class A1S, TSO-C157a Class 1, TSO-C166b Class A1S/B1S, TSO-C195a Class C1, C2, C3, C4	250	6.25 x 1.65 x 10.07	9-33V	
	GTX 345R	A, C, S, ES	1/2.8	$4,995	IFR-certified 250W remote-mounted Mode S transponder with ADS-B compliant ES capability and ADS-B In benefits.
	TSO-C88b, TSO-C112e Level 2es Class 1, TSO-C154c Class A1S, TSO-C157a Class 1, TSO-C166b Class A1S/B1S, TSO-C195a Class C1, C2, C3, C4	250	6.25 x 1.65 x 10.07	9-33V	
	GTX 345R w/GPS	A, C, S, ES	1/2.9	$5,795	IFR-certified 250W remote-mounted Mode S transponder with ADS-B compliant ES capability, built-in WAAS, and ADS-B In benefits.
	TSO-C88b, TSO-C112e Level 2es Class 1, TSO-C145d Class B2, TSO-C154c Class A1S, TSO-C157a Class 1, TSO-C166b Class A1S/B1S, TSO-C195a Class C1, C2, C3, C4	250	6.25 x 1.65 x 10.07	9-33V	
Honeywell Aerospace **BendixKing Avionics** 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KT 74**	NA	1/2.8	$3,278	Mode S ADS-B capable.
	ETSO C112d, ETSO C166b, TSO C112d and TSO C166b	240 W nominal; 125 W minimum	1.7 x 6.30 x 10.7	11 or 33 VDC	
	BendixKing KT 76A	A, C	1/3.1	$2,265	Automatic reply-light dimmer; system test; remote ident capability adapter available.
	C47c; Class 1B	250	6.25 x 1.6 x 10.0	14 or 28 VDC	
	BendixKing KT 76C	A, C	1/3.1	$3,278	Slide-in replacement for KT 76A. Programmable VFR code; remote ident capability; gas-discharge digital display; pushbutton code entry.
	C47c	250	6.25 x 1.63 x 10.73	11-33 VDC	
	BendixKing KT 73	A, C, S, TIS	1/3.6	$6,719	Mode S data link with TIS. Meets European Elementary Surveillance mandate (non-diversity).
	C112	200	6.25 x 1.63 x 10.82	10-32 VDC	
	BendixKing MST 67A	A, C, S	2/8.5	$46,143	Mode S diversity transponder.
	C37c/C38c C74c; Class 3A	250-625	14.0 x 3.0 x 8.9	115 VAC; 400 Hz	

TRANSPONDERS

Manufacturer	Model	Modes	Units/Weight (lb.)	Price	Remarks
	TSO	Power Output (W)	Size or Form Factor	Power Required	
L-3 Aviation Products 5353 52nd St. SE Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 977-6898 **www.L-3Lynx.com**	**Lynx NGT-9000**	A, C, S. ADS-B	1/2.96	$5,495	Touchscreen ADS-B transponder and MFD display. 1090ES (Mode s ES) ADS-B Out, 1090 MHz and 978 MHz (UAT) ADS-B In. ADS-B traffic (1090 and 978 ADS-B, ADS-R and TIS-B) and 978 FIS-B input. WiFi interface module available for connectivity to PED (iPad). Embedded rule compliant position source (WAAS GPS). Embedded options include Class B TAWS and ADS-B aural traffic alerting for the verbal positioning of traffic conflicts.
	C112d, C113a, C145c, C147, C154c, C157a, C166b, C195a	25W minimum/250W maximum	1.8 x x 6.25	14 or 28 VDC	
	Lynx NGT-9000+	A, C, S. ADS-B	1/2.96	$9,555	Same features as the NGT-9000, but with the added feature of the L-3 NextGen Active Traffic. Active traffic is embedded into the same LRU, requiring no separate boxes. Current SkyWatch owners can re-use existing antenna.
	C112d, C113a, C145c, C147, C154c, C157a, C166b, C195a	25W minimum/250W maximum	1.8 x x 6.25	14 or 28 VDC	
	Lynx NGT-9000D	A, C, S, ADS-B	1/2.96	$6,915	Same features as NGT-9000 but with Antenna Diversity for the top and bottom of the aircraft.
	C112d, C113a, C145c, C147, C154c, C157a, C166b, C195a	25W minimum/250W maximum	1.8 x 6,25	14 or 28 VDC	
	Lynx NGT-9000D+	A, C, S, ADS-B	1/2.96	$10,935	Same features as NGT-9000, but with the added feature of the L-3 NextGen Active Traffic and Antenna Diversity.
	C112d, C113a, C145c, C147, C154c, C157a, C166b, C195a	25W minimum/250W maximum	1.8 x 6.25	14 or 28 VDC	
	Lynx NGT-9000R	A, C, S, ADS-B	1/2.96	$5,445	Remote version of the NGT-9000 that integrates and is conrolled by newer aircraft outfitted with glass panels.
	C112d, C113a, C145c, C147, C154c, C157a, C166b, C195a	25W minimum/250W maximum	1.8 x 6.25		
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**TDR-94D**	S	2/8.5	$56,656	Mode S transponder; DO-260B ADS-B Out compliant. European Elementary and Enhanced Surveillance compliant. Compatible with TCAS II Change 6.04, Change 7.0 and Change 7.1 systems. TDR-94 transponder also available for non-diversity applications. Flight ID capable CTL-92E controller available
	C112; Class 3A	250-625	4.9 x 3.3 x 12.5	28 VDC	

WEATHER RADAR

Manufacturer	Model	Ranges	Dish Size & Beam Width (in./deg.)	Scan	Stablztn.	Display Interface	Scope (dia./in.)	Units/ Weight	Price	Remarks
	TSO			Pulse Width	Stabl. Sig.					
	Circuits	Power Output (Peak KW)		Looks/Min.	Ant. Tilt	Colors	Indicator Size	RT. Size	Power	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GWX 70**	Selectable: 2.5, 5, 10, 20, 40, 60, 80, 100, 120, 160, 240, and 320 nm (HSDB interface) 2.5, 5, 10, 20, 40, 80, 160 and 320 nm (ARINC interface)	10/9.0 12/7.8 18/5.6	20, 40, 60, 90, or 120 (HSDB interface); 20 or 120 (ARINC interface)	±30°	HSDB ARINC 429/453	NA	10 in. - 9.3 12-in. - 9.5 18-in. - 11.0	$21,995	Designed for use in a variety of aircraft. Available antenna sizes include 10, 12, and 18 in. Circuits: horizontal and vertical scan; tile, bearing, sector san, gain, stabilization, ex attenuated color highlight, alt. compensated tile and ground clutter suppression control; turbulence detection.
	C63D Class B and C			1.6, 3.2, 6.4 or 13.6	—					
	See remarks	40 W nominal		12 (Range 20 nm or below) 9 (Range 20 nm or above)	±15°	4	NA	8.0 x 9.69 x 7.08 (10 in. & 12 in.) 8.78 x 10.06	14-28 VDC 2.5A @28V	
	GWX 70R	Selectable: 2.5, 5, 10, 20, 40, 60, 80, 100, 120, 160, 240, and 320 nm (HSDB interface) 2.5, 5, 10, 20, 40, 80, 160 and 320 nm (ARINC interface)	10/9.0 12/7.8 18/5.6	20, 40, 60, 90, or 120 (HSDB interface); 20 or 120 (ARINC interface)	±30°	HSDB ARINC 429/453	NA	10 in. - 9.3 12-in. - 9.5 18-in. - 11.0	$21,995	Designed for use in a variety of aircraft. Available antenna sizes include 10, 12, and 18 in. Circuits: horizontal and vertical scan; tile, bearing, sector san, gain, stabilization, ex attenuated color highlight, alt. compensated tile and ground clutter suppression control; turbulence detection.
	C63D Class B and C			1.6, 3.2, 6.4 or 13.6	—					
	See remarks	40 Wnominal		12 (Range 20 nm or below) 9 (Range 20 nm or above)	±15°	4	NA	8.0 x 9.69 x 7.08 (10 in. & 12 in.)	4-28 VDC 2.5A @28V	
	GWX 70H	Selectable: 2.5, 5, 10, 20, 40, 60, 80, 100, 120, 160, 240, and 320 nm (HSDB interface) 2.5, 5, 10, 20, 40, 80, 160 and 320 nm (ARINC interface)	10/9.0 12/7.8 18/5.6	20, 40, 60, 90, or 120 (HSDB interface); 20 or 120 (ARINC interface)	±30°	HSDB ARINC 429/453	NA	10 in. - 9.3 12-in. - 9.5 18-in. - 11.0	$31,995	The helicopter-optimized GWX 70H combines range and adjustable scanning profiles with precision target definition for real-time weather analysis in the cockpit. The GWX 70H offers horizontal scan angles of up to 120 deg. and pilot-adjustable sector scanning from 20 deg.to 120 deg. Circuits: ; tile, bearing, sector san, gain, stabilization, ex attenuated color highlight, alt. compensated tile and ground clutter suppression control; turbulence detection.
	C63D Class B and C			1.6, 3.2, 6.4 or 13.6	—					
	See remarks	40 W nominal		2 (Range 20 nm or below) 9 (Range 20 nm or above)	±15°	4	NA	8.0 x 9.69 x 7.08 (10 in. & 12 in.) 8.78 x 10.06 x 9.93 (18 in.)	4-28 VDC 2.5A @28V	

WEATHER RADAR

Manufacturer	Model	Ranges	Dish Size & Beam Width (in./deg.)	Scan	Stablztn.	Display Interface	Scope (dia./in.)	Units/ Weight	Price	Remarks
	TSO	Power Output (Peak KW)		Pulse Width	Stabl. Sig.	Colors	Indicator Size	RT. Size	Power	
	Circuits			Looks/Min.	Ant. Tilt					
Honeywell Aerospace **BendixKing Avionics** 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing ADR 2000**	10, 20, 40, 80, 160	10/10 12/8 15	90° or 100°	30°	KMD 850 EFIS	N/A	1/9.9	$20,799	Vertical profile feature: scans horizontally or vertically on track line selected by pilot. Alpha-numeric display of range, function and tilt angle.
	C63c	4		4	20-220 mv/det.	4	N/A	10.28 dia.	28 VDC; 10, 26, 115 VAC, 400 Hz	
	Vertical profile, ext. STC, tgt., wx alert, atten., comp., variable gain-map mode			ARINC 429	±15°					
	BendixKing RDR 2100	5, 10, 20, 40, 80, 160, 240, 320	12/8 10/10	90°, 100°, 120°	±30° pitch & roll	KMD 850 EFIS	N/A	1/9.9	$21,181	Vertical profile feature: scans horizontally or vertically on track line selected by pilot; Alpha-numeric display of range, function and tilt angle. KMD 850 MFD, $13,440.
	C63c	6.0		range dependent	20/220 mv/deg. ARINC 429	5	N/A	10.28 dia.	28 VDC; 10, 26, 115 VAC, 400 Hz	
	Vertical profile; extended STC; wx attenuation compensation; variable gain in map mode; wx alert; autotilt			15	±15°					
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**Primus 660**	2.5, 5, 10, 25, 50, 100, 200, 300	12/7.9 18/5.6	60° or 120°	±30°	ARINC 453/708 checklist, data nav, EFIS, MFD, LSZ-860	4	2/15.8	$99,531	Single receiver/transmitter/antenna pedestal.
	C83c	10		2	50 or 200 mv/deg. or ARINC 429	4	4.81 x 6.25 x 12.24	5.0 x 7.6 x 15.0	28 VDC	
	REACT; GMAP target alert, preset & variable gain			12/24	±15°					
	Primus 880	2.5, 5, 10, 25, 50, 100, 200, 300	12/7.9 18/5.6 24/4	60° or 120°	±30°	ARINC 453/708 checklist, data nav, EFIS, MFD, LSZ-860	5	2/15.8	$139,101	Single receiver/transmitter/antenna pedestal.
	C63c	10		2	50 or 200 mv/deg. or ARINC 429	5	4.8 x 6.25 x 12.24	5.0 x 7.6 x 15.0	28 VDC	
	Doppler turb. detec., compensated, tilt, REACT, GMAP target alert, preset & variable gain			12/24	±15°					
	Primus 700A	½, 1, 2.5, 5, 10, 25, 50, 100, 200, 300	10/10, 12/7.9, 10 x 14/ 10 x 7.1, 18/5.6, 24/4	60° or 120°	±30	ARINC 429/708 checklist, data nav, EFIS, lightning sensor LSZ-860	5	4/37	$119,703	Short-range and high-resolution system for special search and surveillance missions, displayed menus. Minimum detect range at 450 ft. Allows full dual-mode operation for pilot and copilot. Price reflects receiver/transmitter and pedestal.
	C63c	10		6	50 or 200 mv/deg. or ARINC 429	5	4.81 x 6.25 x 12.24	5.0 x 7.6 x 15.0	28 VDC; 400 Hz	
	REACT; ground & sea clutter red.; turb. detect-preset & variable gain			12/24	±15°					
	Primus 701A	½, 1, 2.5, 5, 10, 25, 50, 100, 200, 300	10/10, 12/7.9, 10 x 14/ 10 x 7.1, 18/5.6, 24/4	60° or 120°	±30°	ARINC 429/709 checklist, data nav, EFIS, lightning sensor	5	4/39	$125,254	Short-range and high-resolution system for special search and surveillance missions, displayed menus and AC 90-80A specified clear zones. Allows full dual-mode operation for pilot and copilot. Price reflects receiver/transmitter and pedestal.
	C63c, C102	10		6	50 or 200 mv/deg. or ARINC 429	6	4.81 x 6.25 x 12.24	5.0 x 7.6 x 15.0	28 VDC; 115 VAC, 400 Hz	
	REACT; ground clutter reduction; turbulence detect-preset & variable gain			12/24	±15°					

WEATHER RADAR

Manufacturer	Model	Ranges	Dish Size & Beam Width (in./deg.)	Scan	Stablztn.	Display Interface	Scope (dia./in.)	Units/ Weight	Price	Remarks
	TSO	Power Output (Peak KW)		Pulse Width	Stabl. Sig.	Colors	Indicator Size	RT. Size	Power	
	Circuits			Looks/Min.	Ant. Tilt					
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**IntuVue 3D weather radar RDR 4000**	5 to 320 nm	30/3.2; 24/4.2; 18/5.6	Up to 90 deg/sec 1 to 275 sec uncompressed 1 to 12 compressed (Non-Linear FM)	ARINC 429	ARINC 453	N/A	RP-1 - 10.5 TR-1 - 5.1 Antenna+ Drive: 30 in. - 32.0 24 in. 24.0 18 in. 20.8 RP Size: 3 MCU	Call dealer	IntuVue radar with volumetric buffer processing, automatic ground return elimination, automatic weather mode, altitude-based manual wx mode, REACT, predictive windshear, turbulence and optional hail and lightning prediction.
	TSO C63c	40W Peak				4			28 VDC or 115 VAC 400 Hz (depending on part number)	
	See remarks									
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**RTA-4112**	5-320 nm	12/7.4	±60°	stabilized to ±30 degrees in Pitch/Roll, Tilt adjustment is ±15° tilt	ARINC 708A	N/A	1/15.1	$180,976	Price *BCA* estimate.
	C63c			3.44-55usec	—					
	—	38-75 W		—	—	4	—	12 in.	Typical 60 W; Max 80 W	
	RTS-4114	5-320 nm	14/6.7	±60°	stabilized to ±30 degrees in Pitch/Roll, Tilt adjustment is ±15° tilt	ARINC 708A	N/A	1/15.4	$184,150	Price *BCA* estimate.
	C63c			3.44-55usec	—					
	—	38-75 W		13	—	4	varies by indicator	14.0	80 W avg.	
	RTA-4118	5-320 nm	18/5.2	±60°	stabilized to ±30 degrees in Pitch/Roll, Tilt adjustment is ±15° tilt	ARINC 708A	N/A	1/17.0	$188,000	Price *BCA* estimate
	C63c	38-75 W		3.43-55usec		—			Typical 60 Watts Max 80 W	
				--						
	RTA-4218	5-320 nm	18/5.2	±60° WX modes and ±45° in PWS	stabilized to ±30 degrees in Pitch/Roll, Tilt adjustment is ±15° tilt	ARINC 708A	—	18 in	$198,000	Price *BCA* estimate
	C63d	38-75 W		3.43-55usec in WX modes and 2.11-3.43usec in PWS		4			Typical 60 W Max 80 W	

RADAR ALTIMETERS

Manufacturer	Model	Alt. Range	Accuracy	Display	Units/ Weight (lb.)	Price	Remarks
	TSO	Pitch/Roll Limits				Power Required	
FreeFlight Systems 3700 Interstate 35 S. Waco, TX 76706 (254) 662-0000 Fax: (254) 662-9450 **www.freeflightsystems.com**	**RA-4000 and RA-4500**	-20-2,500 ft.	0 to 100 ft. ±3%. 100 to 500 ft. ±3% 500 to 2,000 ft. ±5%	RAD-40 Radar Altimeter display compatible with the RA-4000 and RA-4500	1/2.37	N/A	RA-4000 provides RS 485/422 and RS 232C outputs; RA-4500 provides ARINC 429, RS 485/422 and RS 232 outputs. Two-year warranty. Optional night vision goggle (NVG) compatible display and round faceplate adapter for display. Optional 1/2 ATI (TSO'd) RAD-40 indicator, $3,055; when purchased with RA-4000, $11,190. RAD-40/RA 4500 w/installation kit, $12,699.
	C87	±20°/±30°				28 VDC	
	FRA-5500	-20-2,500 ft.	0 to 100 ft. ±3%. 100 to 500 ft. ±3% 500 to 2,000 ft. ±5%	RAD-40 Radar Altimeter display compatible with the RA-4000 and RA-4500	1/2.37	N/A	Provides compliance for FAR Part 29 operators who need to satisfy the Feb. 21, 2014 Final Rule (RIN 2120-AJ53) requiring installation of radar altimeters. Inegrates with electronic flight information systems (EFIC, flight director(s), and integrated flight decks via available RS-232 or ARINC 429. Options include the night-vision compatible RAD-40 panel-mounted diisplay for altitude pre-select and altimeter readout, and FTG-410 Tone Generator audio alert calls for flight crew attention to critical altitudes and other aircraft conditions.
	C87	0 - 2,500 ft.				28 VDC	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GRA 55**	-20 - 2,550 ft. AGL	±1.5 ft. (3 - 100 ft. AGL) ±2% (>100 - 2,500 Ft. AGL)	GI 205 and/or GIFD	1/3.5	$6,300	All-digital design. Developed for use in hleicopters and general aviation aircraft.
	C87a Funcational Class A ETSO-2C87 Functional Category B/L/C (A1)/A	±20°/±30°	—	—	3.02 x 3.99 x 11.62	14-28 VDC 13.75 W max	
	GRA 5500	-20 - 2,550 ft. AGL	±1.5 ft. (3 - 100 ft. AGL) ±2% (>100 - 2,500 Ft. AGL)	GI 205 and/or GIFD	1/3.5	$13,3000	All-digital design. Developed for helicopter, business jet, transport category and general aviation applications. Can integrate with Class A TAWS, TCAS II or CAT II ILS avionics.
	C87a Funcational Class A ETSO-2C87 Functional Category B/L/C (A1)/A	±20°/±30°	—	—	3.02 x 3.99 x 11.62	14-28 VDC 13.75 W max	

RADAR ALTIMETERS

Manufacturer	Model	Alt. Range	Accuracy	Display	Units/ Weight (lb.)	Price	Remarks
	TSO	Pitch/Roll Limits				Power Required	
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**AA-300 Radio Altimeter System**	0-2,500 ft.	N/A	N/A	4.56 x 4.09 x 11.07	N/A	Pilot Activated Self Test (PAST) input available to verify system operation.
	RT300 C-87, RTCA DO-160A	N/A				21.32 VDC, 0.7 amp max	
	Radar Altimeter KRA 405B	0-2,500 ft.	±2 ft (0.61 m) below 100 ft., ±3% at 100 ft. to 500 ft., and ±5% at 500 to 2,500 ft.	KNI 415 / 416 5V or 28V Black or Gray 28V Black Night Vision	3.0 x 3.5 x 11.0	N/A	Internal 2,500 ft. capability for use with ground proximity systems. Used with KNI-415 or KNI-416 indicators. Used with two KA-54 or KA-54A antennas. Provides analog and ARINC 429 outputs for increased interface capability including GPWS, TCAS, autopilot. Option available with ARINC 552 auxiliary output (-0202 version) Option available that can accept DH input from EFIS or KNI-415 or KNI-416 indicator to generate audio signal (-0202 version).
	C87/ETSO-2C87	N/A				27.5 VDC	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**ALT-1000**	0-2,500 ft	±2 ft or 2%	Analog only outputs*	2/6.8	$17,988	*Requires separate converter for use with ARINC 429 systems.
	C87	±40°/±50°				28 VDC	
	ALT-4000	0-2,500 ft.	±2 ft or 2%	EFIS (analog version available)	2/6.8	$30,728	Interfaces to EFIS high-intensity monitor for Cat II/III certification. Includes two ANT-52 antennas.
	C87	±40°/±50°				28 VDC	

THUNDERSTORM DETECTION SYSTEMS

Manufacturer	Model	Search Arc	Information Display	Display Size	Price	Remarks
	TSO	Max Range		Units/Weight	Power Required	
Avidyne Corp. 55 Old Bedford Rd. Lincoln, MA 01733 (781) 402-7400 Fax: (781) 402-7599 **www.avidyne.com** **info@avidyne.com**	**TWX670**	N/A	lightning strikes are displayed with range bearing and intensity (color). TWXCell mode highlights the most intense regions of thunderstorm activity, presenting a visually contoured color display with dynamic sectors.	see Avidyne MHD300, EX600, EX5000, R9, IFD540, IFD440 specifications. TXW670 has 7 RS 323 ports and is compatible for monochrome strikes on many legacy RS232-capable lightning displays.	$11,990	Third-generation lightning detection system with digital signal processing and noise immunity. Shows lightning from 0 nm - 200 nm including critical 0 nm - 25 nm range for addded tactical benefit. Eliminates radial spread associated with older technology systems. Exclusive TWXCell display provides a dynamic map of the lightning discharge rate and density.
	C110	200 nm			16-35 VDC	
L3 Aviation Products 5353 52nd St. SE Grand Rapids, MI 45912 (616) 949-6600 Fax: (616) 285-4224 **www.L3aviationproducts.com**	**WX-500**	pilot-selectable 120° & 360°	graphical depiction of real-time lightning information in cell or strike modes	see remarks 2.5	$6,656*	Remote-mount sensor interfaces with MFDs for graphical depiction of real-time lightning information Features 360° and 120° views, selectable ranges of 25-200 nm, input for heading stabilzation and options for cell or strike mode data selection. Interfaces to MFDs via RS-422. A separate radar graphics computer (Model RGC-350) is needed for display on dedicated radar indicators. *Processor only.
	C110a	200 nm		Processor: 5.6 x 2.2 12.0	11-32 VDC	
	WX-1000E (429 EFIS)	360°	—	depends on EFIS system	$19,113*	Provides output on EFIS display or radar indicator when paired with RGC35C (sold separately); includes three levels of activity, bearing and distance; optional displays for checklists. *Processor only. Price *BCA* estimate.
	C110a	200 nm		1/6.67	10-32 VDC	
	WX-1000E (429 Navaid)	360°	—	3 ATI	$19,509	ARINC 429 interface allows simultaneous display of thunderstorn info and course line to waypoints. Presentation of six user-selectable nav items. Course deviation indicator display. Consult manufacturer for approved interfaces.
	C110a	200 nm		2/10.95	10-32 VDC	

INTEGRATED FLIGHT CONTROL SYSTEMS

Manufacturer	Model	Air Data Attitude Sensors	Autopilot Flight Director	Power	*Weight* AP Only IFCS	*Price* AP Only IFCS	Remarks
Avidyne Corp. 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 **www.avidyne.com** **info@avidyne.com**	**DFC 90**	digital ADHARS from Avidyne Entegra PFD or Aspen EFD1000 Pro	combined	28 VDC	1/2.02 NA	See remarks	Attitude-based digital autopilot interfaces with Entegra PFD or Aspen EFD Pro. Is slide-in replacement for STEC55X, using existing servos. STEC30/50/60-2/65 series autopilots may also be replaced by a DFC90. Currently certified in Cirrus, Beech Bonanza Series and Cessna 182 series. Price is $9,995 for piston singles and $14,995 for twins and turbine-powered aircraft.
	DFC 100	digital ADAHRS from Avidyne Entegra Release 9 PDF	combined	28 VDC	1/2.02 NA	$9,995 piston singles $14,995 twins and turbine-powered aircraft	Attitude-based digital autopilot includes Straight & Level button, Envelope Protection, and full-time Envelope Alerting. DFC100 interfaces with Entegra Release 9 Integrated Flight Deck as a slide-in replacement for STEC55X, using existing servos. Certified in Cirrus SR20/22 and Piper Matrix & Mirage with Entegra R9. Price is $9,995 for piston singles and $14,995 for twins and turbine-powered aircraft.
Genesys Aerosystems One S-TEC Way, Municipal Airport Mineral Wells, TX 76067 (817) 215-7600 **genesys-aerosystems.com** **Formerly Cobham (S-TEC)**	**IntelliFlight DFCS**	digital ADAHARS	Magic EFIS N/A	14 or 28 VDC	14.5 N/A	See remarks	Designed for piston twins, turbine twins, and light jets. Features include Indicated air speed (IAS) hold; control wheel steering (CWS); GPS steering; heading preselect and hold PFD integration; altitude preselect and hold w/autotrim; digital vertical speed command.
	S-TEC 5000 Digital Autopilot C198, ETSO-C9c, ETSO-C52b, RTCA DO-160G, RTCA DO-178B Level A	N/A N/A	N/A N/A	28 VDC	2.6 lb. /N/A	NA/NA	An RVSM-compatible system offers full capabilities of a top-tier DFCS designed for high-performance jets and turboprops. Straight and level button provides fast recovery from unusual attitudes with an annunciated alert. GPS Steering (GPSS) mode integrates the autopilot with the aircraft's GPS NAV receiver during precision approaches/missed approaches. Features include heading preselect and hold; PFD integration; altitude preselect and hold w/autotrim; digital vertical speed command; course intercept capability; dual mode - HDG/NAV and HDG/APR, VOR/LOC/GS/REV/GPS course; NAV flag warnings; control wheel steering; GPS steering (GPSS); envelope protection and alerting; autopilot mode annunciations; voice annunciations; all-axis trim control and more.
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GFC 700**	GDC 74 (B) DADC GRS 77, GRS 7800	combined	28 VDC	varies by installation	varies by installation	Digital, dual-channel fail-passive system for Cessna Mustang, Caravan, C-172, -182, -206, -350, -400, CJ525, C680 and C750; Cirrus SR20 and SR22; Diamond DA40 and DA42; Embraer Phenom 100 and 300; HBC G36 and G58; Learjet 40/45 and 70/75; Mooney M20R and M20S; Piper Seminole, Seneca, Matrix, Mirage and Meridian; Socata TBM 850; HondaJet.
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**Primus 1000** (in remarks)	micro DADC digital AHRS or IRS	IC-600 combined	28 VDC	varies by installation varies by installation	varies by version varies by version	Digital fail-passive system. CAT II-capable; ARINC 429 interfaces, two-, three-, four- or five-tube, 8 in. x 7 in. EFIS. Bombardier Learjet 40, 45 and 45XR; Embraer ERJ-135, 140 and 145; Cessna Bravo, Encore, Excel and Ultra.

INTEGRATED FLIGHT CONTROL SYSTEMS

Manufacturer	Model	Air Data	Autopilot	Power	*Weight*	*Price*	Remarks
					AP Only	AP Only	
		Attitude Sensors	Flight Director		IFCS	IFCS	
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**Primus 1000** (in remarks)	micro DADC	IC-600	28 VDC	varies by installation	varies by version	Digital fail-passive system. CAT II-capable; ARINC 429 interfaces, two-, three-, four- or five-tube, 8 in. x 7 in. EFIS. Bombardier Learjet 40, 45 and 45XR; Embraer ERJ-135, 140 and 145; Cessna Bravo, Encore, Excel and Ultra.
		digital AHRS or IRS	combined		varies by installation	varies by version	
	Primus 1000 CDS	micro DADC	IC-615	28 VDC	varies by installation	varies by installation	Digital fail-passive system. CAT II-capable; ARINC 429 interfaces; two- to five-tube 10 in. x 8 in. LCD EFIS. Cessna Citation XLS.
		digital AHARS	combined		varies by installation	varies by installation	
	Primus 2000	micro DADC	IC-800	28 VDC	varies by installation	varies by version	Digital, dual-channel fail-passive system. CAT II-capable w/optional auto-throttle, dual-sensor monitoring; five- or six-tube 8 in. x 7 in. CRT EFIS. Global Express and Global 5000; Cessna Citation X; Dassault Falcon 900EX/C.
		digital AHRS or IRS	combined		varies by installation	varies by version	
	Primus Epic CDS	micro DADC	FZ-800	28 VDC	varies by installation	varies by installation	Digital fail-passive system. CAT II-capable, ARINC 429 interfaces. Two-, three-, four- or five-tube 10 in. x 8 in. EFIS. SyberJet SJ30-2.
		digital AHRS or IRS	combined		varies by installation	varies by installation	
	Primus Epic	air data module and micro IRS	integrated modular avionics unit	28 VDC	varies by installation	varies by installation	Integrates all traditional avionics into modular avionics unit. Digital, dual-channel; fail operational system. CAT II-capable w/optional auto-throttle and envelope protection. Includes two- to five-tube 10 in. x 8 in. LCD EFIS or four 13 in. LCDs. Agusta/Bell AB139; Citation Sovereign; Dassault Falcon 900EX, 2000EX and 7X; Embraer 170, 175, 190 and 195; Gulfstream G350, G450, G500 and G550; Hawker 4000.
		air data module and micro IRS			varies by installation	varies by installation	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 **www.rockwellcollins.com**	**APS 4000**	ADC-3000/3010 AHC-3000/4000	integrated	28 VDC	varies by installation	varies by installation	Available only as part of integrated Pro Line 21 system. Built-in diagnostics, dual channel, fail-passive, digital CAT-II certificated autopilot and flight director.
		—	—		varies by installation	see remarks	
	APS-65	AHC-3000	APS-65	28 VDC	varies by installation	varies by installation	Built-in diagnostics; digital Cat II certificated autopilot. Optional EFIS and AHRS. STC kit installer fabricated. Compatible with EFIS-84. *Typical configuration, *$155,976.*
		remote vertical gyro or dual AHRS	EFIS-84 (two tube)		50.6	*	
	APS-85	ADS-86	APS-85	28 VDC, 115 VAC, 400 Hz	varies by installation	varies by installation	Available only as full, dual-channel, fail-passive, digital system; digital Cat II autopilot, 4- or 5-tube EFIS optional; ARINC 429 IRS interface available; includes yaw damper; extensive built-in diagnostics. STC kit installer fabricated. Compatible with EFIS-84. *Typical configuration, *$290,388.*
		dual AHRS AHC-3000	EFIS-85 (three tube)		varies by installation	*	

COLLISION AVOIDANCE SYSTEMS

Manufacturer	Model	Display Interface Options	Processor Size	Price	Remarks
	TSO		Weight (lb.)		
ACSS an L3 & Thales Company 19810 N. 7th Ave. Phoenix, AZ 85023 (623) 445-7000 Fax: (623) 445-7001 **www.acss.com**	**TAWS+**	MFD, EFIS, weather wadar wisplay	2 MCU	$149,593	Terrain Advisory Line and Avoid Terrain features. With GPS version alerts based on aircraft climb capability.
	C151B Class A, C129b2		7.5		
	TCAS 2000 RT-950/951	MFD, EFIS, VSI/TCAS display	4 MCU - 14.7 6 MCU - 15.8	$245,367	Change 7.1 compliant. Standard positions on many regional and business jets. Bombardier, Cessna, Dassault, Embraer, Gulfstream, Hawker Beechcraft. (SFE selectable on all Airbus and Boeing aircraft.)
	C119b		—		
	TCAS 3000SP	MFD, EFIS, weather radar display	4 MCU - 13.85 6 MCU - 16.08	$254,271	Change 7.1 compliant. Flexible to add certified ADS-B in applications combined with TCAS.
	C119b		—		
	T^{2}CAS	MFD, EFIS, weather radar display, VSI/TCAS display	6 MCU - 15.8	$343,058	Combined TCAS and TAWS in one box. Change 7.1 compliant. ADS-B IN/Out capable. Certified on Airbus A320 family.
	C119b, C151b Class A, C129b2		—		
Avidyne Corp. 55 Old Bedford Rd. Lincoln, MA 01773 (800) 284-3963 Fax: (614) 885-8307 **www.avidyne.com**	**TAS600**	MFD, EFIS, weather displays, GPS map displays	7.25 x 11.67 x 3.10	$9,749	Detects and interrogates other aircraft transponders within range, displaying the surrounding traffic on a host of compatible display systems and provides audible and visual alerts in the event of a potential traffic conflict. Provides 30-second decision time at a closure rate of up to 1,200 kt. Head-Up Audible Position Alerting verbally indicates the conflicting aircraft's bearing, range and relative altitude for rapid visual acquisition of traffic. Includes Patented directional top and bottom antennas. Recommended for entry-level, single-engine piston aircraft. Features a 7-nm range, 3,500 ft. vertical separation maximum and 18,500-ft. service ceiling.
	C-147		8.71 (includes processor, dual antennas and coupler)		
	TAS605A	MFD, EFIS, weather displays, GPS map displays	7.25 x 11.67 x 3.10	$10,999	Recommended for mid-performance aircraft and helicopters. Features 13-nm range, 5,500-ft. vertical separation maximum and a 55,000-ft. service ceiling. Accepts ARINC 429 heading input, permitting rapid respositioning of targets during high-rate turns. VeriTAS correlates active-surveillance targets along with 1090 MHz ADS-B IN targets and provides ADS-B collision avoidance logic.
	C-147		8.71 (includes processor, dual antennas and coupler)		
	TAS615A	MFD, EFIS, weather displays, GPS map displays	7.25 x 11.67 x 3.10	$14,990	Recommended for high-performance aircraft and helicopters, the TAS615 features 17-nm range, 10,000-ft. vertical separation maximum and 55,000-ft. service ceiling. Accepts ARINC 429 heading, permitting rapid repositions of targets during high-rate turns. VeriTAS correlates active-surveillance targets along with 1090 MHz ADS-B IN targets and provides ADS-B collision avoidance logic.
	C-147		8.71 (includes processor, dual antennas and coupler)		
	TAS620A	MFD, EFIS, weather displays, GPS map displays	7.25 x 11.67 x 3.10	$20,990	Features 21-nm range, a 10,000-ft. vertical separation maximum and a 55,000-ft. service ceiling. Accepts ARINC 429 heading inut, permitting rapid repositioning of targets during high-rate turns.VeriTAS correlates active-surveillance targets along with 1090 MHz ADS-B IN targets and provides ADS-B collision avoidance logic.
	C-147		8.71 (includes processor, dual antennas and coupler)		

COLLISION AVOIDANCE SYSTEMS

Manufacturer	Model	Display Interface Options	Processor Size	Price	Remarks
	TSO		Weight (lb.)		
Garmin 1200 E. 151st. St. Olathe, KS 66062 (800)800-1020 (800)357-8200 Fax: (913) 397-8282 **www.garmin.com**	**TAWS-B**	GNS 400(W) series, 500(W) series GTN 600 series, GTN 700 series G600, G900X, G950, G1000, G1000 NXi G2000, G3000, G5000	—	varies with installation	
	C151 ETSO-C151		—		
	TAWS-A	GTN 600/700 series, G900X, G950, G1000, G2000, G3000, G5000	—	varies with installation	
	C151 ETSO-C151		—		
	HTAWS	GNS 400 (W) series, GNS 500 (W) series, GTN 600/700 series, G1000H, G5000H	N/A	varies with installation	Available as an option on GTN series touchscreen avionics, as well as legacy GNS 430W/530W navigators, HTAWS (Helicopter Terrain Awareness and Warning System) offers "forward looking" terrain and obstacle avoidance (FLTA) capability to alert in advance where potential hazards may exist.
	C194 ETSO-C194		N/A		
	GTS 800	GNS 400(W) series, 500(W) series, GTN 600 series, GTN 700 series GNS 480, GMX 200 G500, G600 G900X, G950, G1000(H), G1000 NXi G2000, G3000, G5000(H) Third-party controller and display	2.66 x 6.25 x 14.78	$9,995	TAS traffic surveillance system able to track up to 45 targets up to a 22-nm interrogation range
	C147 Class A ETSO C147 Class A C166b		1/8.92		
	GTS 825	GNS 400(W) series, 500(W) series GTN 600 series, GTN 700 series GNS 480, GMX 200 G500, G600 G900X, G950, G1000(H), G1000 NXi G2000, G3000, G5000(H) Third-party controller and display	6.2 x 3.0 x 12.1	$19,995	Affordable TAS Traffic survelliance system able to track up to 75 targets up to a 40-nm interrogation range.
	C147 Class A ETSO C147 Class A C166b ETSO C166b		1/11.3		
	GTS 855	GNS 400(W) series, 500(W) series GTN 600 series, GTN 700 series GNS 480, GMX 200 G500, G600 G900X, G950, G1000(H), G1000 NXi G2000, G3000, G5000(H) Third-party controller and display	3.42 x 6.25 x 14.78	$$24,995	TCAS I collision avoidance system able to track up to 75 targets within an 80-nm forward interrogation range
	C118 ETSO C118 C166b ETSO 166b		1/11.3		
	GTS 8000	GNS 400(W) series, 500(W) series GTN 600 series, GTN 700 series G900X, G950, G1000(H), G1000 NXi G2000, G3000, G5000(H) Third-party controller and display	3.42 x 6.25 x 14.78	$89,995	TCAS II Change 7.1 system, includes GTS 8000 TCAS processor and two GTX 3000 TCAS transponder.
	C119c ETSO C119c C116b ETSO C166b		1/11.3		

COLLISION AVOIDANCE SYSTEMS

Manufacturer	Model	Display Interface Options	Processor Size	Price	Remarks
	TSO		Weight (lb.)		
Honeywell Aerospace **BendixKing Avionics** 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KGP 560**	KMD 550 MFD, KMD 850 MFD and most MFDs	2.2 x 4.15 x 6.25	$12,865	EGPWS exceeds Class B requirements. Provides aural and visual warnings; Internal GPS; worldwide database by region.
	C151 Class B		1.5		
	BendixKing KGP 860	KMD 550 MFD, KMD 850 MFD and most MFDs	2.2 x 4.15 x 6.25	$15,615	EGPWS exceeds Class B requirements. Provides aural and visual warnings; internal GPS; worldwide database by region. EFIS displays additional warning modes.
	C151 Class B		1.5		
	Mark XXI	KMD 550 MFD, KMD 850 MFD and most MFDs	4.5 x 7.0 x N/A	$19,011	Helicopter EGPWS.
	C118 Class B		1.5		
	BendixKing KTA 870	KMD 550 MFD, KMD 850 MFD and most MFDs	4.5 x 7.0 x 13.8	$27,982	Traffic Advisory System (TAS) is an active system providing aural and visual advisories. Single or dual directional antennas.
	C147		8.75		
	KTA 970	dual-color, flat-panel LCD combined IVSI/TA display, KMD 550, EFIS, KMD 850 or weather radar	4.5 x 7.0 x 13.8	$36,767	TCAS I system.
	C118		8.75		
	BendixKing KMH 880	KMD 550 MFD, KMD 850 MFD and most MFDs	4.5 x 7.0 x 13.8	$43,730	Traffic Advisory System (TAS) and EGPWS in one box. Active traffic system providing aural and visual adviories. Single or dual directional antennas.
	C147, C151, Class B		8.75		
	BendixKing KMH 980	KMD 550 MFD, KMD 850 MFD and most MFDs	4.5 x 7.0 x 13.8	$56,723	TCAS I and GA-EGPWS.
	C118, C151 Class B		9.68		
	CAS 66A System	dual-color, flat-panel LCD combined IVSI/TA/RA display KTA 870, KMH 880, EFIS or weather radar	1/2 ATR-S (4 MCU)	$136,934	TCAS I system. Includes processor, control panel, directional antenna and IVSI/TA display. Does not include installation kits. Upgradable to TCAS II.
	C118		17.0		
	CAS 67A System	CAS-67A systems includes one TPU-67A ; TCAS Antenna; Mode S Transponder; TA/RA/VSI IVA 81D	1/2 ATR-S (4 MCU)	$231,799	
	C118		NA		
	CAS 67B System	CAS-67A systems includes one TPU-67A ; TCAS Antenna; Mode S Transponder; TA/RA/VSI IVA 81D	1/2 ATR-S (4 MCU)	$225,203	
	CAS-100 System C119c	Dual-color, flat-panel LCD combined IVSI/TA/RA display (included in price show). Also can interface with KMD 550 MFD, KMD 850 MFD, EFIS or weather radar	1/2 ATR (4 MCU)	$219,179*	CAS-100 system includes one TPA-100B with Change 7.1; one ANT-81A; one IVA-81D VSI display; one CTA-100A control panel. **BCA* estimate.
	C119c		1/13.5		
	EGPWS MK V-A	EFIS, MFD and radar indicators	7.9 x 2.4 x 12.8	$115,858 (without internal GPS)	MK V-A is for turbofan aircraft equipped with analog avionics.
			1/6.5		
	EGPWS MK XXI	See remarks	3.95 x 2.20 x 3.25		Helicopter EGPWS enhanced features: detailed terrain database, obstacle database, airports and heliports, look-ahead algorithms, terrain alerting, obstacle alerting, en route terrain display (peaks), pop-up feature, auto ranging feature, geometric altitude, enhanced envelope modulation, speed expansion, internal GPS card.

COLLISION AVOIDANCE SYSTEMS

Manufacturer	Model	Display Interface Options	Processor Size	Price	Remarks
	TSO		Weight (lb.)		
Honeywell Aerospace BendixKing Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**KGX 150T ADS-B UAT Transceiver**	Mode A/C and Mode S transponder interface 2 ARINC 429; 1 RS 485 and 4 discrete inputs 1 RS 232/422 and 2 discrete outputs 10-40 VDC input voltage .02 A @ 12 VDC Input current 6.5 VDC output voltage 350 mA output	5 x 5.75 x 1.7	$2,849	ADS-B receiver and UAT transmitter with optional Wi-Fi, best optimized for the those who fly below 18,000 ft. Also includes an integrated ADS-B OUT Compliant WAAS GPS. The KGX 150T provides the ADS-B traffic and weather services to non-certified wireless tablet or certified compatible panel display. An optional control head is available for additional ADS-B required information and annunciations.
	TSO-C157A (FISB) TSO-C195A (TIS-B) TSO-C154C (UAT) TSO-C145C (for GNSS) DO-160G DO-178B level C DO-254 Level C STC Approved in accordance with AC20-165A				
	KGX 150R ADS-B UAT Receiver with Integrated WAAS	Mode A/C and Mode S transponder interface 2 ARINC 429; 1 RS 485 and 4 discrete inputs 1 ARINC 429; 4 RS 232/422 and 2 discrete outputs 10-40 VDC input voltage .02 A @ 12 VDC Input current 6.5 VDC output voltage 350 mA output	5 x 5.75 x 1.7	$2,648	ADS-B receiver with optional Wi-Fi, best optimized for those who fly above and below 18,000 ft. or want to replace their existing transponder with the KT 74 1090 extended squitter transponder. Also includes an integrated ADS-BOUT Compliant WAAS GPS. The KGX 150R provides the ADS-B traffic and weather services to non-certified wireless tablet or certified compatible panel display. No external controller is needed.
	TSO-C157A (FISB) TSO-C195A (TIS-B) TSO-C154C (UAT) TSO-C145C (for GNSS) DO-160G DO-178B level C DO-254 Level C STC Approved in accordance with AC20-165A				
	KGX 130R ADS-B UAT Receiver	Mode A/C and Mode S transponder interface 2 ARINC 429; 1 RS 485 and 4 discrete inputs 1 ARINC 429; 4 RS 232/422 and 2 discrete outputs 10-40 VDC input voltage .02 A @ 12 VDC input current 6.5 VDC output voltage 350 mA output	5 x 5.75 x 1.7	$1,699	ADS-B receiver with optional Wi-Fi, best optimized for those who fly above and below 18,000 ft. and want to replace their existing transponder with the KT 74 1090 extended squitter transponder. The KGX 130R uses your existing WAAS Garmin GNS 430W/530W GPS and provides the ADS-B traffic and weather services to non-certified wireless tablet or certified compatible panel display.
	TSO-C157A (FISB) TSO-C195A (TIS-B) TSO-C154C (UAT) DO-160G DO-178B level C DO-254 Level C STC Approved in accordance with AC20-165A				
L3 Aviation Products 5353 52nd St. S.W. Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3aviationproducts.com**	**LandMark TAWS 8000**	TAWS compatible Arinc 453 EFIS, Arinc 453 weather radar indicators and compatible MFDs. Display on non-Arinc 453 radar indicators requires the RGC 350 Radar Graphics Computer (sold separately)	7.0 x 2.25 x 9.0	$14,120	Remote processor that offers predictive warning functions using position data from a GPS receiver, flight configuration and an internal terrain and obstacle database. Both aural and visual warnings are issued whenever CFIT situations arise. LandMark is designed to meet or exceed Class B requirements of TSO C151a. Baro-corrected altitude input required.
	C151a Class B		3.35		
	LandMark TAWS 8100	AWS compatible Arinc 453 EFIS, Arinc 453 weather radar indicators and compatible MFDs. Display on non-Arinc 453 radar indicators requires the RGC 350 Radar Graphics Computer (sold separately)	7.0 x 2.25 x 9.0	$15,230*	Features a WAAS GPS Sensor. With its accurate positioning information, the LandMark 8100 eliminates the need for multiple inputs from other aircraft sensors, simplifying the installation. The 8100 provides the highest integrity terrain data without complicated GPS, ADC or OAT inputs. 320 nm range. **BCA* estimate.
	C151b Class B		3.40		

COLLISION AVOIDANCE SYSTEMS

Manufacturer	Model	Display Interface Options	Processor Size	Price	Remarks
	TSO		Weight (lb.)		
L3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3aviataionproducts.com**	**Lynx NGT-9000+**	see remarks	6.25 x 1.8 x 10.75	$9,555	Panel-mounted touchscreen transponder that also displays traffic information onto compatible flight displays and iPad and Android apps. Can be configured to view ADS-B and active traffic on the same screen without the need for additional boxes. Aural traffic alerting is an available option.
			5.2		
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-1000 Fax: (319) 295-2297 **www.rockwellcollins.com**	**TCAS 4000**	Collins EFIS, MFD TCAS compatible VSI (RA) Collins TVI-920 (RA, TA)	4 MCU	$422,064* (typical installation)	TCAS II system. European ACAS compatible Mode S Level III. AC/DC in one part number includes control panel and two TRE antennas. Displays range/alt. separation from traffic. Max range 3 mi. Two surveillance volumes and MSL of traffic. Top/bottom antennas to optimize coverage. Upgrades to 8800 Gold. **BCA* estimate.
	C119 (C119a when issued)		17.0		
Sandel Avionics 2401 Dogwood Way Vista, CA 92081 (877) 726-3357 ((760) 727-4900 Fax: (760) 727-4899 **www.sandel.com**	**ST3400H HeliTAWS**	Integrated rear projection LCD with LED backlighting	3 ATI panel-mount	$18,950	3-ATI helicopter TAWS with integrated display. Can replace existing radar altimeter indicator. Sunlight readable LED backlit display with 180 deg. viewing angle and over 10,000-hr. MTBF. NVIS compatible version $22,200.
	C87, C113, C151b, C194		2.9		
	ST3400 TAWS	Integrated rear projection LCD with LED backlighting	3 ATI panel-mount	$24,250	3-ATI Class A or Class B TAWS with integrated display. Sunlight readable LED backlit display with 180-deg. viewing angle and over 10,000 hr. MTBF. Optional interface for traffic, $980. Class A version, $38,600.
	C113, C151b		2.9		
Universal Avionics Systems Corp. 3260 E. Universal Way Tucson, AZ 85756 (520) 295-2300 (800) 321-5253 Fax: (520) 295-2395 **www.uasc.com**	**TAWS A** **TAWS B**	*Universal Avionics* EFI-890R, MFD-640, UNS FMS (5-in. display) *Honeywell* numerous weather radar, MFD and EFIS displays *Rockwell Collins* numerous weather radar, MFD and EFIS displays *Smiths* BAE ATP EFIS additional display options available	2 MCU LRU	*TAWS A* $40,700 *TAWS B* $26,200	Worldwide terrain database with 480+ MB data. High-resolution analog video views; 3-D perspective view; profile view; map view. Map view of terrain can be output using ARINC 708 or WXPF formats for interface with various existing weather radars. Both version include obstacle database.
	C151b, C92c		9.6		

COCKPIT VOICE RECORDERS (CVR)/FLIGHT DATA RECORDERS (FDR)

Manufacturer	Type	Recording Medium	Size	Price	Remarks
	Model				
	TSO	Duration	Weight (lb.)	Power Required	
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**Business Aviation**	solid-state	7.45 x 5.92 x 4.0	N/A	A fully compliant recorder developed for business aviation. **BCA* estimate.
	LW-CVR (429)	120 min.	<7.0 with AR for factor mounting adapter	28 VDC	
	980-6044-002				
	Air Tranport	solid-state	½ ATR Short	N/A	A fully compliant recorder developed air business aviation.
	HFR5-CVR	120 min.	8.6	28 VDC 115 AC	
	980-6032-003				
	Business Aviation	solid-state	7.45 x 5,92 x 4.0	N/A	A fully compliant recorder developed air business aviation.
	LW-FDR (717)	25 hr. @ 512 wps	<7.0 with AR form foactor mounting adapter	28 VDC	
	980-4131-002				
	Air Transport	solid-state	½ ATR Long or Short	N/A	A fully compliant recorder developed air business aviation.
	HFR5-FDR	25 hr. @ 1,024 wps	10.0	115 VAC 28 VDC	
	½ ATR Long only				
	Business Aviation	solid-state	7.45 x 5. 92 x 4.0	N/A	A fully compliant recorder developed air business aviation.
	LWCVR/FDR	120 min. CVR 25 hr. @512 wps FDR	<7.0 with AR form factor mounting adapter	28 VDC	
	980-6050-042 (429 input) 980-6050-072 (717 imput)				
	—	solid state, digital	8.8	N/A	Non-ARINC size with underwater locator beacon; control panel and mounting tray not required. ARINC 557 and ARINC 757.
	CVR AR 120 CVR	120-min. CVR	9.5 x 5.88 x 5.75	28 VDC	
	980-6023-002 ED 56A, C123a				
	—	solid-state, digital	8.8	N/A	Non-ARINC FDR, ARINC 717, 429. Mounting tray not required.
	AR FDR	25 hr. @ 64, 128, 256 wps	9.5 x 5.88 x 5.75	28 VDC	
	980-4710-00X ED 55, C124e				

COCKPIT VOICE RECORDERS (CVR)/FLIGHT DATA RECORDERS (FDR)

Manufacturer	Type Model TSO	Recording Medium Duration	Size Weight (lb.)	Price Power Required	Remarks
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**CVR** **AR 120 CVR 980-6023-002** ED 56A, C123a	solid-state, digital 120 min.	9.5 x 5.88 x 5.75 8.8	N/A 28 VDC	Non-ARINC size with underwater locator beacon; control panel and mounting tray not required. ARINC 557 and ARINC 757.
	CVR **SSCVR 980-6022-011** ED 56A, C123	solid-state, digital 120 min.	½ ATR Short 11.5	N/A 28 VDC 115 AC	Solid-state CVR with underwater locator beacon. ARINC 557 and ARINC 757.
	DVDR/FDR **AR Combi 980-6021-06X** ED 56A, C123a	solid-state, digital 120-min. voice; 25-hr. data @ 64, 128, 256 wps	½ ATR Short 11.5	N/A 28 VDC	Combination CVR/FDR; ARINC Form Factor. Mounting tray not required. Data download through front access PCMCIA.
L3 Aviation Recorders 100 Cattlemen Rd. Sarasota, FL 34232 (941) 371-0811 **www.L3aviationproducts.com**	**CVR/FDR** **FA2100** C123b, C124b, EUROCAE ED-112	solid-state 2-hr. min. CVR; 25-hr. min. FDR	1/½ ATR Short CVR; 1/2 ATR Short or Long FDR CVR/FDR Short: 12.6 x 5.0 x 5.5 FDR Long: 19.6 x 5.0 x 5.5 10.0	$32,719, CVR $39,261 FDR 115 VAC 400 Hz or 28 VDC	Includes underwater locator beacon, mounting tray required. ARINC 757 connector CVR, ARINC 747 connector FDR, GMT or FSK time-signaling source for CVR. Separate RIPS module available for CVR, rotor-speed input for CVR for helicopter applications; CPDLC data link recording for CVR; minimum 25-hr. 64 wps up to 1024 wps recording rate for FDR; ramp (portable) and shop (bench) GSE hardward and software diagnostics and readout tools optional.
	CVDR **FA2100** C123b, C124b, EUROCAE ED-112	solid-state 2-hr. min. CVR; 25-hr. min. FDR	½ ATR Short 12.6 x 5.0 x 5.5 10.0	$54,575 115 VAC 400 Hz or 28 VDC	Includes underwater locator beacon, mounting tray required. ARINC 757 connector, GMT or FSK time-signaling source for CVR. Separate RIPS module available for CVR, rotor-speed input for CVR for helicopter applications; CPDLC data link recording for CVR, OMS output for CVR, minimum 2-hr. 4-channel high-quality audio recording for CVR, minimum 25-hr., 128 wps up to 1024 wps recording rate for FDR; rap (portable) and shop (bench) GSE hardware and software diagnostics and readout tools available.
	CVR/FDR **CVDR Model FA5000** C123b — CVR C124b — FDR EUROCAE ED-112 — CVR and FDR	solid-state 2-hr. min. CVR; 25-hr. min. FDR	½ ATR Short 12.6 x 4.8 x 6.5 7.9	$50,703 115 VAC 400 Hz or 28 VDC	Includes underwater locator beacon, mounting tray required. MIL-C-38999 connector, GMT or FSK time-signaling source for CVR. Separate RIPS module available for CVR, rotor-speed input for CVR for helicopter applications; CPDLC data link recording for CVR, OMS output for CVR, minimum 2-hr. 4-channel high-quality audio recording for CVR, minimum 25-hr., 128 wps up to 1024 wps recording rate for FDR; rap (portable) and shop (bench) GSE hardware and software diagnostics and readout tools available. Ethernet data output.

COCKPIT VOICE RECORDERS (CVR)/FLIGHT DATA RECORDERS (FDR)

Manufacturer	Type	Recording Medium	Size	Price	Remarks
	Model	Duration	Weight (lb.)	Power Required	
	TSO				
L3 Aviation Recorders 100 Cattlemen Rd. Sarasota, FL 34232 (941) 371-0811 **www.L3aviationproducts.com**	**CVDR/SRVIVR**	solid-state	6.55 x 5.55 x 3.25	$40,675	Same as FA5000
	—	2 hr. CVR 25 hr. FDR	6.75	28 VDC	
	C123b, C124b EUROCAE Ed-112				
	Lightweight Data Recorder	solid-state	8.0 x 3.9 x 4.9	$21,370	No mounting tray required; 2-hr. 2-channel voice recording; 25-hr. GPS data recording; 5-hr. ARINC 717 data recording; 2-hr. analog video recording at 5 fps. Ethernet data output.
	LDR	2 hr. CVR 25 hr. FDR 2-hr. video	5.0	28 VDC	
	C197, EUROCAE ED-155				
	Micro Quick Access Recorder	Minimum 2 GB compact flash memory	2.7 x 2.2 x 1.8	$8,513	ARINC 573/717/747 compatible; data rates 64 wps up to 1024 wps; USB or Ethernet data output. Fixed or removable flash card media. Data download software utility optional.
	—	—	6 oz.	115 VAC 400 Hz or 28 VDC	
	—				
Universal Avionics Systems Corp. 3260 E. Universal Way Tucson, AZ 85756 (520) 295-2300 Fax: (520) 295-2395 **www.uasc.com**	**Combi CVR/FDR**	solid-state flash memory	6.0 x 4.9 x 8.0	$19,500	No internal batteries. No periodic maintenance. Four channels of cockpit audio data, UTC from ARINC 429 bus, UTC from a Frequency Shift Keying (FSK) signaling source, Rotor Speed for helicopter application. ARINC 717 Flight Data Recording, analog/digital sensor signals via FDAU, ARINC 758 data link information. PC-based ramp testing/diagonstics.
	CVFDR-145	120-min. voice & ambient audio +25 hr. (min.) Flight data +120 minute data link messaging	7.0	28 VDC	
	C123b, C124b, C177, C123a, C124a, EUROCAE ED-112				
	Combi CVR/FDR w/ embedded Re-dorded Independedt Power Supply (RIPS)	solid-state flash memory	6.0 x 4.9 x 8.0	$27,500	Embedded RIPS. Solid state memory. No internal batteries. No periodic maintenance. Four channels of cockpit audio data, UTC from ARINC 429 bus, UTC from a Frequency Shift Keying (FSK) signaling source, Rotor Speed for helicopter application. ARINC 717 Flight Data Recording, analog/digital sensor signals via FDAU, ARINC 758 data link information. PC-based ramp testing/diagonstics.
	CVFDR-145R	120-min. voice & ambient audio +25 hr. (min.) Flight data +120 minute data link messaging	8.68	28 VDC	
	C123b, C124b, C155, C177, C123a, C124a, EUROCAE ED-112				
	CVR	solid-state flash memory	6.0 x 4.9 x 8.0	$16,500	No internal batteries. No periodic maintenance. Four channels of cockpit audio data, UTC from ARINC 429 bus, UTC from a Frequency Shift Keying (FSK) signaling source, rotor Speed for helicopter applications, ARINC 758 data link information. PC-based ramp testing/diagonstics.
	CVR-120A	120-min. voice & ambient audio	7.9	28 VDC	
	C123b, C177, C123a, EUROCAE ED-112				

COCKPIT VOICE RECORDERS (CVR)/FLIGHT DATA RECORDERS (FDR)

Manufacturer	Type	Recording Medium	Size	Price	Remarks
	Model				
	TSO	Duration	Weight (lb.)	Power Required	
Universal Avionics Systems Corp. 3260 E. Universal Way Tucson, AZ 85756 (520) 295-2300 Fax: (520) 295-2395 **www.uasc.com**	**CVR** w/embedded Recorded Independent Power Supply (RIPS)	solid-state flash memory	6.0 x 4.9 x 8.0	$24,500	Embedded RIPS. Solid-state memory. No internal batteries. No periodic maintenance. Four channels of cockpit audio data, UTC from ARINC 429 bus, UTC from a Frequency Shift Keying (FSK) signaling source, rotor speed for helicopter applications. ARINC 758 data link information. PC-based ramp testing/diagonistics.
	CVR-120R	120 min. voice & ambient audio	8.68	28 VDC	
	C123b, C155, C177, C123a, EUROCAE ED-112				
	FDR	solid-state flash memory	6.0 x 4.9 x 8.0	$16,500	No internal batteries. No periodic maintenance. ARINC 717 Flight Data Recording. Additional data storage beyond 25 hr., analog/digital sensor signals via FDAU. PC-based ramp testing/diagonstics.
	FDR-25	25 hr. (min) Flight data + 120 min. data link messaging	7.9	28 VDC	
	C124b, C124a, EUROCAE ED-112				

HEAD-UP DISPLAYS

Manufacturer	Model	Inputs & Outputs	Units/Weight (lb.)	Price	Remarks
			Size or Form Factor	Power Required	
Elbit Systems of America-Fort Worth Operations 4700 Marine Creek Pkwy. Fort Worth, TX 76179 **www.elbitsystems-us.com**	Advanced Technology HUD (AT-HUD)	ARINC 429, ARINC 615 descrets, Enchaced Vision (EVS) video, Synthetic Vision (SVS) video	3/35.0	$356,000*	Fully digital EFVS video ready LCD HUD that is compact and lightweight. *Contact manufacturer for specific pricing.
			14.0 x 6.0 x 5.0	28 VDC	
Rockwell Collins (Head Up Guidance Systems) 400 Collins Rd. NE Cedar Rapids, IA 52498 **www.rockwellcollins.com**	**HGS-4000**	ARINC 429, various discretes, enhanced vision, synthetic vision	48.0 - 55.0	$409,405*	Provides Cat III landing and Low Visibility Takeoff capability. *BCA estimate
			3 LRUs	N/A	
	HGS-3500	ARINC 429, various discretes, enhanced vision, synthetic vision	varies by configuration/less than 15 lb.	Price not provided	Compact wave-guide Head-Up Display developed for light to midsize business aircraft applications.
			3 LRUs		
	HGS-5000	ARINC 429, various discretes, enhanced vision, synthetic vision	48.0 - 53.0	Price not provided	First-generation digital Head-Up Display developed for numerous commercial and business aircraft platforms.
			3 LRUs		
	HGS-6000	ARINC 429, various discretes, enhanced vision, synthetic vision	40.0 - 46.0	Price not provided	Second-generation digital Head-Up Diplsay developed for numerous commercial and business aircraft platforms.
			3 LRUs		

AIRCRAFT SITUATION DISPLAYS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Display Size			Size or Form Factor	Power Required	
Aspen Avionics 5001 Indian School Rd. NE Albuquerque, NM 87110 (505) 856-5034 Fax: (505) 314-5440 **www.aspenavionics.com**	**1000 MFD**	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/static quick connect	ARINC 429 (1) RS-232 (3)	*display:* 2.6 lb w/mounting bracket *remote sensor:* 0.2 lb	$8,995*	Includes integral ADAHRS backup battery and emergency GPS, integral altitude alterter/preselect, GPS flight plan map views: 360° and arc, slaved directional gyro with heading bug.
	C2d, C3d, C4c, C6d, C8d, C10b, C106, C113	6.0-in diag.			*display:* 3.50 x 7.0 x 4.15 *depth:* 6.35 in. *remote sensor:* 2.65 x 4.40 x 1.0 in.	14-28 VDC (provided by PFD)	
	1000C3 Pro	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/static quick connect	ARINC 429 (1) RS-232 (3)	*display:* 2.6 lb w/mounting bracket *remote sensor:* 0.2 lb	$8,995	Same as EFD 1000, plus full EHSI with dual bearing pointers; dual GPS, dual VHF nav support; autopilot and flight director integration; integral GPS steering; base map with curved flight paths; (optional) traffic, weather overlays.
	C2d, C3d, C4c, C6d, C8d, C10b, C106, C113	6.0-in. diag.			*display:* 3.50 x 7.0 x 4.15 *depth:* 6.35 in. *remote sensor:* 2.65 x 4.40 x 1.0 in.	14-28 VDC (provided by PFD	
	EFD1000 Pro Primary Flight Display	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/ static quick connect		Display: 2.6 lbs w/ mounting bracket remote sensor: 2.65.4.40 x 1.0	$10,995	Economical full-feature glass primary flight display for GA retrofit; EFIS six-pack replacement; Compatible with many avionics.
	C2D, C3D, C4C, C6D, C8D, C10B, C106, C113	6.0-in. diag.			Display: 3.50 x 7.0 x 4.15, depth: 6.35-in. remote sensor: 2.65 x 4.40 x 1.0 in.	8 to 32 VDC	
	EFD1000 Multifunction Display	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/ static quick connect		Display: 2.6 lb. w/ mounting bracket remote sensor: 2.65. x 4.40 x 1.0 in.	$8,995	Duplicate sensor set providing full PFD redundancy; may eliminate requirement for backup instruments; sectional-style moving maps with hazard awareness overlays; charts and geo-referenced airport diagrams; customizable screen layouts; built-in back-up battery and emergency GPS.
	C2D, C3D, C4C, C6D, C8D, C10B, C106, C113	6.0-in. diag.			Display: 3.50 x 7.0 x 4.15, depth: 6.35-in. remote sensor: 2.65 x 4.40 x 1.0 in.	8 to 32 VDC	
	EFD1000 Pro Plus Primary Flight Display	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/ static quick connect		Display: 2.6 lb. w/ mounting bracket remote sensor: 2.65.4.40 x 1.0 in.	$13,995	EFD1000 PFD with Evolution Synthetic Vision and angle of attack indicator; Lowest price full-featured glass panels for GA retrofit; advanced EFIS six-pack replacement; works with your panel's existing avionics — nearly every GPS or nav radio; broadest autopilot/flight director support.
		6.0-in. diag.			Display: 3.50 x 7.0 x 4.15, depth: 6.35-in. remote sensor: 2.65 x 4.40 x 1.0 in.	8 to 32 VDC	
	EFD500 Multifunction Display	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/ static quick connect		Display: 2.6 lb. w/ mounting bracket remote sensor: 2.65.4.40 x 1.0 in.	$5,495	Sectional-style moving maps with hazard awareness overlays; customizable screen layouts; dharts and geo-referenced airport diagrams; built-in backup battery; broadest autopilot/flight director support.
	C113	6.0-in. diag.			Display: 3.50 x 7.0 x 4.15, depth: 6.35-in. remote sensor: 2.65 x 4.40 x 1.0 in.	8 to 32 VDC	
	EFD1000 VFR Primary Flight Display	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/ static quick connect		Display: 2.6 lbs w/ mounting bracket Remote Sensor: 2.65.4.40 x 1.0 in.	$4,995	Consolidates traditional six-pack instrument information plus CDI into a single display with a back battery and emergency GPS; Lowest price, full-featured PFD for GA aircraft; works with your panel's existing avionics; unique PFD design slides into existing panel cutouts; Options include autopilot interface, (GPS steering); weather and traffic; Affordable upgrades include HSI; bearing pointer and IFR features with easy software upgrade.
	C2D, C3D, C4C, C6D, C8D, C10B, C106, C113	6.0-in. diag.			Display: 3.50 x 7.0 x 4.15, depth: 6.35-in. Remote Sensor: 2.65 x 4.40 x 1.0-in.	8 to 32 VDC	

AIRCRAFT SITUATION DISPLAYS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Display Size			Size or Form Factor	Power Required	
Aspen Avionics 5001 Indian School Rd. NE Albuquerque, NM 87110 (505) 856-5034 Fax: (505) 314-5440 **www.aspenavionics.com**	**EFD1000H Helicopter Primary Flight Display**	TFT AMLCD (400 x 760)	ARINC 429 (5) RS-232 (5) Pitot/ static quick connect		Display: 2.6 lb. w/ mounting bracket Remote Sensor: 2.65.4.40 x 1.0 in.	$15,195	Special vibration mount meets DO-160F helicopter vibration standards; airspeed and altitude tapes, with altitude alerter; built-in GPS steering; full electronic HSI with dual bearing pointers; base map with flight plan legs and waypoints; integral air data computer and attitude heading reference system; built-in back-up battery; optional evolution hazard awareness provides traffic and weather displays; lowest price, full-featured glass panels; works with your panel's existing avionics.
	C2D, C3D, C4C, C6D, C8D, C10B, C106, C11	6.0-in. diag.			Display: 3.50 x 7.0 x 4.15, depth: 6.35-in. Remote Sensor: 2.65 x 4.40 x 1.0-in.	8 to 32 VDC	
Avidyne Corp. 55 Old Bedford Rd. Lincoln, MA 01773 (800) 284-3963 Fax: (614) 885-8307 **www.avidyne.com**	**EX600**	AMLCD	RS-232 ARINC 429 ARINC568 DME	ARINC 429	4.75	$8,995 without radar; starting at $12,990 w/radar	Full overlay of GPS flight plan along with traffic, wx radar, data-linked wx, and special-use airspace. Features include full vector-based moving map and interfaces for traffic and lightning, CMax approach charts and airport diagrams, plus 20 different radar models. Many optional radar interfaces and acts as a display replacement for many older CRT radar displays.Dedicated knobs for radar control of tilt and bearing, plus second set of context-sensitive knobs for range and other functions. Features map panning keys and allows pilot to toggle between the present position and a panned-to position — such as destination airport — with a single button push. Many options available.
	C63c, C110a, C113, C118, C147, C157, C43c, C106	5.7-inch diagonal 640 x 480 pixels (VGA)			6.25 x 4.93 x 11.0	28VDC	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (800) 357-8200 Fax: (913) 397-8282 **www.garmin.com**	**TAWS -B**	GNS 400 (W) series, 500 (W) series	Not provided by manufacturer	N/A	N/A	Varies	
	C151 ETSO-C151	—			N/A	N/A	
	TAWS-A	GTN 600 series, GTN 700 series, G900X, G950	Not provided by manufacturer	N/A	N/A	Varies	
	C151 ETSO-C151	—			N/A	N/A	

AIRCRAFT SITUATION DISPLAYS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Display Size			Size or Form Factor	Power Required	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (800) 357-8200 Fax: (913) 397-8282 **www.garmin.com**	**GTS 800**	GNS 400 (W) series, 500 (W) series, GTN 600 series, GTN 700 series, GNS 480, GMX	Not provided by manufacturer	—	1/8.92	$9,995	TAS traffic surveillance system able to track up to 45 targets up to a 22-nm interrogation range.
	C147 Class A ETSO 147 Class A C166B	—			2.66 x 6.25 X 14.78	2.6A @ 14 VDC 1.5A @ 28 VDC	
	GTS 825	GNS 400 (W) series, 500 (W) series, GTN 600 series, GTN 700 series, GNS 480, GMS 200	Not provided by manufacturer	—	1/11.3	$19,995	TAS traffic surveillance system able to track up to 75 targets up to a 40-nm interrogation range.
	C147 Class A ETSO 147 Class A C166B ETSO C166b	—			3.42 x 6.25 x 14.78	3.5A @ 14 VDC 1.7A @ 28 VDC	
	GTS 855	GNS 400 (W) series, 500 (W) series, GTN 600 series, GTN 700 series, GNS 480, GMX	Not provided by manufacturer	—	1/11.3	$24,995	HIgh-performance TCAS I collision avoidance solution able to track up to 75 targets within an 80-nm forward interrogation range.
	C118 ETSO C118 C116b ETSO C166b	—			3.42 x 6.25 x 14.78	3.5A @ 14 VDC 1.7A @ 28 VDC	
	GTS 8000	GNS 400 (W) series, 500 (W) series, GTN 600 series, GTN 700 series, G900X, G950	Not provided by manufacturer	—	1/11.3	$89,995	TCAS II Change 7.1 syste, includes GTS 8000 TCAS processor and two GTX 3000 TCAS transponders.
	C119c ETSO C119c C166b ETSO C166b	—			3.42 x 6.25 x 14.78	3.5A @ 14 VDC 1.7A @ 28 VDC	

AIRCRAFT SITUATION DISPLAYS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Display Size			Size or Form Factor	Power Required	
Honeywell Aerospace BendixKing 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KDR 610 XM Weather Receiver**	see remarks	weather displays via XM satellite	weather displays via XM satellite interfaced to Bendix/King KMD 250, KMD 550 and KMD 850 MFDs	1/1.5	$6,888	Part of an MFD system; data link weather receiver provides high- speed textual and graphical weather to the cockpit. Available weather products include composite NEXRAD radar, graphical METARs, AIRMETS and SIGMETS. The active flight plan can be overlaid on all graphical weather images. System enables user to pan, zoom and interrogate areas of interest via joystick.
	C157	see remarks			see remarks	10-32 VDC	
	BendixKing KSN 770/765 Integrated Navigator WAAS/GPS/ NAV (KSN 770 only)/COMM (KSN 770 only)/MFD	Active Matrix LCD, 40 x 480 pixels (Full VGA) / 5.7 in. diagonal	ARINC 429 input; 10 ARINC 429 output; 2 RS-232 input; 4 RS-232 output; 4 RS-222 input; 3 RS-222 output; 28 discrete input; 20 discrete output		1 / (770/765) 9.9/ 8.1 / 6.25” x 5.25” x 10”	List Price Starting at $10,995	KSN 770 combines GPS navigation, terrain mapping, charting and safety sensor displays. It can also display XM Datalink Weather, radar-based weather, traffic and terrain. Offers many ways to interface with information via a combination of hard buttons, cursor control and touchscreen. The KSN 770 features Wide Area Augmentation System (WAAS) and Localizer Performance with Vertical Guidance (LPV). Can also display safety systems including on-board weather radar, Enhanced Ground Proximity Warning System (EGPWS), XM Datalink Weather. Numerous options.
	N/A	see remarks			N/A	11-33 VDC	
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602 365-3343 **www.honeywell.com**	**Honeywell MFRD**	LCD	RS-232 ARINC 429, radar, datalink, EGPWS, traffic, NTSC video	display	1/7.5	$64,525	Multi-function display of weather radar, traffic, terrain, navigation maps, checklists.
	C63c, C110a, C113, C196	6 in. diag.			6.24 (w) x 4.82 (h) x 8.38 (panel depth)	28 VDC or 115 VAC 400 Hz	
Innovative Solutions & Support (IS&S) 720 Pennsylvania Dr. Exton, PA 19341 (610) 646-9800 **www.innovative-ss.com**	**Integrated Standy Unit (ISU)**	10-, 15-, 17-, 20-in. flat panel displays	RS 422/232: 3 channels Input/Output ARINC 429: Optional 6 inputs (configurable for VOR, ILS, DME, FMS, GPS)	2 outputs, high speed/ low speed (softward configurable)	N/A	N/A	Calculates and displays altitude, attitude, airspeed, slip/skid and navigation display information.
	NA	N/A			3 ATI clamp mount, optional panel mount	28 VDC 9.8 W	
L3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3aviationproducts.com**	**Trilogy ESI-1000**	AMLCD; optional NVG compatibility	N/A	N/A	1/2.22	$14,995	Electronic standby instrument designed to level “A” software and hardware compliances, the Trilogy ESI replaces traditional standby instruments and combines attitude, altitude and airspeed infomation into a compact 3.8-in. diagonal display while maintaining a 3-ATI chassis design. Heading is available when coupled with the optional magnetometer. For fixed-wing and helicopter applications.
	C2d, C3e, C4c, C6e, C10b, C46a, C113, C179	4.0 x 3.0			3-ATI chassis 4.0 x. 3.35 x 7.66	14-28 VDC	

AIRCRAFT SITUATION DISPLAYS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Display Size			Size or Form Factor	Power Required	
L3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3aviationproducts.com**	**Trilogy ESI-2000**	AMLCD; optional NVG compatibility	NA	NA	1/2.56	$15,700	Electronic standby instrument incorporates an internal battery to meet the requirements for independent, dedicated back-up power for aircraft without dual electrical system. The lithium ion battery is integrated into the ESI-2000 hardware with a triple redundant safetydesign and provides a minimum of 1 hr. and up to 4 hr. of standby power. Heading is available when coupled with the optional magnetometer. For fixed-wing and helicopter applications.
	C2d, C3e, C4c, C6e, C10b, C46a, C113, C179	4.0 x 3.0			3-ATI chassis 4.0 x. 3.00 x 6.7	14-28 VDC	
	GH-3900 ESIS	Active matrix LCD	ARINC 429, RS-232, discrete and analog	ARINC 429, RS-232, discrete and analog	1/3.0	$38,000	Features a lighter and shorter chassis than previous models and allows the installer to define multiple I/O interfaces., SSEC and VMO values. An Aircraft configuration PC Software Tool simplifies the setup of the unit, allowing installers to define and customize the presentation of colors, flight cues and navigation data. Designed for FAR Part 25, Part 23 (Class III & IV). Part 27 and Part 29. Variety of air data and heading input options as well as built-in accelerometers. Classified as Non-ITAR.
	C2d, C3e, C4c, C6e, C8e, C10b, C34e, C35d, C36e, C40c, C46a, C66c, C95a, C106, C113, C115b, C145c	3 ATI			8.33 x 3.19 x 3.19	Dual 28 VDC inputs (18 VDC emergency power)	
	GH-39RSU ESIS	DU-42 Display Acitve Matrix LCD	DU-42 Display: 3 ARINC 429; 1 USB Serial Bus; 1 RS-232 Serial Bus; 12C Serial Bus; 1 Analog Remote Sensor Unit: 7 ARINC 429; 1 RS-232 Serial Bus; 6 Discrete Pneumatic pressure ports	DU-42 Display: 1 ARINC 429 Remote Sensor Unit: 3 ARINC 429; 2 Discrete; 2 Analog	DU-42 Display: 1.5 Remote Sensor Unit: 3.0	N/A	Features a 4.2-in. diagonal igh-resolution display (DU-42) and a separate Remote Sensor Unitt (RSU). 1.5-in.-deep display allows installation in aircraft with limited space behind the panel. Configurable I/O interfaces and SSEC and VMO values, as well as display parameters. Designed for FAR Part 25 and Part 23 (Class III & IV aircraft, and Part 27 and Part 29 helicopters.
	DU-42 Display: C2d, C3e, C4c, C6e, C8e, C10b, C34e, C35d, C36e, C40c, C46a, C66c, C95a, C106, C113a Remote Sensor Unit: C2d, C3e, C4c, C6e, C8e, C10b, C46a, C95a, C106	1.50 (l) x 5.25 (w) x 3.0 (h) null			—	+28 VDC nominal	
	ESI-500	24-bit color LCD; optional NVG compatibility	Inputs: - discrete pneumatic pressure ports — ARINC 429 GPS or VLOC input or both (navigation) - MAG-500 magnetometer or an ARINC-429 (heading) - GPS (aircraft track) — OAT to compensate baro-corrected altitudes for temperature		—	$5,600	Standby system designed for piston and turboprop aircraft and helicopters. Comes standard with altitude, attitude, slip/skid, vertical speed and aircraft track. Options available for display of navigation information and synthetic vision inputs, including terrain and obstacles. Magnetic heading optional when coupled with MAG-500 magnetometer. ESI-500 is compatible with existing NAV radios and GPS hardware. An internal lithium-ion battery pack automatically powers the system without interruption upon loss of main input power.
	C2d (Type B) C8e (Type B) C10b (Type 1, Range: -1,500 to +35,000 ft.) C34e C35d C36e C40c C46a (Range: 20 to 300 kt.) C106 C113a C179a C201 C2d (Type B) C8e (Type B) C10b (Type 1, Range: -1,500 To +35,000 ft.)	3.0 x 3.0			2.75 3.25 x 3.25 in. bezel; 3.0 x 3.0 display	14-28 VDC	

AIRCRAFT SITUATION DISPLAYS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Price	Remarks
	TSO	Display Size			Size or Form Factor	Power Required	
Rogerson Aircraft 2201 Alton Pkwy. Irvine, CA 92606 (949) 660-0666 **www.rogersonaircraft.com**	**5 ATI EFIS**	AMLCD flat panel	analog synchro (XYZ, Sin/Cos) variable AC/DC discretes & digital ARINC 429, 419, 453, 735, RS-232	analog synchro (XYZ, Sin/Cos) variable AC/DC discretes & digital ARINC 429, 419, 453, 735, RS-232	1/7.75	$42,000*	One, two or four programmable, self-contained flat-panel AMLCD EADI and EHSIs. Radio altimeter functions such as DH, expanded scale for landing helicopter operations, TCAS I and II, and EGPWS display capability, in addition to standard ADI, HSI, bearing pointers, CDI, autopilot annunciation, flight director cross bars or 'V' bars. Upgrade packages available. **BCA* estimate.
	C3d, C4c, C5e, C6d, C8d, C9c, C34e, C35d, C36e, C40c, C41d, C52b, C63c, C66c, C67, C87, C92c, C113, C117a, C118, C119b, C129a, C147, C161a	5 ATI or 6.4-in. diagonal			5 ATI or 6.4 dia.	28 VDC 44 W max	
Sandel Avionics 2401 Dogwood Way Vista, CA 92081 (877) 726-3357 (760) 727-4900 Fax: (760) 727-4899 **www.sandel.com**	**SA4550 Primary Attitude Display**	rear projection LCD w/LED backlighting	analog: attitude glideslope, locaiizer, flight director command inputs, radar altimeter mode annunciators	NA	1/3.4	$20,950*	Designed to upgrade legacy ADIs. Incorporates flight director command bars, glideslope/localizer deviation scale, fast/ slow indicator and mode annunciations. Selectable single-cue/split-cue display option. Sunlight readable LED backlit dis play with 180-degree viewing angle and over 10,000-hour MTBF. *High-vibration version, $23,800. NVIS compatible version, $27,050
	C113, C3d, C4c, C34e, C36e, C52b	4 ATI			4 ATI	28 VDC 40 W	
Universal Avionics Systems Corp. 3260 E. Universal Way Tucson, AZ 85756 (520) 295-2300 Fax: (520) 295-2395 **www.uasc.com**	**EFI-890R**	active matrix color LCD	Analog: 6 - ARINC 429 5 - CSDB 2 - ARINC708 3 -Manchester bus ports 2 VGA or 1-RDR-1E/F & 1 -VGS, 2 - RS-170 or 2 - NTSC comp. or 18:1 1 - RS-232 (maint.) Digital: 28 GND/OPN discretes 14 - 28 VDC/opn 4- ARINC 407 with 2 ref. inputs 15- analog DC	Analog: 2 ARINC 429 2 - CSDB 1 - Manchester bus port Digital: 5 - GND/OPN discretes 3 - 28 VDC/OPN discretes 6 - analog resolvers 2 - DC differential 2 - DC single ended	1/ 12.0	$62,000*	Horizontal viewing angle +60°/-60°, vertical viewing angle +45°/-10°; resolution: 780 x 780 pixels; 124.5 color groups per inch (CGPI); sunlight readability with greater than 10,000/1 dimming range. *Depending on configuration.
	C2d, C3d, C4c, C52, C6d, C8d, C10b, C34e, C35d, C36c, C40c,C41d, C52,b, C63c, C66c, C87, C92c, C95, C105, C113, C115b, C118, C119a, C129a, C151a	6.3 c 63 (8.0-om. dia.)			Bezel: 7.84 h x 7.42 w Depth: 9.79 (back of bezel to read of connector)	28 VDC	

ELECTRONIC FLIGHT BAGS

Manufacturer	Model	Display	Inputs and Outputs	Units/Weight (lb.)	Price	Remarks
	Class	Display Size		Size	Power Required	
Esterline CMC Electronics 600 Dr. Frederik Phillips Blvd. Montreal, Quebec, Canada 4HM2S9 (514) 748-3184 Fax: (514) 748-3100 **www.cmcelectronics.ca**	**PilotView CMA-1100 (8.4 in.) or CMA-1410 (10.4 in.) or CMA-1612 (12.1 in.)**	touchscreen XGA AMLCD 8.4-in. or 10.4-in. diagonal	Ethernet, ARINC 429, discrete, RS422/232, USB 2.0, ARINC 717, ARINC 615, ARINC 619	EDU 8.4 in.: 3.5 EDU 10.4 in.: 4.0 EDU 12.1 in.: 5.1 EEMU: 2.0	$20,000-$25,000	CMC's Aircraft Information Server acts as an integrated aircraft information management server and aircraft interface device, enabling a wide range of applications and interfaces with any display or tablet solution.
	Class 2 and Portable	8.4-in. or 10.4-in. diagonal			N/A	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (913) 397-6200 Fax: (913) 397-8282 **www.garmin.com**	**aera 796**	NA	RS 232, USB, Bluetooth	1/26.4 oz.	$1,899	Portable GPS with EFB, charting, terrain, moving map, weather, XM and other capabilities. New 3-D vision technology shows a virtual 3-D behind-the-aircraft perspective of surrounding terrain derived from GPS and the onboard terrain database. With 2 serial ports, aera 796 allows for simultaneous connectivity with other hardware. With optional GTX 330 Mode S transponser interface, can access Traffic Information Service (TIS) alerts, where available, right on the device while also sending frequencies to a GTR 225 comm radio or GNC 255 nav/comm. Can also relay position reports to other devices.
	Class 1 or Class 2	7-in. diagonal				
	aera 660	5” Diagonal	RS-232, USB, Bluetooth, Wi-Fi	1/8.64 oz.	$799	Portable GPS/EFB with charting, terrain, moving map, weather, wire-strike avoidance, wireless database updating and more.
	Class 1 or Class 2					

ENHANCED/SYNTHETIC VISION SYSTEMS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Remarks
	TSO				Size	
Esterline CMC Electronics 600 Dr. Frederik Philllips Blvd. Montreal, Quebec, Canada H4M2S9 (514) 748-3184 Fax: (514) 748-3100 **www.cmcelectronics.ca**	**CMA-2600 SureSight I-series EVS-IR Sensor**	HUD/HDD	single, dual-band sensor operating in the short to medium wavelengths, 1-5 microns	2-ANSI/SMPTE 170M ARINC 429 RS 422 discretes	1/LRU 21.0	Certified as part of an EFVS which provides operational landing credits as well as enhanced situational awareness to pilots in low-visibility conditions.
	—				NA	
	CMA-2700 SureSight I-Series EVS-IR sensor	HUD/HDD	single, dual-band sensor operating in the short to medium wavelengths, 1-5 microns	2-ANSI/SMPTE 170M ARINC 429 RS 422 descretes 2 ARINC 818	1/LRU 21.0	Certified as part of an EFVS for operational landing credits by three leading Airworthiness Authorities (EASA, TCCA, and the FAA). Fully compliant for FAR 91.176
					—	
Elbit Systems of America Fort Worth Operations 4700 Marine Creek Pkwy. Fort Worth, TX 76179 **www.elbitsystems-us.com**	**EVS II**	HUD/HDD	1-5 micron infrared sensor	RS-170/SMPTE 170M; SMPTE 259; RS 232/RS 422; ARINC 429 descrets	3/22.0	EFVS certified for FAR 91.175 (l) and (m) operational credit. EFVS certified for Part 91, 135 and 121 operations on fixed- and rotary-wing applications. Contact manufacturer for specific application pricing.
	—	—			1/2 ATR	
	GAViS	any RS-170/ SMPTE, 170M analog video capable display	8-14 micron infrared sdensor	RS-170/SMPTE 170M, analog video	1/3.5	EVS certified for situational awareness in all weather conditions. Certified for fixed- and rotary-wing aircraft. Contact manufacturer for specific application pricing.
	see remarks				3.0 x 6.0 x 11.0	
L3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3aviationproducts.com**	**IRIS A100**	any RS-10 compatible displays	7 -14 micron, uncooled ferroelectric sensor	RS-170, NTSC compatible video or PAL	1/1.7	Uses uncooled BST technology, IRIS provides enhanced visibility of almost any object, day or night, by measuring variations in heat signatures. A real-time, black and white image of people, animals, aircraft and terrain is displayed on any compatible RS-170 cockpit display. King Air, Bell 206 and Twin Commander STC kits additional.
	see remarks				5.4 x 5.4 x 3.4	

ENHANCED/SYNTHETIC VISION SYSTEMS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb.)	Remarks
	TSO				Size	
Astronics/MAX-VIZ, Inc. 11241 SE Hwy 212 Clackamas, OR 97015 (503)968-3036 **sales@mv.com**	**Max-Viz 1500**	MFD or EFB	long-wave uncooled 320 x 240	RS-170 video FOV discreet	sensor 2 lb.; PWS module 2.5 lb.	Multiple STCs for fixed- and rotory-wing aircraft. Turbine helicopter, high-performance turboprop and jet fixed-wing aircraft.
	—				3.75 x 5.0 x 2.25	
	Max-Viz 1400	MFD or EFB	long-wave uncooled 640 x 480	RS-170 video FOV digital zoom polarity select	1.2 lb.	The Max-Viz 1400 is a general aviation enhanced vision sensor using a 640 x 480 pixel resolution long-wave infrared thermal imager with electronic zoom.
	—				3.07 x 6.16 x 2.09	
	Max-Viz 1200	MFD or EFB	long-wave uncooled 320 x 240	RS-170 video	1.2 lb.	Developed for general aviation piston aircraft, helicopters, and slower single-engine turboprop fixed-wing aircraft.
	—				3.07 x 6.16 x 2.09	
	Max-Viz 600	MFD or EFB	long-wave uncooled CMOS blended with IR 320 x 240	RS-170 video	1.2 lb.	Developed for general aviation piston aircraft, helicopters, and slower single-engine turboprop fixed-wing aircraft.
	—				3.77 x 8.69 x 2.21	
Lexavia 4020 52nd Ave Ct. NW Gig Harbor, WA 98335 (850) 343-1147 **www.Lexavia.com**	**LFS-3500 Long-Wave Infrared Sensor**	any NTSC RS-170 or PAL compatible display device (PFD, PND, MFD or dedicated display)	12: 28VDC input power, NTSC-RS-170	PAL video output; serial control interface — RS-232, RS-422, RS-485	1.0 lb.	Price: $29,250 (640 x 512 resolution), $22,933 (336 x 256)/28 VDC. High-performance rugged sensor design provides an increased level of situational awareness for improved safety of operations. Optional controller and stowable video displays also available.
	—				2.5 x 2.8 x 6.3	
	LFS-6000 Long-Wave Infrared Sensor	any NTSC RS-170 or PAL compatible display device (PFD, PND, MFD or dedicated display)	12: 28VDC input power, NTSC-RS-170	PAL video output Serial Control Interface — RS-232, RS-422, RS-485	0.4 lb.	Price: $39,495 (640 x 512 resolution), $31,913 (336 x 256)/28 VDC. Compact, lightweight and aerodynamically shaped EVS sensor provides an increased level of situational awareness for improved safety of operations. Optional controller and stowable video displays also available.
	—				2.42 x 2.32 x 5.31	
	LFX-2010 Long-Wave Infrared Sensor	any NTSC RS-170 or PAL compatible display device (PFD, PND, MFD or dedicated display)	12: 28VDC input power, NTSC-RS-170	PAL video output Serial Control Interface — RS-232, RS-422, RS-485	1.4 lb	Price: $33,424 (640 x 512 resolution) 28 VDC. High-performance ruggedized sensor designed for special operations (hoist, fast rope and external operations) to provide an increased level of situational awareness for mission critical applications and improved safety of operations. Optional controller and stowable video displays also available.
	—				2.5 x 2.58 x 5.1	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-1000 Fax: (319) 295-2297 **www.rockwellcollins.com**	**EVS-3000**	HUD/HDD	uncooled multi-spectral infrared sensor, ARINC 429		9.2 lb.	Provides situational awareness at night and in low-visibility conditions. When displayed head up, operational approval for landing minima under FAR Part 91.175 is available. Contact OEM for specific application pricing.
	—				1 LRU	

FLIGHT MANAGEMENT SYSTEMS

Manufacturer	Model	CDU Type	# Available ARINC 429 (In/Out)	Vertical Nav Modes	Performance Management	Air Data In (# types)	Specific Interfaces	Weight (lb.)	Price / Remarks
	TSOs	Display Type	TSO'd Nav Sensors	# Available ARINC 429 Procedure Legs	Remote Radio Tuning		ARINC 429 (Out)	CDU Dimensions	
	RNP Certification				ARINC Radar (In)			Power	
Esterline CMC Electronics 600 Dr. Frederik Philllips Blvd. Montreal, Quebec, Canada H4M2S9 (514) 748-3184 Fax: (514) 748-3100 **www.cmcelectronics.ca**	**CMA-9000**	full alpha keyborad	24/8	fully coupled performance VNAV	Yes	ARINC 429/ ARINC 575	429 DME std.; 429 VOR std.	8.0	Price varies by installation. Coupled, performance optimized and advisory VNAV for climb, cruise, descent, approach. Performance table based. FANS-1 capable LPV Approach capabile. Optional NVG display.
	C129	AMLCD,color	GPS, WAAS, VOR, DME, INS, IRS, TACAN		Yes			6.75 x 5.75 x 7.15	
	RNP 0.3, -10, BRNAV, PRNAV				No			—	

FLIGHT MANAGEMENT SYSTEMS

Manufacturer	Model	CDU Type	# Available ARINC 429 (In/Out)	Vertical Nav Modes	Performance Management	Air Data In (# types)	Specific Interfaces	Weight (lb.)	Price / Remarks
	TSOs				Remote Radio Tuning			CDU Dimensions	
	RNP Certification	Display Type	TSO'd Nav Sensors	# Available ARINC 429 Procedure Legs	ARINC Radar (In)		ARINC 429 (Out)	Power	
FreeFlight Systems 3700 Interstate 35 S. Waco, TX 76706 (254) 662-0000 Fax: (254) 662-9450 **www.freeflightsystems.com**	**2101 Approach Plus**	Dzus	4/0	Advisory	No	ARINC 565, ARINC 575; Coarse/Fine A407 Synchro, ARINC 545, TAS, ARINC 429 ADC, RS-232 ADC	ARINC 429	3.65	$7,245. Price includes receiver, data card, installation kit (with antena), installation manual and pilot guide, Unit also available with NVG capability.
	—				No			3.0 x 5.75 x 7.68	
	BRNAV	LED	GPS, WAAS	4	None		GPS RS-232	10- 40 VDC	
	2101 I/O Approach Plus	Dzus	4/0	Advisory	No	ARINC 565, ARINC 575; Coarse/Fine A407 Synchro, ARINC 545, TAS, ARINC 429 ADC, RS-232 ADC	ARINC 429	3.65	$11,500. Price includes receiver, datacard, installation kit (with antena), installation manual and pilot guide. Sole means oceanic approval; interfaces with EGPWS.
	—				No			3.0 x 5.75 x 7.68	
	BRNAV	LED	GPS, WAAS	4	None		GPS RS-232	10- 40 VDC	
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**FMS 3000/5000**	full alpha keyboard	4/3	multi-waypoint	Yes	see remarks	see remarks	8.9	LPV approach capability and RF legs are available on some aircraft types. *FMS I/O provided by four redundant concentrators. Remote computer dimensions 1.7 x 8.84 x 6.06 in.; FMS 5000 requires radio tuning unit; FMS 3000 radio tuning is internal.
	C129 GPS, C146 WAAS-B1, -C1				Yes			6.375 x 5.75 x 6.33	
	RNP 0.3, -10, BRNAV	color LCD	GPS, WAAS, DME, INC, Loran C	23	see remarks			20- 40 VDC	
	FMS 4200/6000	full alpha keyboard	4/3	multi-waypoint	Yes	see remarks	see remarks	4	LPV approach capability and RF legs are available on some aircraft types. *FMS I/O provided by four redundant concentrators. See FMS3000 remarks for remote computer; FMS4200 has advisory VNAV but not FMS-to-ILS auto transfer; Coupled VNAV available on FMS6000.
	C129 GPS, C146 WAAS-B1, -C1				Yes			6.375 x 5.75 x 6.33	
	RNP 0.3, -10 BRNAV	color LCD	GPS, WAAS, DME, INC, Loran C	23	see remarks			20- 40 VDC	
	FMS 6100	full alpha keyboard	4/3	multi-waypoint	Yes	see remarks	see remarks	4	FMS I/O provided by four redundant concentrators. See FMS 3000 remarks for remote computer. WAAS/SBAS capable.
	C129 GPS, C146 WAAS-B1, -C1				Yes			6.375 x 5.75 x 6.33	
	RNP 0.3, -10 BRNAV	color LCD	VOR< GPS, WAAS, DME, INS, Loran C	23	see remarks			20- 40 VDC	

FLIGHT MANAGEMENT SYSTEMS

Manufacturer	Model TSOs RNP Certification	CDU Type Display Type	# Available ARINC 429 (In/Out) TSO'd Nav Sensors	Vertical Nav Modes # Available ARINC 429 Procedure Legs	Performance Management Remote Radio Tuning ARINC Radar (In)	Air Data In (# types)	Specific Interfaces ARINC 429 (Out)	Weight (lb.) CDU Dimensions Power	Price / Remarks
Universal Avionics Systems Corp. 3260 E. Universal Way Tucson, AZ 85756 (520) 295-2300 (800) 321-5253 Fax: (520) 295-2395 **www.uasc.com**	**UNS-1Lw** C129 GPS, C146B Gamma RNP 0.3, -5, -10	Full alpha keyboard color LCD	8/5 GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	23 multi-waypoint	opt. opt. std.	ARINC 575, ARINC 429 ADC std.; ARINC 565, Course/ Fine A407 Snchro, ARINC 545 TAS opt. See remarks	ARINC 429 GPS, S422A CSDB DME, Arinc 429 DME, Bendix 429 VOR, ARINC 429 VOR, ARINC 429 INS	2.9 4.5 x 5.75 x 6.33; remote computer: 2 MCU, 7.7 lb. 20- 40 VDC	$54,500. Air data converter unit available; 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.
	UNS-1LEw C129 GPS, C146B Gamma	full alpha keyboard color LCD	8/5 GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	23 multi-waypoint	opt. opt. std.	ARINC 575, ARINC 429 ADC std.; ARINC 565, Course/ Fine A407 Snchro, ARINC 545 TAS opt. See remarks	ARINC 429 GPS, S422A CSDB DME, Arinc 429 DME, Bendix 429 VOR, ARINC 429 VOR, ARINC 429 INS	7.86 6.38 x 5.75 x 8.96 20- 40 VDC	$69,000. 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.
	UNS-1Espw C129 GPS, C146B RNP 0.3, 5, 10	full alpha keyboard color LCD	8/5 GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	23 multi-waypoint	opt. opt. std.	ARINC 575, ARINC 429 ADC std.; ARINC 565, Course/ Fine A407 Snchro, ARINC 545 TAS opt. See remarks	ARINC 429 GPS, S422A CSDB DME, Arinc 429 DME, Bendix 429 VOR, ARINC 429 VOR, ARINC 429 INS	7.25 6.38 x 5.75 x 7.62 20- 40 VDC	$68,000. 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.
	UNS-1Fw C129 GPS, C146B Gamma RNP 0.3, 5, 10	full alpha keyboard color LCD	8/5 GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	23 multi-waypoint	opt. opt. std.	ARINC 575, ARINC 429 ADC std.; ARINC 565, Course/ Fine A407 Snchro, ARINC 545 TAS opt.	ARINC 429 GPS, S422A CSDB DME, Arinc 429 DME, Bendix 429 VOR, ARINC 429 VOR, ARINC 429 INS	4.1 6.38 x 7.5 x 3.5; remote computer: 2.0 lb. 20- 40 VDC	$81,500. 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type	Dimensions	Operational Capabilities	Weight (lb.)	Dimensions	Power Required	Price/Remarks
Avidyne Corp. 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 **www.avidyne.com**	**Entegra Release 8**	see remarks	see remarks	see remarks		FMS, PFD/ MFD, AP/ IFCS, EFIS, TAWS, RMU, SVS, CAS/ TAWS	18.75	two 10.4 in. diagonal, color active matris displays	28 VDC	Integrates primary flight information, navigation, terrain, weather, traffic on two or three large-formate displays. Selectable IAS and V-speed ranges to suit aircraft installations. Dual-PFD version features CCS Cross Compare System that monitors cross-side PDF and ADAHARS signals 30 times per second. Works with DFC90 or STEC 55 X autopilot and 3rd party GPS/NAV/Coms for position information.
	Entegra Release9	see remarks	see remarks	see remarks		FMS, PFD/ MFD, AP/ IFCS, EFIS, TAWS, RMU, SVS, CAS/ TAWS	18.75	two 10.4 in. diagonal, color active matris displays	28 VDC	Cirrus starting at $90,000; Piper Matrix starting at $105,800. Integrates primary flight information, navigation, weather and traffic on 2 or 3 large-format displays. Includes dual VHF nav/com, dual WAAS, GPS, dual FMS 900w dual ADAHARS, remote transponder tuning. ACD 215 alpha-numeric FMS keypad with display. Works with DFC100 digital autopilot. Optional SVS.
Genesys Aerosystems One S-TEC Way Municipal Airport Mineral Wells, TX 76067 **Formerly: Cobham Commercial Systems**	**Chelton Flight Systems EFIS**	WX500, ADF, TCASi/II, TCAD, ADS-B, TIS-B, radar altimeter, ARNC 429, RS-232, RS-422, 10 discretes	ARINC 429, RS-232, RS-422, 10 discretes, autopilot	color LCD	6.25 x 5.5 in. NVG compatible	FMS, PDF/ MFD, AP/ IFCS, EFIS, TAWS, SVVS, CAS/TAWS	two screen: 2.0 four screen: 50.0	—	10-32 VDC	Two screens: $95,000; Four screens: $150,000.
Garmin International 1200 E. 151st St. Olathe, KS 66062-3426 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**G1000 NXi**	TCAS i/II, RS 232, RS-422, RS-485; ARINC 429; HSDB, CD/ HIS, RMI, air data	ARINC 429; HSDB, CD/HIS, RMI, air data, RS-232, RS 422, RS-485; ARINC 429; HSDB, CD/HIS, RMI, air data	Varies by installation	Varies by installation	See remarks	N/A			Price varies by installation. An all-glass avionics suite designed for OEM or custom retrofit installation on a wide range of aircraft. Integrates primary flight information, navigation, communication, weather, terrain and traffic data on two or three large format displays. Tailored to specific OEM requirements. Features include 3-axis, all-digital flight control system; Synthetic Vision Pathway navigation; dual AHRS; dual radio modules with WAAS certified IFR Oceanic-approved GPS, VHF Nav with ILS and VHF Com; dual RVSM compliant DADC; EICAS; ADS-B In and Out Transponder(s); Class B TAWS; Digital weather radar. Optional Bluetooth connectivity to select mobile devices. Retrofit system also available for King Air 300/350 and 200.
	G1000H (helicopter version)	TCAS i/II, RS 232, RS-422, RS-485; ARINC 429; HSDB, CD/ HIS, RMI, air data	ARINC 429; HSDB, CD/HIS, RMI, air data, RS-232, RS 422, RS-485; ARINC 429; HSDB, CD/HIS, RMI, air data	Varies by installation	Varies by installation	see remarks	N/A			Price varies by installation. An all-glass avionics suite designed for OEM or custom retrofit installation on a wide range of aircraft. Integrates primary flight information, navigation, communication, weather, terrain and traffic data on two or three large format displays. Tailored to specific OEM requirements. Features include 3-axis, all-digital flight control system; Synthetic Vision Pathway navigation; dual AHRS; dual radio modules with WAAS certified IFR Oceanic-approved GPS, VHF Nav with ILS and VHF Com; dual RVSM compliant DADC; EICAS; ADS-B In & Out Transponder(s); Class B TAWS; Digital weather radar. Optional Bluetooth connectivity to select mobile devices.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type Dimensions	Operational Capabilities	Weight (lb.) Dimensions Power Required	Price/Remarks
Garmin International 1200 E. 151st St. Olathe, KS 66062-3426 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**G2000 (piston engine aircraft version)**	TCAS I/II, RS-232, RS-422, RS -485; ARINC 429; HSDB, CD/HIS, RMI, air data	TCAS I/II, RS- 232, RS-422, RS -485; ARINC 429; HSDB, CD/HIS, RMI, air data	12- or 14-in. backlit LED See remarks	See remarks	N/A N/A N/A	Price varies by installation. Integrates primary flight information, navigation, communication, weather, terrain and traffic data on large format displays. Tailored to specific OEM requirements. Features include three-axis, all-digital automatic flight control system; Synthetic Vision Pathway navigation; dual solid-state AHRS; dual integrated radio modules with WAAS certified IFR Oceanic-approved GPS, VHF Nav with ILS and VHF Com with 16-W transceivers and 8.33-kHz spacing; dual RVSM compliant DADC; EICAS; Class B TAWS; digital weather radar; Garmin FliteCharts; and Garmin SafeTaxi.
	G3000 (light turbine aircraft version)	TCAS I/II, RS-232, RS-422, RS- 485; ARINC 429; HSDB, CD/HIS, RMI, air data	TCAS I/II, RS-232, RS-422, RS-485; ARINC 429; HSDB, CD/HIS, RMI, air data	14.1-in. diagonal WXGA See remarks	See remarks	N/A N/A N/A	Price varies by installation. Integrates primary flight information, navigation, communication, weather, terrain and traffic data on large format displays. Tailored to specific OEM requirements. Features include three-axis, all-digital automatic flight control system; Synthetic Vision Pathway navigation; dual solid state AHRS; dual integrated radio modules with WAAS certified IFR oceanic-approved GPS, VHF navigation with ILS and VHF communication with 16-watt transceivers and 8.33-kHz channel spacing; dual RVSM-compliant digital air-data computer; EICAS; Class B TAWS; XM Wx and/or digital weather radar; Garmin FliteCharts; and Garmin SafeTax
	G5000H (helicopter version)	TCAS I/II, RS-232, RS-422, RS- 485; ARINC 429; HSDB, CD/HIS, RMI, air data	RS 232, RS 422, RS 485, ARINC 429; HSDB, CD/HIS, RMI, discretes, air data	varies by installation See remarks	See remarks	N/A N/A N/A	Price varies by installation. Advanced flight deck designed for OEM installation on medium-lift turbine helicopters. Bright high-resolution displays with Helicopter Synthetic Vision Technology (HSVT) let you see clearly even in IFR conditions. Displays divide into 2 pages to help display multiple systems and sensors. Intuitive touchscreen interface with shallow menus and audible feedback. Graphical synoptics. Weather, charts, traffic, terrain and Global connectivity options. TOLD, performance planning and paperless cockpit support. Digital document display for electronic charts, flight manual data and more.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type Dimensions	Operational Capabilities	Weight (lb.) Dimensions Power Required	Price/Remarks
Garmin International 1200 E. 151st St. Olathe, KS 66062-3426 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**G5000**	TCAS i/II, RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, air data	RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, air data	four backlit LED XGA 1280 X 800 pixels touch-screen displays see remaks	see remarks	NA NA NA	Price varies by installation. Intended for use aboard a broad range of professionally flown air transport category aircraft, ranging from light jets to large-cabin, transoceanic aircraft. Integrates primary flight information, navigation, communication, weather, terrain and traffic data on large-format displays. Features include three-axis, all-digital automatic flight control system; Synthetic Vision Pathway navigation; dual solid state AHRS; dual integrated radio modules with WAAS certified IFR oceanic approved GPS, VHF navigation with ILS and VHF communication with 16-watt
	G500	TCAS i/II, RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, air data	RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, air data	dual 6.5-in. VGA LCDs —	see remarks	NA NA NA	$15,995. Includes CDU, digital AHRS, ADC, magnetometer, temperature probe. Also certified to C2d, C10b and C34c. Replaces standard six-pack instruments. Features 6.5-in. PFD and MFD plus AHRS. SVT is standard with G600 and optional for G500. Optional TAWS-B for G600 only. GWX70 radar sold separately. Includes CDU (dual 6.5-in. VGA LCD), digital AHRS, ADC, magnetometer, temperature probe. Enhanced autopilot interface capabilities using the optional GAD 43
	G600	TCAS i/II, RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, air data	RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, air data	dual 6.5-in. VGA LCDs —	see remarks	NA NA NA	$29,995. Includes CDU, digital AHRS, ADC, magnetometer, temperature probe. Also certified to C2d, C10b and C34c. Replaces standard six-pack instruments. Features 6.5-in. PFD and MFD plus AHRS. SVT is standard with G600 and optional for G500. Optional TAWS-B for G600 only. GWX70 radar sold separately. Includes CDU (dual 6.5-in. VGA LCD), digital AHRS, ADC, magnetometer, temperature probe. Enhanced autopilot interface capabilities using the GAD 43.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type Dimensions	Operational Capabilities	Weight (lb.) Dimensions Power Required	Price/Remarks
Honeywell Aerospace BendixKing 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**Primus Apex AeroVue** (C106 in progress) C115b, C198 Class A1, B, C	TCASI/II RS-232, RS-422, ARINC 429, ARINC 453, ethernet air data, video, discretes, analogs	ARINC 429, ARINC 453, RS-232, RS-422, discretes, analogs	12.0-in. color LCDs	FMS with Flight Director; Dual ADAHRS; Graphical flight planning; SmartView SVS; Digital 3-axis autopilot; Electronic checklist; XM Weather; Vertical nav profile; Video inputs; Dual WAAS GPS receivers; Integrated EIS; Mode S transponder; Dual audio panels with Bluetooth	see remarks see remarks see remarks	Integrated flight deck with three or four 12" LCDs, depending upon the aircraft insallation. Includes a variety of advanced features: digital autopilot capable of coupled VNAV, SmartViewTM Synthetic Vision System, Interactive Navigation (INAVTM) for graphical flight planning, and both a Cursor Control Device (CCD) and Multifunction Controller for a more ergonomic user experience. Weather radar, TCAS I, EGPWS, and radar altimeter also available. Price and weight are dependent upon installation. Announced programs include the Beechcraft King Air C90, 200, B200, and Cessna Citation V, Ultra, and Encore.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type Dimensions	Operational Capabilities	Weight (lb.) Dimensions Power Required	Price/Remarks
Honeywell Aerospace BendixKing Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**Bendix King KSN 770/765 Integrated Navigator WAAS/ GPS/ NAV (KSN 770 only)/ COMM (KSN 770 only)/ MFD**	RS-422 Interface; Weather Radar; Traffic; Terrain; EGPWS; XM Weather; Air data/ Heading Interface; Fuel Flow Air Data Computer and others.	AARINC 429 input; 10 ARINC 429 output; 2 RS-232 input; 4 RS-232 output; 4 RS-222 input; 3 RS-222 output; 28 discrete input; 20 discrete output	5.7 in. Active Matrix LCD	WAAS, LPV. Can displays safety systems information including On-board weather radar, Enhanced Ground Proximity Warning System (EGPWS), XM Datalink Weather, Terrain awareness and warning System (TAWS) and Traffic Collision Avoidance System (TCAS). Split-screen capabilities.	8.5 lb. N/A	Combines GPS navigation, Nav/ Com, terrain mapping, charting and safety sensor displays. Also displays XM Datalink Weather, radar-based weather, traffic and terrain. The KSN offers many ways of interfacing with your information with a combination of hard buttons, cursor control and touchscreen.
Innovative Solutions & Support (IS&S) 70 Pennsylvania Dr. Exton, PA 19341 (610) 646-9800 Fax: (610) 646-0149 **www.innovative-ss.com**	**Cessna Citation AdViz Flat Panel Display**	ARINC 429, A453/708, Ethernet, Descretes, Analog, Synchro, RS-422, CSDB, USB	ARINC 429, A453/708, Ethernet, Descretes, Analog, Synchro, RS-422, CSDB, USB	AMLCD 10.4 in.	See remarks	7.0 NA NA	Price varies by installation. Designed to replace existing instruments, including the EADI and EHSI displays, altimeter, airspeed and vertical speed indicators. Retrofitting existing aircraft requires minimal changes to existing aircraft wiring while reducing power consumption and weight. Options include satellite weather, e-charts, video and remote radio control.
	Eclipse Avio NG	ARINC 429, ARNC 453, RS 232, RS 42, Byteflite, Ethernet, discretes	ARINC 429, ARNC 453, RS 232, RS 42, Byteflite, USB, Ethernet, discretes	AMLCD PDF: 10.4 in. (2) MFD: 15.4 in.	See remarks	PFD: 8.5 MFD: 12.5 PFD: 10.4 in. (2) MFD: 15.4 in. PFD: 50 W MFD: 75 W	Price varies by installation. FMS options include either integrated WAAS-based FMS, exterior WAAS-based FMS or non-WAAS-based FMS; system provides PFD/ND with MFD functions and engine instruments; system interfaces with new or existing AP/FD/IFCS; TAWS display provided and connects directly with TAWS; remote tuned radios optional; e-charts, moving maps, radar display, satellite weather, TCAS-I, fuel management and aircraft systems pages.
	Pilatus PC-12 FPDS System	Contact OEM for details	Contact OEM for details	AMLCD 10.4; 15.0	See remarks	15 in. IPFD, 14 lb., 70 W; 10 in. IPFD, 8 lb., 35 W; DCP, 3.0 lb., 8 W	Price varies by installation. FMS options include either WAAS-based FMS, exterror WAAS-based FMS or non-WAAS-based FMS; systems provides PFD/ND with MFD functions; coupled WAAS LPV approach; system interfaces with new or existing AP/FD/IFCS; RVSM certified, options isnclude RS 170 or DVI video input on 5.15-in. IPFD; TAWS terrain display provided and connects directly with TAWS; e-charts certified.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type Dimensions	Operational Capabilities	Weight (lb.) Dimensions Power Required	Price/Remarks
Innovative Solutions & Support (IS&S) 70 Pennsylvania Dr. Exton, PA 19341 (610) 646-9800 Fax: (610) 646-0149 **www.innovative-ss.com**	**Vantage Cockpit/IP Flat Panel Display System**	Contact OEM for details	Contact OEM for details	AMLCD 10.4	See remarks	FPD: 6.0 lb., 30 watts RNCU: 9.75 lb., 25 watts; ECSU: 25 watts	Price varies by installation. FMS options include either WAAS-based FMS, exterror WAAS-based FMS or non-WAAS-based FMS; systems provides PFD/ND with MFD functions and engine instruments; system interfaces with new or existing AP/FD/IFCS; EVS input can be input fromEVS camera or other video camera via RS-170; TAWS terrain display provided and connect directly with TAWS; remote tuned radios optional. e-charts, moving maps (worldwide terrain 3-arc/second, radar display, satellite weather, TCAS-I/II, fuel management exceedance recording and video.
Rockwell Collins 400 Collins Rd. NE Cedar Rapids, IA 52498 (319) 295-4085 Fax: (319) 295-2297 **www.rockwellcollins.com**	**Pro Line Fusion**	See Remarks	See Remarks	Color LCD 15.1-in. color LCD SXGA: 14.1-in. color LCD WXGA	FMS, PFD/ Adapts to 3, 4 or 5 LCD graphic display congiguration integrating PFD/MFD flight information	Various, depending on installation	Features include dual comm/nav, single, dual or triple FMS, GPS WAAS, single or dual integrated Flight Information system (IFIS), weather radar with turbulence detection, data link communication, onboard maintenance system, information management system, surface management, surveillance video, enhanced vision, sythethic vision, head-up guidance and functionality to meet Next Gen airspeace requirments. Display systems available with touch screen capability. Customized to OEM requirements. Price varies by installation.
	Pro Line 21	Numerous	Numerous	Color LCD 6.375 (h) x 5.75 (w) x 6.33 (l)	FMS, PDF/ MFD, EFIS, TAWS, RMU, EVS, SVS pending	Various, depending on installation	Price varies by installation. The typical Pro Line 21 major retrofit package includes three-four 8 x 10 in. LCDs with advanced graphics, all digital CNS radios with dual comm/navs, dual transponders with enhanced surveillance, dual DME, single or dual FMS GPS WAAAS, Digital Flight Control System (DFCS) with coupled VNAV, single or dual Integrated Flight Information Systems (IFIS), dual channel radar altimeter, dual solid-state Attitude Heading Reference Systems (AHRS), dual air data systems (RVSM compliant), solid-state radar with turbulence detection, Engine indications on PFD or MFD, 2nd or 3rd FMS, 3rd FMS, 3rd AHRS, 3rd VHF-4000, 2nd ALT-4000, TCAS 4000, ADS-B transponders, single or dual HF-9000 radio, Satcom, CMU-4000 data link system, XM weather, maintenance diagnostics system, DBU-5000 data loader and all-new wiring and connectors.

INTEGRATED AVIONICS SYSTEMS

Manufacturer	Model	Inputs	Outputs	CDU Type Dimensions	Operational Capabilities	Weight (lb.) Dimensions Power Required	Price/Remarks
Rogerson Aircraft 2201 Alton Pkwy. Irvine, CA 92606 (949) 660-0666 **www.rogersonaircraft.com**	**Series 700 Integrated Avionics System** for Bell 412 and Bell 429; TC on Bell 429 and STC on Bell 412 using 6 x 8 ALMD displays	ARINC 429, Synchro, Discretes, RGB, NTSC, PAL video capability	ARINC 429, variable DC, Discretes	Course Heading Select Panel (CHSP) 6 x 8 ALMD displays	PFD, MFD, EICAS Mission functions: FLIR, RS-170 video, fuel and hydraulics	Each display unit: 13.5	Prices based on quantity; dependent on engine type.
	Series 600 Integrated Avionics System using 6 x 8 AMLCD displays	ARINC 429, Synchro, Discretes, RGB, NTSC, PAL video capability	ARINC 429, Synchro, Discretes, RGB, NTSC, PAL video capability	Course Heading Select Panel (CHSP) 6 x 8 ALMD displays	PFD, MFD Mission functions: FLIR, RS-170 video, fuel and hydraulics	Each display unit: 13.5	Prices based on quantity.
Sandel Avionics 2401 Dogwood Way Vista, CA 92081 (877) 726-3357 (760) 727-4900 Fax: (760) 727-4899 **www.sandel.com**	**Avilon**	see capabilities	see capabilities	6 touchscreen displays* —	ADS-B, ADC, AHRS, autopilot, audio, engine instruments, flight director, FMS, GPS, Mode S transponder, Nav, Com, TAWS, weather radar display	weight savings of 100-150 lb.	$175,000 installed price. Delivered as a prewired assembly allowing for a five-day installation time. Initial STC for King Air 200 with additional models to follow. Designed for performance-based navigation with an emphasis on safety. *Existing panel is removed and replaced with Avilon.

Purchase Planning Handbook

2017 Business Airplanes

Business jet operators are flying more than **4.3 million missions per year**, the highest since 2009 and even more than in 2008 prior to the Great Recession.

BY **FRED GEORGE** fred.george@penton.com

The U.S. economy has shown steady improvement as indicated by the 0.2%, 0.5% and 0.6% increases for November and December 2016 and January 2017, respectively, in the Conference Board Leading Economic Index, a composite measure of manufacturing activity, consumer and business demand for goods and services, stock prices and new building permits, among other factors. But you'd never know there was any improvement from looking at the general aviation market.

New aircraft sales revenues plunged by nearly $5 billion in 2016 from one year earlier, according to the General Aviation Manufacturers Association (GAMA). Business jet deliveries fell from 718 units in 2015 to 661 units in 2016, the industry's lowest figure since 2004. Activity was strongest in North America and Europe, but a prolonged and pronounced slump in Latin America, Asia-Pacific, the Middle East and Africa dragged down total sales. North America and Europe accounted for more than 80% of turbofan deliveries and more than two-thirds of the turboprop deliveries.

GAMA reports that turboprops fared slightly better than in the previous year, with a slight uptick in deliveries from 557 units in 2015 to 582 deliveries in 2016. North America, Asia-Pacific and Europe saw slight increases, while Latin America witnessed a minor decline. Overall, turbine aircraft deliveries have remained flat since 2009 and actually declined since 2013. More telling, turbine aircraft sales revenues fell nearly 15% in 2016 compared to the previous year.

Piston aircraft deliveries also fell by nearly 5% in 2016, although North America had a slight increase, accounting for nearly 70% of the sales.

Yet, the size of the world's turbofan and turboprop fleet increased slightly to 36,674 aircraft, according to GAMA citing data published by Jetnet LLC.

Sales and deliveries of new aircraft historically have tracked with global economic activity. But that's no longer the case in the business aircraft industry, says Rolland Vincent of his eponymous Aviation Consulting firm in Plano, Texas. His firm surveys 500 business aircraft owners and operators every 90 days.

In collaboration with Utica, New York-based Jetnet, Vincent publishes quarterly history and forecast reports used for planning purposes by the business aircraft industry.

The Jetnet IQ report for first quarter 2017, for instance, says that 80% of North American respondents believe the economy there will grow faster in the next 12 months than in the previous year. More than 80% of North Americans believe the Donald Trump administration will be beneficial to aviation during the next year. And business jet operators are flying more than 4.3 million missions per year, the highest since 2009 and even more than in 2008 prior to the Great Recession.

Robert Stallard of Vertical Research Partners also notes that business aircraft operations grew at 2.9% in early 2017 year-over-year. For early 2016, year-over-year growth was only 1.1% versus 2015.

The economies of China and India should continue to expand, but the average GDP growth of 18 other nations, including the U.S., will hover near 2.0% in 2017, according to Vincent. These 20 nations account for most of the world's business aircraft.

Still, potential buyers are not rushing to new aircraft sales offices and asking for demo flights. In fact, Vincent projects that new turbofan aircraft deliveries will drop again this year to 640 units, accompanied by a slight decline in sales revenues. And he forecasts another 5.5% decrease to 605 units in 2018.

The reason? Oversupply. Book-to-bill ratios for Bombardier, Dassault, Embraer, Gulfstream and Textron all are below 1:1, meaning that the manufacturers are taking fewer orders for new equipment than the number of units they ship from their plants. Dassault, for example, had a book-to-bill ratio of less than 0.5 to 1 in 2015 and 2016.

Asking prices for turbofan aircraft are soft in 2017. Compare list prices in *BCA's May 2016 Handbook* with prices this year. Most turbofans are priced the same as last year, though a few Falcon and Gulfstream models show modest increases. To increase competitiveness, Embraer dropped the Legacy 600 in favor of the new Legacy 650E that is priced $5.7 million less than last year's Legacy 650. And Gulfstream dropped the G150 from its lineup due to low demand.

There also is a widening gap between list prices and sale prices. For instance, Vincent says Bombardier is selling some models at a 33% discount, forcing other manufacturers to sacrifice profit margins or lose sales. While the Canadian manufacturer garnered the largest number of business aircraft deliveries in 2016 among business jet makers, any such discounting would likely result in razor-thin margins.

Textron Aviation is faring better than most others. CEO Scott Ernest's capacity discipline resulted in the best book-to-bill ratio of any of the five jet makers from 2013 through 2016. But last year it still was hovering at slightly less than 1:1, according to Vincent, hardly a banner year for business jets.

This year, the FAA revised its general aviation fleet forecast, lowering growth of the general aviation fleet to 0.1% per year for the next two decades, with new turbine aircraft deliveries offsetting a projected contraction of the piston aircraft fleet, according to its Aerospace Forecast Report Fiscal Years 2017 to 2037. GAMA also notes that the general aviation pilot population is shrinking, although there was a slight uptick in student starts in 2015. While the general aviation fleet growth is lackluster, the FAA estimates that business jet operations will increase 3.0% from 2017 to 2037 in its latest forecast.

The report also says "there is uncertainty regarding the impact of the new U.S. administration's policies on economic growth." And with both U.S. Rep. Bill Shuster (R-Penn.), chairman of the House Transportation and Infrastructure Committee, and President Trump pushing to spin off FAA ATC into to a private corporation with a board of directors dominated by the airlines, business aircraft operators potentially could face substantial airspace and airport user fees.

On a more positive note, the FAA believes that the price for turbine fuel will increase only modestly in 2017 because the price of crude oil should stabilize at about $47 per barrel, up from $39 per barrel in 2016. Crude oil shouldn't again reach its 2013 price of $100 per barrel until 2026, according to the FAA Forecast.

Regardless of the price of fuel or user fees, the FAA estimates that piston

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aircraft deliveries will continue to decline. In 2016, piston-engine aircraft deliveries from U.S. manufacturers were down 4.2% from 2015, according to GAMA. The FAA estimates that the piston aircraft fleet will atrophy at 0.8% per year from 2017 to 2036, due to “unfavorable pilot demographics, overall increased cost of aircraft ownership” and “new aircraft deliveries not keeping pace with retirements of the aging fleet.”

BOMBARDIER

Bombardier’s Global 7000 did not make it into the tables this year because performance details were not released by the manufacturer. Look for its debut in the 2018 edition.

Nonetheless, most piston aircraft manufacturers are hiking prices this year. That includes Cirrus Aircraft, Piper and Textron Aviation, but Mooney, whose future seems uncertain, is holding 2016 pricing for its M20 models. Notably, GAMA reports Mooney delivered just seven aircraft in 2016, and there is very little activity at the factory in Kerrville, Texas. However, the M20U Ovation Ultra and M20V Acclaim Ultra, models featuring left- and right-side doors, received certification in March, and development of the diesel-powered models was still pending as we closed this issue.

Not all the news for 2017 is bad, however. This year, Textron Aviation’s 3,500-nm range super-midsize Cessna CE-700 Citation Longitude makes its debut in the Purchase Planning Handbook. Due for certification late this year, the Longitude’s evolutionary design combines a stretched and strengthened Citation Latitude fuselage mated to proven wing and empennage structures that were modified and adapted for the mission. The aircraft is powered by well-proven Honeywell HTF7700L turbofans, features Garmin G5000 avionics and offers double-club seating for eight passengers.

Vincent foresees a sweet spot in the business jet market for 3,000-nm to 4,000-nm super-mids, such as the Longitude. Textron’s new model could spur Bombardier, Embraer and Gulfstream to look at derivatives or new models in this segment. He’s also bullish on the Falcon 5X because of its cabin size, range and fuel efficiency. But ongoing problems with its Snecma Silvercrest turbofans have slowed Dassault’s development program by several years.

Gulfstream’s 6,200-nm range, Mach 0.85 cruise G600 also is making its debut in this year’s Handbook. A longer cabin, wider wingspan and longer-range derivative of the G500, it features active side-sticks, fly-by-wire (FBW) flight controls and Gulfstream’s signature Symmetry flight deck. It’s slated for certification late next year.

Bombardier’s Global 7000 was due to make its debut in this year’s *Handbook*. But the manufacturer declined to release performance details despite having two aircraft in flight testing. A third test aircraft, slated for first flight later this year, should be fully production conforming, Vincent believes. Look for the Global 7000 to appear in the 2018 *Handbook*.

The single-engine turboprop sector also remains stable to strong. Epic, Piper, Mahindra, Quest and Textron held prices unchanged or close to 2016 levels. Epic Aircraft is making changes to the E1000 to ensure it complies with upcoming certification requirements. Daher is replacing the TBM 900 with the TBM 910, a derivative upgraded with Garmin G1000 NXi avionics and other modifications. Both Daher and Pilatus increased prices in response to strong order books.

While most new piston and turbofan aircraft deliveries remain stubbornly stagnant, several developments are buoying spirits in the business aircraft industry. The European Aviation Safety Agency (EASA) issued final regulations permitting commercial single-engine turbine aircraft operations in instrument meteorological conditions (IMC). Notably, Europe is the last large business aircraft market that, with few exceptions, did not permit commercial single-engine operations in IMC.

After seven years, the 36-state International Civil Aviation Organization (ICAO) council adopted uniform CO_2 emission standards for aircraft. Such standardization facilitates creation of market-based measures to move toward carbon-neutral growth of aircraft operations by 2020. Reduction in CO_2 will be made possible by more-efficient air traffic management, use of sustainable alternative fuels, replanting rain forests and developing more-fuel-efficient aircraft.

The FAA also continues to progress through Phase II of its Piston Aviation Fuels Initiative by developing a drop-in replacement unleaded avgas by 2018. Shell Oil and Swift Fuels have been selected to partner with the FAA to develop ASTM standards for unleaded avgas that will have the least technical and financial impact on general aviation aircraft operators and establish a fuel distribution infrastructure. However, it’s still not clear how much the price of that fuel will change from the cost per gallon of 100LL gasoline.

So, in the short term, look for single-engine and multiengine turboprops to be solid sellers. The piston-engine market is in for a rough ride because of aging pilot demographics, increasing direct operating costs and tougher local airport authority rules, regulations and restrictions, particularly in California. The turbofan aircraft market will remain relatively flat because of oversupply in almost all segments. But a new generation of roomy, fuel-efficient and fast U.S. transcontinental-range and transatlantic-range super-midsize to large-cabin aircraft hold the promise to lift the turbofan sector out of its doldrums. **BCA**

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How to Use the Airplane Charts

BOMBARDIER

For an aircraft to be listed in the *Purchase Planning Handbook,* a production conforming article must have flown by May 1 of this year. The dimensions, weights and performance characteristics of each model listed are representative of the current production aircraft being built or for which a type certificate application has been filed. The basic operating weights we publish should be representative of actual production turboprop and turbofan aircraft because we ask manufacturers to supply us with the average weights of the last 10 commercial aircraft that have been delivered. However, spot checks of some manufacturers' BOW numbers reveal anomalies. We reserve the right to make adjustments to weights, dimensions and performance data. These data adjustments will be noted in the Remarks section for specific models as "*BCA* Estimated Data."

The takeoff field length distances are based on maximum takeoff weight for maximum range missions.

Please note that "all data preliminary" in the Remarks section indicates that actual aircraft weight, dimension and performance numbers may vary considerably after the model is certified and delivery of completed aircraft begins. ***All data for these aircraft is highlighted with a blue tint.***

Manufacturer, Model and Type Designation

In some cases, the airplane manufacturer's name is abbreviated. The model name and the type designation also are included in this group.

BCA Equipped Price

▶ Price *estimates* are first quarter, current year dollars for the next available delivery. Some aircraft have long lead times, thus the actual price will be higher than our published price because of block point changes and inflation adjustments. Note well, manufacturers may change prices without notification.

▶ **Piston-powered airplanes** — Computed retail price with at least the level of equipment specified in the "*BCA* Required Equipment List."

▶ **Turbine-powered airplanes** — Computed retail price with at least the level of equipment specified in the "*BCA* Required Equipment List," if available. Some manufacturers decline to provide us with actual prices of delivered aircraft, so we may estimate them. The aircraft serial numbers aren't necessarily consecutive because of variations in completion time and because some aircraft may be configured for non-commercial, special missions.

Characteristics

▶ **Seating:** Crew + Typical Executive Seating/High-Density Seating/Max Certification Seating — For example, 2+8/13/19 indicates that the aircraft requires two pilots, there are eight seats in the typical executive configuration, 13 seats with optional high-density seating and up to 19 passenger seats based upon FAA and/or EASA certification limits. A four-place single-engine aircraft is shown as 1+3/3, indicating that one pilot is required and there are three other seats available for passengers. We require two pilots for all turbofan airplanes, except for single-pilot certified aircraft such as the Cirrus Vision SF-50, Eclipse 550, Cessna Citation CJ series, HondaJet and Syberjet SJ30-2, which have, or will have, a large percentage of single-pilot operators. Four crewmembers are specified for ultra-long-range aircraft — three pilots and one flight attendant. However, Dassault only provides data with three crewmembers aboard for its ultra-long-range aircraft, thus the notations for the Falcon 8X.

Each occupant of a turbine-powered airplane is assumed to weigh 200 lb., thereby allowing for stowed luggage and carry-on items. In the case of piston-engine airplanes, we assume each occupant weighs 170 lb. There is no luggage allowance for piston-engine airplanes.

▶ **Wing Loading —** MTOW divided by total wing area.

▶ **Power Loading —** MTOW divided by total rated takeoff horsepower or total rated takeoff thrust.

▶ **FAR Part 36 Certified Noise Levels —** Flyover noise in A-weighted decibels (dBA) for small and turboprop aircraft. For turbofan-powered aircraft, we provide Part 36 EPNdB (effective perceived noise levels) for Lateral, Flyover and Approach.

Dimensions

▶ **External Length, Height and Span** dimensions are provided for use in determining hangar and/or tie-down space requirements.

Internal Length, Height and Width are based on a completed interior, including insulation, upholstery, carpet, carpet padding and fixtures. Note well: These dimensions are not intended to be based upon green aircraft dimensions. They must reflect the actual net dimensions with all soft goods installed. Some manufacturers provide optimistic measurements, thus prospective buyers are advised to measure aircraft themselves.

As shown in the Cabin Interior Dimensions illustration, for small airplanes other than "cabin-class" models, the length is measured from the forward bulkhead ahead of the rudder pedals to the back of the rear-most passenger seat in its normal, upright position. The upright position of the aft seat backs allows room for luggage in the cabin.

For so-called cabin-class and larger aircraft, we show two or three dimensions, depending on aircraft class. **The first** is the overall length of the passenger cabin, measured from the aft side of the forward cockpit/cabin divider to the aft-most bulkhead of the cabin. The aft-most point is defined by the rear side of a baggage compartment that is accessible to passengers in flight or the aft pressure bulkhead. The overall length is reduced by the length of any permanent mounted system or structure that is installed in the fuselage ahead of the aft bulkhead. For example, some aircraft have full fuselage cross-section fuel tanks mounted ahead of the aft pressure bulkhead.

The second length number is the net length of the cabin that routinely is occupied by passengers. It's measured from the aft side of the forward cockpit/cabin divider to an aft point defined by the rear of the cabin floor capable of supporting passenger seats, the rear wall of an aft galley or lavatory, an auxiliary pressure bulkhead or the front wall of the pressurized baggage compartment. Some aircraft have the same net and overall interior length because the manufacturer offers at least one interior configuration with the aft-most passenger seat located next to the front wall of the aft luggage compartment.

The third length dimension is the main seating area of the cabin, including all passenger seats in the standard aircraft configuration that are certified for full-time occupancy. Some manufacturers may fit their aircraft with forward, side-facing divans, ahead of areas with individual fore-aft facing chairs. The main seating length dimension may include such forward cabin side-facing divans at the discretion of the manufacturer. The length of the lavatory, even though it may have a seat certified for full-time occupancy, may not be included in the main seating length dimension.

Interior height is measured at the center of the cabin cross-section. If the aircraft has a dropped aisle, the maximum depth below the adjacent cabin floor is shown. Some aircraft have dropped aisles of varying depths, resulting in less available interior net height in certain sections of the cabin.

Two width dimensions are shown for multiengine turbine airplanes — one at the widest part of the cabin and the other at floor level. The dimensions, however, are not completely indicative of the usable space in a specific aircraft because of individual variances in interior furnishings.

Power

Number of engines, if greater than one, and the abbreviated name of the manufacturer: GE — General Electric; GE/Honda — General Electric and Honda; Honeywell; CFMI — CFM International; IAE — International Aero Engines; Lyc — Textron Lycoming; P&WC — Pratt

& Whitney Canada; RR — Rolls-Royce; Snecma; TCM — Teledyne Continental; and Wms — Williams International.

▶ **Output —** Takeoff rated horsepower for propeller-driven aircraft or pounds thrust for turbofan aircraft. If an engine is flat rated, enabling it to produce takeoff rated output at a higher than ISA (standard day) ambient temperature, the flat rating limit is shown as ISA+XXC. Highly flat-rated engines, i.e. engines that can produce takeoff rated thrust at a much higher than standard ambient temperature, typically provide substantially improved high density altitude, climb and high-altitude cruise performance.

▶ **Inspection Interval** is the longest scheduled hourly major maintenance interval for the engine, either "t" for TBO or "c" for compressor zone inspection. In some cases, we show a second number if the engine manufacturer has obtained an extended maintenance interval, provided that the engines are enrolled in the manufacturer's service program. OC is shown only for engines that have "on condition" repair or replace parts maintenance.

AIRBUS CORPORATE JETS

Weights (lb.)

Weight categories are listed as appropriate to each class of aircraft.

▶ **Max Ramp —** Maximum ramp weight for taxi.

▶ **Max Takeoff —** Maximum takeoff weight as determined by structural limits.

▶ **Max Landing —** Maximum landing weight as determined by structural limits.

▶ **Zero Fuel —** Maximum zero fuel weiht, shown by "c," indicating the certified MZFW or "b," a *BCA*-computed weight based on MTOW minus the weight of fuel required to fly 1.5 hr. at high-speed cruise.

▶ **Max ramp, max takeoff and max landing** weights may be the same for light aircraft that may only have a certified max takeoff weight.

▶ **EOW/BOW —** Empty Operating Weight is shown for piston-powered airplanes. EOW is based on the factory standard weight, plus items specified in the "*BCA* Required Equipment List," less fuel, loose equipment and cabin stores.

Basic Operating Weight is shown for turbine-powered airplanes. BOW is based on the average EOW weight of the last 10 commercial deliveries, plus 200 lb. for each required crewmember. Three flight crewmembers and one cabin crewmember are required for ultra-long-range aircraft, unless otherwise noted.

While there is no requirement to add in the weight of cabin stores, some manufacturers choose to include galley stores and passenger supplies as part of the BOW build-up. Life vests, life rafts and appropriate deep-water survival equipment are included in the weight buildup of the 80,000+ lb., ultra-long-range aircraft.

▶ **Max Payload —** Zero Fuel weight minus EOW or BOW, as appropriate. For piston-engine airplanes, Max Payload frequently is a computed value because it is based on the *BCA* ("b") computed maximum ZFW.

▶ **Max Fuel —** Usable fuel weight based on 6.0 lb. per U.S. gallon for avgas or 6.7 lb. per U.S. gallon for jet fuel. Fuel quantity is based upon the largest capacity tanks that are available as standard equipment.

▶ **Available Payload With Max Fuel —** Max Ramp weight minus the tanks-full weight, not to exceed Zero Fuel weight minus EOW or BOW.

▶ **Available Fuel With Max Payload —** Max Ramp weight minus Zero Fuel weight, not to exceed maximum fuel capacity.

Limits

BCA lists V speeds and other limits as appropriate to the class of airplane. These are the abbreviations used on the charts:

▶ **VNE —** Never exceed speed (redline for piston-engine airplanes).

▶ **VNO —** Normal operating speed (top of the green arc for piston-engine airplanes).

▶ **VMO —** Maximum operating speed (redline for turbine-powered airplanes).

▶ **MMO —** Maximum operating Mach number (redline for turbofan-powered airplanes and a few turboprop airplanes).

▶ **FL/VMO —** Transition altitude at which VMO equals MMO (large turboprop and turbofan aircraft).

▶ **VA —** Maneuvering speed (except for certain large turboprop and all turbofan aircraft).

▶ **VDEC —** Accelerate/stop decision speed (multiengine piston and light multiengine turboprop airplanes).

▶ **VMCA —** Minimum control airspeed, airborne (multiengine piston and light multiengine turboprop airplanes).

▶ **VSO —** Maximum stalling speed, landing configuration (single-engine airplanes).

▶ **VX —** Best angle-of-climb speed (single-engine airplanes).

▶ **VXSE —** Best angle-of-climb speed, one-engine inoperative (multiengine piston and multiengine turboprop airplanes under 12,500 lb.).

▶ **VY —** Best rate-of-climb speed (single-engine airplanes).

▶ **VYSE —** Best rate-of-climb speed, one-engine inoperative (multiengine piston and multiengine turboprop airplanes under 12,500 lb.).

▶ **V2 —** Takeoff safety speed (large turboprops and turbofan airplanes).

▶ **VREF —** Reference landing approach speed (large turboprops and turbofan airplanes, four passengers, NBAA IFR reserves; eight passengers for ultra-long-range aircraft).

▶ **PSI —** Cabin pressure differential (all pressurized airplanes).

Airport Performance

Airplane Flight Manual takeoff runway performance is shown for sea level, standard day and for 5,000-ft. elevation/25C day density altitude. All-engine takeoff distance (TO) is shown for single-engine and multiengine piston, and turboprop airplanes with an MTOW of less than 12,500 lb. Takeoff distances and speeds assume MTOW, unless otherwise noted.

▶ **Accelerate/Stop distance (A/S)** is shown for small multiengine piston and small turboprop airplanes.

▶ **Takeoff Field Length (TOFL),** the greater of the one-engine inoperative (OEI) takeoff distance or the accelerate/stop distance, is shown for FAR Part 23 Commuter Category and FAR Part 25 airplanes. If the accelerate/stop and accelerate/stop distances are equal, the TOFL is the balanced field length.

▶ **Landing distance (LD)** is shown for FAR Part 23 Commuter Category and FAR Part 25 Transport Category airplanes. The landing weight is BOW plus four passengers and NBAA IFR fuel reserves. We assume that 80,000+ lb. ultra-long-range aircraft will have eight passengers on board.

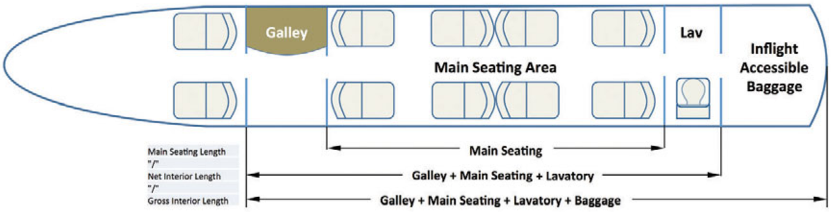
▶ **V2 and VREF** speeds are useful for reference when comparing the TOFL and LD numbers because they provide an indication of potential minimum-length runway performance when low RCR or runway gradient is a factor.

BCA lists two additional warm day airport performance numbers for large turboprop- and turbofan-powered airplanes. First, we publish the Mission Weight, which is the maximum allowable takeoff weight when departing a 5,000-ft. elevation/ISA+20C airport with at least four passengers aboard.

Mission Weight, when departing from a 5,000-ft./ISA+20C airport, may be less than the MTOW at sea level on a standard day because of FAR Part 25 second-segment, one-engine-inoperative, climb performance requirements. If maximum allowable mission weight at takeoff is restricted under said conditions, it's flagged with a "p." Aircraft with highly flat-rated engines are less likely to have a performance limited mission weight when departing under said warm day conditions.

Second, we publish the NBAA IFR range for said warm day conditions, assuming a transition into standard-day, ISA flight conditions after takeoff. For purposes of computing NBAA IFR range, the aircraft is flown at the long-range cruise speed shown in the "Cruise" block or at the same speed as shown in the "Range" block. Notably, some aircraft may actually have slightly better range performance when departing from said warm day airport because they have a 5,000-ft. head start on the climb to cruise altitude.

Cabin Length



Climb

The all-engine time to climb provides an indication of overall climb performance, especially if the aircraft has an all-engine service ceiling well above our sample time-to-climb altitudes. We provide the all-engine time to climb to one of three specific altitudes, based on type of aircraft departing at MTOW from a sea-level, standard-day airport: (1) FL 100 (10,000 ft.) for normally aspirated single-engine and multiengine piston aircraft, plus pressurized single-engine piston aircraft and unpressurized turboprop aircraft; (2) FL 250 for pressurized single-engine and multiengine turboprop aircraft; or (3) FL 370 for turbofan-powered aircraft. These data are published as time-to-climb in minutes/climb altitude. For example, if a non-pressurized twin-engine piston aircraft can depart from a sea-level airport at MTOW and climb to 10,000 ft. in 8 min., the time to climb is expressed as 8/FL 100.

We also publish the initial all-engine climb feet per nautical mile gradient, plus initial engine-out climb rate and gradient, for single-engine and multiengine pistons and turboprops with MTOWs of 12,500 lb. or less.

The one-engine-inoperative (OEI) climb rate for multiengine aircraft at MTOW is derived from the Airplane Flight Manual. OEI climb rate and gradient are based on landing gear retracted and wing flaps in the takeoff configuration used to compute the published takeoff distance. The climb gradient for such airplanes is obtained by dividing the product of the climb rate (fpm) in the Airplane Flight Manual times 60 by the VY or VYSE climb speed, as appropriate.

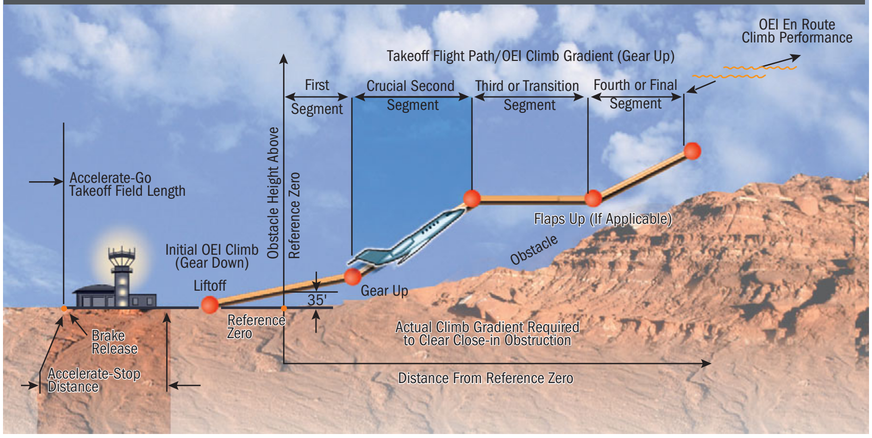
The OEI climb gradients we show for FAR Part 23 Commuter Category and FAR Part 25 Transport Category aircraft are the second-segment net climb performance numbers published in the AFMs. Please note: The AFM net second-segment climb performance numbers are adjusted downward by 0.8% to compensate for variations in pilot technique and ambient conditions.

The OEI climb gradient is computed at the same flap configuration used to calculate the takeoff field length.

Ceilings (ft.)

▶ **Maximum Certificated Altitude** — Maximum allowable operating altitude

FAR Part 25 and Part 23 Commuter Category OEI Climb Performance



determined by airworthiness authorities.

▶ **All-Engine Service Ceiling** — For turbofan aircraft: maximum altitude at which at least a 300-fpm rate of climb can be attained, assuming the aircraft departed a sea-level, standard-day airport at MTOW and climbed directly to altitude. For piston and turboprop aircraft: 100 fpm rate of climb.

▶ **OEI (Engine Out) Service Ceiling**

▶ **Sea-Level Cabin (SLC) Altitude** — Maximum cruise altitude at which a 14.7-psia, sea-level cabin altitude can be maintained in a pressurized airplane.

Cruise

Cruise performance is computed using EOW with four occupants or BOW with four passengers and one-half fuel load. Ultra-long-range aircraft carry eight passengers for purposes of computing cruise performance.

Assume 170 lb. for each occupant of a piston-engine airplane and 200 lb. for each occupant of a turbine-powered aircraft.

▶ **Long Range** — True air speed (TAS), fuel flow in pounds/hour, flight level (FL) cruise altitude and specific range for long-range cruise by the manufacturer.

▶ **Recommended (Piston-Engine Airplanes)** — TAS, fuel flow in pounds/hour, FL cruise altitude and specific range for normal cruise performance specified by the manufacturer.

▶ **High Speed** — TAS, fuel flow in pounds/hour, FL cruise altitude and specific range for short-range, high-speed performance specified by the aircraft manufacturer.

Speed, fuel flow, specific range and altitude in each category are based on one mid-weight cruise point and these data reflect standard-day conditions. They are not an average for the overall mission and they are not representative of the above standard-day temperatures at cruise altitudes commonly encountered in everyday operations.

BCA imposes a 12,000-ft. maximum cabin altitude requirement on CAR3/FAR Part 23 normally aspirated aircraft. Non-pressurized turbocharged piston-engine airplanes are limited to FL 250, providing they are fitted with supplemental oxygen systems having sufficient capacity for all occupants for the entire duration of the mission. Pressurized CAR3/FAR Part 23 aircraft are limited to a maximum cabin altitude of 10,000 ft. For FAR Part 23 Commuter Category and FAR Part 25 aircraft, the maximum cabin altitude for computing cruise performance is 8,000 ft.

To conserve space, we use flight levels (FL) for all cruise altitudes, which is appropriate considering that we assume standard-day ambient temperature and pressure conditions. Cruise performance is subject to *BCA*'s verification.

Range

BCA shows various paper missions for each aircraft that illustrate range versus payload tradeoffs, runway and cruise performance, plus fuel efficiency. Similar to the cruise profile calculations, *BCA* limits the maximum altitude to 12,000 ft. for normally aspirated, non-pressurized CAR3/FAR Part 23 aircraft, 25,000 ft. for turbocharged non-pressurized airplanes with supplemental oxygen, 10,000 ft. cabin altitude for pressurized CAR 3/FAR Part 23 airplanes and 8,000 ft. cabin altitude for FAR Part 23 Commuter Category or FAR Part 25 aircraft.

▶ **Seats-Full Range (Single-Engine Piston Airplanes)** — Based on typical executive configuration with all seats filled with 170-lb. occupants, with maximum available fuel less 45-min. IFR fuel reserves. We use the lower of seats full or maximum payload.

▶ **Tanks-Full Range (Single-Engine Piston Airplanes)** — Based on one 170-lb. pilot, full fuel less 45-min. IFR fuel reserves.

▶ **Max Fuel With Available Payload (Single-Engine Turboprops)** — Based on BOW, plus full fuel and the maximum available payload up to maximum ramp weight. Range is based on arriving at destination with NBAA IFR fuel reserves, but only a 100-mi. alternate is required.

▶ **Ferry (Multiengine Piston Airplanes and Single-Engine Turboprops)** — Based on one 170-lb. pilot, maximum fuel less 45-min. IFR fuel reserves.

Please note: None of the missions for piston-engine aircraft includes fuel for diverting to an alternate. However, single-engine turboprops are required to have NBAA IFR fuel reserves, but only a 100-mi. alternate is required.

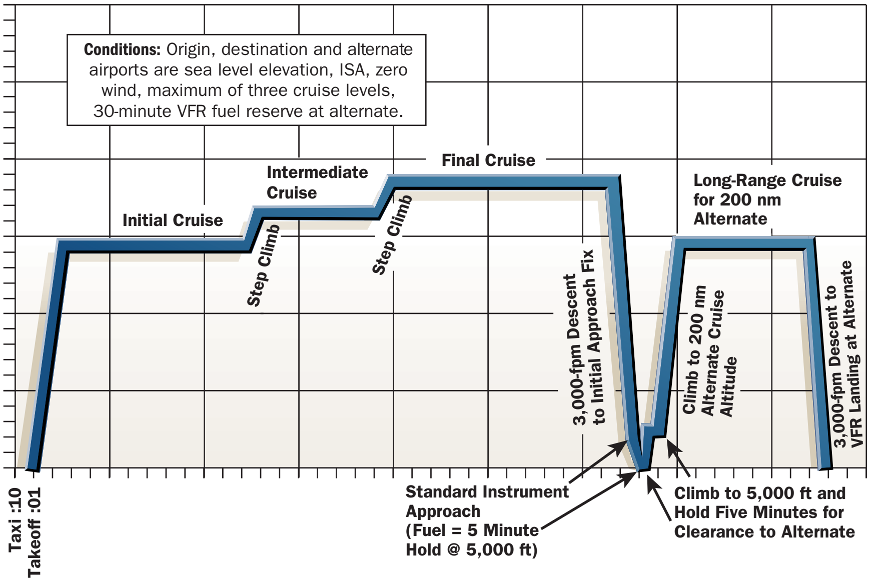
NBAA IFR range format cruise profiles, having a 200-mi. alternate, are used for turbine-powered aircraft with MTOWs equal to, or greater than, 22,000 lb. Turbine aircraft having MTOWs less than 22,000 lb. only need a 100-mi. NBAA alternate. The difference in alternate requirements should be kept in mind when comparing range performance of various classes of aircraft.

▶ **Available Fuel With Max Payload (Multiengine Turbine Airplanes)** — Based on aircraft loaded to maximum zero fuel weight with maximum available fuel up to maximum ramp weight, less NBAA IFR fuel reserves at destination.

▶ **Available Payload With Max Fuel (Multiengine Turbine Airplanes)** — Based on BOW plus full fuel and maximum available payload up to maximum ramp weight. Range based on NBAA IFR reserves at destination.

▶ **Full/Max Fuel With Four Passengers (Multiengine Turbine Airplanes)** — Based on BOW plus four 200-lb. passengers and the lesser of full fuel or maximum available fuel up to maximum ramp

NBAA IFR RANGE PROFILE



Conditions: Origin, destination and alternate airports are sea level elevation, ISA, zero wind, maximum of three cruise levels, 30-minute VFR fuel reserve at alternate.

weight. Ultra-long-range aircraft must have eight passengers on board.

▶ **Ferry (Multiengine Turbine Airplanes) —** Based on BOW, required crew and full fuel, arriving at destination with NBAA IFR fuel reserves.

We allow 2,000-ft. increment step climbs above the initial cruise altitude to improve specific range performance, even though current air traffic rules in North America provide for 4,000-ft. altitude semicircular directional traffic separation above FL 290. The altitude shown in the range section is the highest cruise altitude for the trip — not the initial cruise or mid-mission altitude.

The range profiles are in nautical miles, and the average speed is computed by dividing that distance by the total flight time or weight-off-wheels time en route. The Fuel Used or Trip Fuel includes the fuel consumed for start, taxi, takeoff, cruise, descent and landing approach but not after-landing taxi or reserves.

The Specific Range is obtained by dividing the distance flown by the total fuel burn. The Altitude is the highest cruise altitude achieved on the specific mission profile shown.

TEXTRON AVIATION/CITATION LONGITUDE FIRST FLIGHT

Missions

Various paper missions are computed to illustrate the runway requirements, speeds, fuel burns and specific range, plus cruise altitudes. The mission ranges are chosen to be representative for the airplane category. All fixed-distance missions are flown with four passengers on board, except for ultra-long-range airplanes, which have eight passengers on board. The pilot is counted as a passenger on board piston-engine airplanes. If an airplane cannot complete a specific fixed distance mission with the appropriate payload, *BCA* shows a reduction of payload in the remarks section or marks the fields NP (Not Possible) at our option.

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BCA Required Equipment List

	Single-Engine Pistons	Single-Engine Pistons, Turbocharged	Single-Engine Pistons, Pressurized	Multiengine Pistons	Multiengine Pistons, Turbocharged	Single-Engine Turboprops	Turboprops ≤12,500 lb.	Turboprops >12,500 lb.	Jets <20,000 lb.	Jets ≥20,000 lb.
POWERPLANT SYSTEMS										
Batt temp indicator (nicad only, for each battery)						●	●	●	●	●
Engine synchronization									🔵	🔵
Fire detection, each engine						●	●	●	●	●
Fire extinguishing, each engine						●	●	●	●	●
Propeller, reversible pitch						●	●	●		
Propellers, synchronization							●	●		
Thrust reversers									🔵	🔵
AVIONICS										
ADF receiver (non U.S. deliveries)						●	●	●	●	●
Altitude alerter						●	●	●	●	●
Altitude encoder	●	●	●	●	●	●	●	🔵	🔵	🔵
Audio control panel	●	●	●	●	●	●	●	🔵	🔵	🔵
Automatic flight guidance, 2-axis, alt hold	●	●	●	●						
Automatic flight guidance, 3-axis, alt hold					●	●	●	●	●	🔵
Digital air data computer							●	🔵	🔵	🔵
DME or approved GPS distance indication	●	●	●	●	●	●	●	●	●	🔵
EFIS/large-format flat-panel displays	●	●	●	●	●	●	●	●	●	●
ELT	●	●	●	●	●	●	●	●	●	●
FMS (TSO C115) or GPS (TSO C129/145/146)	●	●	●	●	●	●	●	●	●	🔵
Marker beacon receiver	●	●	●	●	●	●	●	●	🔵	🔵
Radio altimeter						●	●	●	●	🔵
RVSM certification						●	●	🔵	🔵	🔵
Satcom, Iridium, or Inmarsat									●	●
TAS or TCAS I						●	●	●		
TAWS						●	●	●	●	●
TCAS I/II									●	●
Transponder, Mode S 1090ES	●	●	●	●	●	●	●	🔵	🔵	🔵
VHF comm transceiver, 25-KHz spacing	●	●	●	●	●	●	●	●		
VHF comm tranceiver, 8.33-kHz spacing									🔵	🔵
VOR/ILS	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵
Weather data link										
Weather radar						●	●	●	●	●
GENERAL										
Air conditioning, vapor cycle (not required with APU)				●		●	●	●	●	●
Anti-skid brakes (not required MTOW <10,000 lb.)								●	●	●
APU (required for air-start engines, ACM air conditioning)										●
Cabin/cockpit bulkhead divider								●	●	●
Corrosion-proofing	●	●	●	●	●	●	●	●	●	●
Exterior paint, tinted windows	●	●	●	●	●	●	●	●	●	●
Fire extinguisher, cabin						●	●	●	●	●
Fire extinguisher, cockpit	●	●	●	●	●	●	●	●	●	●
Fuel tanks, long-range	●	●	●	●	●					
Ground power jack	●	●	●	●	●	●	●	●	●	●
Headrests, air vents at all seats	●	●	●	●	●	●	●	●	●	●
Lavatory								●	●	●
Lights, external — nav/beacon/strobe/landing/taxi	●	●	●	●	●	●	●	●	●	●
Lights, internally illuminated instrument/cockpit flood	●	●	●	●	●	●	●	●	●	●
Oxygen, supplemental — all seats		●			●	●	●	●	●	●
Refreshment center							●	●	●	●
Seats, crew, articulating	●	●	●	●	●	●	●	●	●	●
Seats, passenger, reclining	●	●	●	●	●	●	●	●	●	●
Shoulder harness, all seats/crew with inertial reel	●	●	●	●	●	●	●	●	●	●
Tables, cabin work						●	●	●	●	●
ICE AND RAIN PROTECTION										
Alternate static pressure source (not required with dual DADC)	●	●	●	●	●	●	●			
Flight Into Known Icing (FIKI) approval			●	●	●	●	●	●	●	●
Ice protection plates							●	●		
Pitot heat	●	●	●	●	●	●	●	🔵	🔵	🔵
Windshield rain removal, mechanical/pneumatic/hygroscopic							●	●	●	●
INSTRUMENTATION										
Angle-of-attack stall margin indicator									●	●
EGT	●	●	●	●	●					
IVSI (or equivalent DADC function)	●	●	●	●	●	●	●	●	●	●
OAT	●	●	●	●	●	●	●	●	●	●
Primary flight instruments	●	●	●	●	●	●	🔵	🔵	🔵	🔵

● Required
🔵 Dual Required

Runway performance is obtained from the Approved Airplane Flight Manual. Takeoff distance is listed for single-engine airplanes; accelerate/stop distance is listed for piston twins and light turboprops; and takeoff field length, which often corresponds to balanced field length, is used for FAR Part 23 Commuter Category and FAR Part 25 large Transport Category airplanes.

Flight Time (takeoff to touchdown, or weight-off-wheels, time) is shown for turbine airplanes. Some piston-engine manufacturers also include taxi time, resulting in a chock-to-chock, Block Time measurement. Fuel Used, though, is the actual block fuel burn for each type of aircraft, but it does not include fuel reserves. The cruise altitude shown is that which is specified by the manufacturer for fixed-distance missions.

▶ **200 nm** — (Piston-engine airplanes).

▶ **500 nm** — (Piston-engine airplanes).

▶ **300 nm** — (Turbine-engine airplanes, except ultra-long-range).

▶ **600 nm** — (Turbine-engine airplanes, except ultra-long-range).

▶ **1,000 nm** — (All turbine-engine airplanes).

▶ **3,000 nm** — (Ultra-long-range turbine-engine airplanes).

▶ **6,000 nm** — (Ultra-long-range turbine-engine airplanes).

Remarks

In this section, *BCA* generally includes the base price, if it is available or applicable; the certification basis and year; and any notes about estimations, limitations or qualifications regarding specifications, performance or price. All prices are in 2017 dollars, FOB at a U.S. delivery point, unless otherwise noted. The certification basis includes the regulation under which the airplane was originally type certified, the year in which it was originally certified and, if applicable, subsequent years during which the airplane was re-certified. "*BCA* Estimated Data" indicates that we made adjustments to data provided by manufacturers.

General

The following abbreviations are used throughout the tables: **"NA"** means not available; "—" indicates the information is not applicable and **"NP"** signifies that specific performance is not possible. **BCA**

Single-Engine Pistons normally aspirated

Manufacturer			Cirrus Design	Piper	Textron Aviation	Cirrus Design
Model			**SR20**	**Arrow PA-28R-201**	**Cessna Skylane CE-182T**	**SR22**
BCA Equipped Price			$389,900	$466,880	$480,000	$539,900
Characteristics		Seating	1+3/4	1+3/3	1+3/3	1+3/4
		Wing Loading	21.7	16.2	17.8	23.5
		Power Loading	14.65	13.75	13.48	11.61
		Noise (dBA)	83.4	77.7	77.7	83.7
External Dimensions (ft.)		Length	26.0	24.7	29.0	26.0
		Height	8.9	7.9	9.3	8.9
		Span	38.3	35.4	36.0	38.3
Internal Dimensions (ft.)		Length	8.0	7.7	7.2	8.0
		Height	4.1	3.7	4.0	4.1
		Width	4.1	3.5	3.5	4.1
Power		Engine	Lyc IO-390-C3B6	Lyc IO-360-C1C6	Lyc IO-540-AB1A5	Cont IO-550-N
		Output (hp)	215	200	230	310
		Inspection Interval	2,000t	2,000t	2,000t	2,000t
Weights (lb.)		Max Ramp	3,160	2,758	3,110	3,610
		Max Takeoff	3,150	2,750	3,100	3,600
		Max Landing	3,150	2,750	2,950	3,600
		Zero Fuel	3,043b	2,636b	2,976b	3,400c
		EOW	2,120	1,798	1,965	2,260
		Max Payload	923	838	1,011	1,140
		Useful Load	1,040	960	1,145	1,350
		Max Baggage	130	200	200	130
		Max Fuel	336	432	522	552
		Available Payload w/Max Fuel	704	528	623	798
		Available Fuel w/Max Payload	117	122	135	210
Limits		V_{NE}	201	183	175	205
		V_{NO}	164	146	140	176
		V_A	133	118	110	140
Airport Performance		TO (SL elev./ISA temp.)	2,530	1,600	1,514	1,756
		TO (5,000-ft. elev.@25C)	4,305	3,250	2,708	3,016
		V_{SO}	62	55	49	64
		V_X	81	78	65	88
		V_Y	88	90	80	108
Climb		Time to Climb (min.)/Altitude	20/FL 100	16/FL 100	15/FL 100	11/FL 100
		Initial Gradient (ft./nm)	540	560	694	775
Ceiling (ft.)		Service	17,500	16,200	18,100	17,500
Cruise	**Long Range**	TAS	135	124	125	160
		Fuel Flow	53	51	61	68
		Altitude	FL 080	FL 100	FL 100	FL 080
		Specific Range	2.547	2.431	2.049	2.353
	Recommended	TAS	145	130	135	171
		Fuel Flow	61	68	69	92
		Altitude	FL 080	FL 090	FL 100	FL 080
		Specific Range	2.369	1.912	1.957	1.859
	High Speed	TAS	152	137	144	180
		Fuel Flow	71	76	83	107
		Altitude	FL 080	FL 060	FL 060	FL 080
		Specific Range	2.129	1.803	1.735	1.682
Ranges	**Seats Full**	Nautical Miles	672	537	795	1,118
		Average Speed	135	121	131	162
		Fuel Used	275	156	414	492
		Specific Range/Altitude	2.444/FL 080	3.442/FL 070	1.920/FL 120	2.272/FL 080
	Tanks Full	Nautical Miles	672	926	912	1,118
		Average Speed	135	121	131	162
		Fuel Used	275	408	471	492
		Specific Range/Altitude	2.444/FL 080	2.270/FL 070	1.936/FL 120	2.272/FL 080
Missions (4 occupants)	**200 nm**	Runway	1,685	1,600	1,216	1,303
		Block Time	1+26	1+29	1+37	1+09
		Fuel Used	112	125	123	127
		Specific Range/Altitude	1.786/FL 080	1.600/FL 070	1.626/FL 120	1.575/FL 080
	500 nm	Runway	1,685	1,600	1,369	1,519
		Block Time	3+30	3+50	3+52	2+49
		Fuel Used	245	278	269	305
		Specific Range/Altitude	2.041/FL 080	1.799/FL 090	1.859/FL 120	1.639/FL 080
Remarks		Suggested Base Price	$389,900	$466,880	$480,000	$539,900
		Certification Basis	FAR 23, 1999/2017 Includes Garmin Perspective+ avionics.	CAR 3, 1976/2001 Garmin G500 standard.	FAR 23, 1996/2001 A 23-6 Garmin G1000 NXi with GFC 700 autopilot.	FAR 23, 2000 Includes Garmin Perspective+ avionics.

Single-Engine Pistons normally aspirated

Manufacturer			Mooney	GippsAero	Textron Aviation
Model			Ovation Ultra M20U	Airvan GA-8	Beechcraft Bonanza G36 G36
BCA Equipped Price			$689,000	$726,960	$815,000
Characteristics		Seating	1+3/4	1+6/7	1+4/5
		Wing Loading	19.3	20.7	20.2
		Power Loading	10.86	13.33	12.17
		Noise (dBA)	NA	84.9	76.7
External Dimensions (ft.)		Length	26.9	29.3	27.5
		Height	8.3	12.8	8.6
		Span	36.1	40.7	33.5
Internal Dimensions (ft.)		Length	8.1	11.6	12.6
		Height	3.7	3.7	4.2
		Width	3.6	4.2	3.5
Power		Engine	Cont IO-550-G-AP	Lyc IO-540-K1A5	Cont IO-550-B
		Output (hp)	310	300	300
		Inspection Interval	2,200t	2,000t	1,900t
Weights (lb.)		Max Ramp	3,374	4,014	3,663
		Max Takeoff	3,368	4,000	3,650
		Max Landing	3,200	4,000	3,650
		Zero Fuel	3,197b	3,849b	3,509b
		EOW	2,260	2,241	2,600
		Max Payload	937	1,608	909
		Useful Load	1,114	1,773	1,063
		Max Baggage	120	180	670
		Max Fuel	600	540	444
		Available Payload w/Max Fuel	514	1,233	619
		Available Fuel w/Max Payload	177	166	154
Limits		V_{NE}	195	185	203
		V_{NO}	174	143	165
		V_A	127	121	139
Airport Performance		TO (SL elev./ISA temp.)	2,300	1,860	1,913
		TO (5,000-ft. elev.@25C)	3,400	3,670	3,450
		V_{SO}	59	57	59
		V_X	75	70	84
		V_Y	105	86	100
Climb		Time to Climb (min.)/Altitude	10/FL 100	15/FL 100	14/FL 100
		Initial Gradient (ft./nm)	NA	787	730
Ceiling (ft.)		Service	NA	20,000	18,500
Cruise	**Long Range**	TAS	163	127	160
		Fuel Flow	50	78	71
		Altitude	FL 120	FL 120	FL 080
		Specific Range	3.260	1.628	2.254
	Recommended	TAS	186	135	167
		Fuel Flow	84	88	86
		Altitude	FL 121	FL 080	FL 080
		Specific Range	2.214	1.534	1.942
	High Speed	TAS	196	142	174
		Fuel Flow	114	101	94
		Altitude	FL 080	FL 060	FL 080
		Specific Range	1.719	1.406	1.851
Ranges	**Seats Full**	Nautical Miles	1,075	487	217
		Average Speed	161	124	153
		Fuel Used	438	339	115
		Specific Range/Altitude	2.454/FL 121	1.437/FL 120	1.887/FL 040
	Tanks Full	Nautical Miles	1,465	690	859
		Average Speed	173	125	159
		Fuel Used	558	464	403
		Specific Range/Altitude	2.625/FL 121	1.487/FL 120	2.132/FL 080
Missions (4 occupants)	**200 nm**	Runway	1,230	1,860	1,664
		Block Time	1+13	1+38	1+11
		Fuel Used	115	157	130
		Specific Range/Altitude	1.739/FL 050	1.274/FL 120	1.538/FL 060
	500 nm	Runway	1,290	1,860	1,870
		Block Time	2+58	3+55	2+54
		Fuel Used	221	339	304
		Specific Range/Altitude	2.262/FL 100	1.475/FL 120	1.645/FL 060
		Suggested Base Price	$689,000	$726,960	$815,000
Remarks		Certification Basis	CAR 3/FAR 23, 1955/94; STC SA02483CH Includes Garmin G1000; composite fuselage shell with left and right doors.	FAR 23 A 54 Includes Garmin G500. All data preliminary. 2016 data.	CAR 3, 1956/69/83/2005 A/C system standard; Garmin G1000 NXi.

Single-Engine Pistons turbocharged

Manufacturer			Cirrus	Textron Aviation	Textron Aviation	*GippsAero*	Mooney
Model			**SR22T SR 22**	**Cessna Turbo Stationair HD CE-T206H**	**Cessna TTx CE-T240**	***GA8 Airvan TC GA8-320 TC***	**Acclaim Ultra M020V**
BCA **Equipped Price**			$639,900	$665,000	$715,000	*$761,030*	$769,000
Character-istics		Seating	1+3/4	1+5/5	1+3/3	*1+6/7*	1+3/3
		Wing Loading	23.5	21.8	25.5	*20.7*	19.2
		Power Loading	11.43	12.22	11.61	*13.13*	12.03
		Noise (dBA)	80.3	82.6	81.4	*85.4*	78.0
External Dimensions (ft.)		Length	26.0	28.3	25.2	*28.3*	26.9
		Height	8.9	9.3	9.0	*9.3*	8.3
		Span	38.3	36.0	36.0	*36.0*	36.4
Internal Dimensions (ft.)		Length	8.0	9.3	7.9	*11.6*	8.1
		Height	4.1	4.1	4.1	*3.7*	3.7
		Width	4.1	3.7	4.0	*4.2*	3.6
Power		Engine	Cont TSIO-550-K	Lyc TIO-540-AJ1A	Cont TSIO-550-C	*Lyc TIO-540-AH1A*	Cont TSIO-550-G
		Output (hp)	315	310	310	*320*	280
		Inspection Interval	2,000t	2,000t	2,000t	*1,800t*	2,200t
Weights (lb.)		Max Ramp	3,610	3,806	3,600	*4,214*	3,374
		Max Takeoff	3,600	3,789	3,600	*4,200*	3,368
		Max Landing	3,600	3,600	3,420	*4,000*	3,200
		Zero Fuel	3,400c	3,618b	3,300c	*4,053b*	3,173b
		EOW	2,342	2,336	2,535	*2,349*	2,378
		Max Payload	1,058	1,282	765	*1,704*	795
		Useful Load	1,268	1,470	1,065	*1,865*	996
		Max Baggage	130	180	120	*180*	120
		Max Fuel	552	522	612	*540*	612
		Available Payload w/Max Fuel	716	948	453	*1,325*	384
		Available Fuel w/Max Payload	210	188	300	*161*	201
Limits		V_{NE}	205	182	230	*185*	195
		V_{NO}	176	149	181	*143*	174
		V_A	140	125	158	*121*	127
Airport Perfor-mance		TO (SL elev./ISA Temp.)	1,517	1,970	1,900	*1,840*	1,900
		TO (5,000-ft. elev.@25C)	2,268	2,845	2,460	*2,788*	3,300
		V_{SO}	64	59	61	*61*	60
		V_X	88	70	82	*71*	80
		V_Y	103	88	110	*81*	105
Climb		Time to Climb (min.)/Altitude	7/FL 100	12/FL 100	7/FL 100	*13/FL 100*	7/FL 100
		Initial Gradient (ft./nm)	782	724	701	*825*	770
Ceilings (ft.)		Certificated	25,000	25,000	25,000	*20,000*	25,000
		Service	25,000	27,000	25,000	*20,000*	25,000
Cruise	**Long Range**	TAS	171	137	208	*125*	215
		Fuel Flow	76	85	78	*68*	99
		Altitude	FL 250	FL 240	FL 250	*FL 200*	FL 250
		Specific Range	2.250	1.612	2.667	*1.838*	2.172
	Recommended	TAS	201	155	227	*130*	227
		Fuel Flow	98	99	130	*78*	128
		Altitude	FL 250	FL 240	FL 250	*FL 200*	FL 180
		Specific Range	2.051	1.566	1.746	*1.667*	1.773
	High Speed	TAS	213	164	235	*135*	242
		Fuel Flow	110	114	152	*98*	130
		Altitude	FL 250	FL 200	FL 250	*FL 200*	FL 250
		Specific Range	1.936	1.439	1.546	*1.378*	1.862
Ranges	**Seats Full**	Nautical Miles	1,021	512	666	*233*	500
		Average Speed	171	137	202	*125*	178
		Fuel Used	486	387	345	*220*	259
		Specific Range/Altitude	2.101/FL 250	1.323/FL 200	1.930/FL 250	*1.059/FL 200*	1.931/FL 160
	Tanks Full	Nautical Miles	1,021	655	1,270	*618*	1,122
		Average Speed	171	138	204	*125*	200
		Fuel Used	486	459	572	*459*	539
		Specific Range/Altitude	2.101/FL 250	1.427/FL 240	2.220/FL 250	*1.346/FL 200*	2.082/FL 250
Missions (4 occupants)	**200 nm**	Runway	1,405	1,396	1,730	*1,743*	1,300
		Block Time	1+08	1+23	1+03	*1+35*	1+05
		Fuel Used	197	163	159	*125*	139
		Specific Range/Altitude	1.015/FL 100	1.227/FL 150	1.258/FL 150	*1.600/FL 120*	1.439/FL 120
	500 nm	Runway	1,699	1,597	1,880	*1,743*	1,380
		Block Time	2+28	3+22	2+24	*3+30*	2+54
		Fuel Used	360	385	338	*373*	259
		Specific Range/Altitude	1.389/FL 180	1.299/FL 240	1.479/FL 250	*1.340/FL 200*	1.931/FL 250
		Suggested Base Price	$639,900	$665,000	$715,000	*$597,500*	$769,000
Remarks		Certification Basis	FAR 23, 2010 Includes Garmin Perspective+ Global avionics.	FAR 23, 1998 Utility version w/2,183-lb. EOW, $658,650; Garmin G1000 NXi w/GFC 700 a/p; new interior.	FAR 23 Includes Garmin G2000, SVT, AP, TAWS, TAS, ESP, A/C, Ti LE, leather.	*FAR 23, 1998 Garmin G500; KC 225 All data preliminary. 2016 data.*	CAR 3, 1955/89/2006 Includes Garmin G1000; new composite fuselage shell with left and right doors.

Single-Engine Pistons pressurized

Manufacturer			Piper Aircraft	Piper Aircraft
Model			Matrix PA-46R-350	M350 PA-46-350P
BCA Equipped Price			$916,680	$1,178,610
Characteristics		Seating	1+4/5	1+4/5
		Wing Loading	24.8	24.8
		Power Loading	12.40	12.40
		Noise (dBA)	81.0	81.0
External Dimensions (ft.)		Length	28.9	28.9
		Height	11.3	11.3
		Span	43.0	43.0
Internal Dimensions (ft.)		Length	12.4	12.4
		Height	3.9	3.9
		Width	4.2	4.2
Power		Engine	Lyc TIO-540-AE2A	Lyc TIO-540-AE2A
		Output (hp)	350	350
		Inspection Interval	2,000t	2,000t
Weights (lb.)		Max Ramp	4,358	4,358
		Max Takeoff	4,340	4,340
		Max Landing	4,123	4,123
		Zero Fuel	4,123c	4,123c
		EOW	2,969	3,146
		Max Payload	1,154	977
		Useful Load	1,389	1,212
		Max Baggage	200	200
		Max Fuel	720	720
		Available Payload w/Max Fuel	669	492
		Available Fuel w/Max Payload	235	235
Limits		VNE	198	198
		VNO	168	168
		VA	133	133
		PSI	5.5	5.5
Airport Performance		TO (SL elev./ISA temp.)	2,090	2,090
		TO (5,000-ft. elev.@25C)	2,977	2,977
		VSO	58	58
		VX	81	81
		VY	110	110
Climb		Time to Climb (min.)/Altitude	8/FL 100	8/FL 100
		Initial Gradient (ft./nm)	703	703
Ceilings (ft.)		Certificated	25,000	25,000
		Service	25,000	25,000
		Sea-Level Cabin	—	12,300
Cruise	**Long Range**	TAS	156	156
		Fuel Flow	66	66
		Altitude	FL 250	FL 250
		Specific Range	2.364	2.364
	Recommended	TAS	203	203
		Fuel Flow	108	108
		Altitude	FL 250	FL 250
		Specific Range	1.880	1.880
	High Speed	TAS	213	213
		Fuel Flow	120	120
		Altitude	FL 250	FL 250
		Specific Range	1.775	1.775
Ranges	**Seats Full**	Nautical Miles	867	535
		Average Speed	151	138
		Fuel Used	457	312
		Specific Range/Altitude	1.897/FL 200	1.715/FL 120
	Tanks Full	Nautical Miles	1,343	1,343
		Average Speed	158	159
		Fuel Used	658	670
		Specific Range/Altitude	2.041/FL 250	2.004/FL 250
Missions (4 occupants)	**200 nm**	Runway	2,090	2,090
		Block Time	1+07	1+06
		Fuel Used	168	167
		Specific Range/Altitude	1.190/FL 120	1.198/FL 200
	500 nm	Runway	2,090	2,090
		Block Time	2+31	2+31
		Fuel Used	350	350
		Specific Range/Altitude	1.429/FL 250	1.429/FL 250
		Suggested Base Price	$916,680	$1,178,610
Remarks		Certification Basis	FAR 23, 1983/88 Garmin G1000; FIKI optional.	FAR 23, 1983/88 Garmin G1000; FIKI optional.

Multiengine Pistons normally aspirated

Manufacturer			Vulcanair SpA	Vulcanair SpA
Model			P.68C P 68C	Victor P 68R
BCA Equipped Price			$830,800	$848,200
Characteristics		Seating	1+5/6	1+5/6
		Wing Loading	22.9	22.7
		Power Loading	11.49	11.37
		Noise (dBA)	74.7	78.8
External Dimensions (ft.)		Length	31.3	31.3
		Height	11.2	11.2
		Span	39.4	39.4
Internal Dimensions (ft.)		Length	10.6	10.6
		Height	3.9	3.9
		Width	3.8	3.8
Power		Engines	2 Lyc IO-360-A1B6	2 Lyc IO-360-A1B6
		Output (hp each)	200	200
		Inspection Interval	2,000t	2,000t
Weights (lb.)		Max Ramp	4,630	4,548
		Max Takeoff	4,594	4,548
		Max Landing	4,365	4,321
		Zero Fuel	4,167c	4,374b
		EOW	3,153	3,197
		Max Payload	1,014	1,177
		Useful Load	1,477	1,351
		Max Fuel	1,063	1,063
		Available Payload w/Max Fuel	415	289
		Available Fuel w/Max Payload	463	174
Limits		VNE	194	197
		VNO	154	157
		VA	132	127
Airport Performance		TO (SL elev./ISA Temp.)	1,312	1,260
		TO (5,000-ft. elev.@25C)	4,000	4,000
		A/S (SL elev./ISA)	2,150	1,410
		A/S (5,000-ft. elev.@25C)	2,950	2,370
		VMCA	60	60
		VDEC	70	70
		VXSE	82	82
		VYSE	88	88
Climb		Time to Climb (min.)/Altitude	12/FL 100	12/FL 100
		Initial Engine-Out Rate (fpm)	217	217
		Initial All-Engine Gradient (ft./nm)	1,100	920
		Initial Engine-Out Gradient (ft./nm)	147	147
Ceilings (ft.)		Certificated	—	—
		All-Engine Service	18,000	20,000
		Engine-Out Service	5,000	5,650
Cruise	**Long Range**	TAS	144	144
		Fuel Flow	94	94
		Altitude	FL 080	FL 080
		Specific Range	1.532	1.532
	Recommended	TAS	155	155
		Fuel Flow	108	108
		Altitude	FL 080	FL 080
		Specific Range	1.435	1.435
	High Speed	TAS	162	162
		Fuel Flow	116	116
		Altitude	FL 080	FL 080
		Specific Range	1.397	1.397
Ranges	**Max Payload**	Nautical Miles	300	300
		Average Speed	140	140
		Trip Fuel	315	315
		Specific Range/Altitude	0.952/FL 080	0.952/FL 080
	Ferry	Nautical Miles	1,000	1,000
		Average Speed	145	145
		Trip Fuel	975	975
		Specific Range/Altitude	1.026/FL 080	1.026/FL 080
Missions (4 occupants)	**200 nm**	Runway	1,450	1,450
		Block Time	1+28	1+28
		Fuel Used	140	140
		Specific Range/Altitude	1.429/FL 080	1.429/FL 080
	500 nm	Runway	1,500	1,500
		Block Time	3+25	3+25
		Fuel Used	375	375
		Specific Range/Altitude	1.333/FL 080	1.333/FL 080
		Suggested Base Price	$830,800	$848,200
Remarks		Certification Basis	FAR 23, 1976/80 Garmin G950; STEC 55X DFCS. *BCA* estimated data.	EASA 23, 2009 Garmin G950; STEC 55X DFCS. *BCA* estimated data.

Multiengine Pistons normally aspirated

Manufacturer			Textron Aviation
Model			Beechcraft Baron G58 G58
BCA Equipped Price			$1,400,000
Character-istics		Seating	1+4/5
		Wing Loading	27.6
		Power Loading	9.17
		Noise (dBA)	77.6
External Dimensions (ft.)		Length	29.8
		Height	9.8
		Span	37.8
Internal Dimensions (ft.)		Length	12.6
		Height	4.2
		Width	3.5
Power		Engines	2 Cont IO-550-C
		Output (hp each)	300
		Inspection Interval	1,900t
Weights (lb.)		Max Ramp	5,524
		Max Takeoff	5,500
		Max Landing	5,400
		Zero Fuel	5,215b
		EOW	3,970
		Max Payload	1,245
		Useful Load	1,554
		Max Fuel	1,164
		Available Payload w/Max Fuel	390
		Available Fuel w/Max Payload	309
Limits		VNE	223
		VNO	195
		VA	165
Airport Performance		TO (SL elev./ISA Temp.)	2,345
		TO (5,000-ft. elev.@25C)	4,144
		A/S (SL elev./ISA)	3,009
		A/S (5,000-ft. elev.@25C)	4,335
		VMCA	84
		VDEC	85
		VXSE	100
		VYSE	101
Climb		Time to Climb (min.)/Altitude	10/FL 100
		Initial Engine-Out Rate (fpm)	390
		Initial All-Engine Gradient (ft./nm)	988
		Initial Engine-Out Gradient (ft./nm)	232
Ceilings (ft.)		Certificated	—
		All-Engine Service	20,688
		Engine-Out Service	7,284
Cruise	Long Range	TAS	185
		Fuel Flow	144
		Altitude	FL 080
		Specific Range	1.285
	Recommended	TAS	192
		Fuel Flow	174
		Altitude	FL 080
		Specific Range	1.103
	High Speed	TAS	200
		Fuel Flow	190
		Altitude	FL 080
		Specific Range	1.053
Ranges	Max Payload	Nautical Miles	333
		Average Speed	178
		Trip Fuel	293
		Specific Range/Altitude	1.137/FL 040
	Ferry	Nautical Miles	1,480
		Average Speed	180
		Trip Fuel	1,081
		Specific Range/Altitude	1.369/FL 120
Missions (4 occupants)	200 nm	Runway	2,862
		Block Time	1+02
		Fuel Used	226
		Specific Range/Altitude	0.885/FL 060
	500 nm	Runway	2,941
		Block Time	2+31
		Fuel Used	531
		Specific Range/Altitude	0.942/FL 060
		Suggested Base Price	$1,400,000
Remarks		Certification Basis	CAR 3, 1957/69/83/2005 A/C system standard; Garmin G1000.

Multiengine Pistons turbocharged

Manufacturer			Vulcanair SpA	Piper Aircraft
Model			P 68C-TC P 68C-TC	Seneca V PA-34-220T
BCA Equipped Price			$877,500	$999,900
Character-istics		Seating	1+5/5	1+4/5
		Wing Loading	20.7	22.8
		Power Loading	10.94	10.80
		Noise (dBA)	74.7	75.6
External Dimensions (ft.)		Length	31.3	28.6
		Height	11.2	9.9
		Span	39.4	38.9
Internal Dimensions (ft.)		Length	10.6	10.4
		Height	3.9	3.6
		Width	3.8	4.1
Power		Engines	2 Lyc TIO-360-C1A6D	2 Cont TSIO-360-RB
		Output (hp each)	210	220
		Inspection Interval	2,000t	1,800t
Weights (lb.)		Max Ramp	4,630	4,773
		Max Takeoff	4,594	4,750
		Max Landing	4,365	4,513
		Zero Fuel	4,140b	4,479c
		EOW	3,197	3,491
		Max Payload	943	988
		Useful Load	1,433	1,282
		Max Fuel	1,062	732
		Available Payload w/Max Fuel	371	550
		Available Fuel w/Max Payload	490	294
Limits		VNE	194	204
		VNO	154	164
		VA	132	139
Airport Perfor-mance		TO (SL elev./ISA temp.)	1,260	1,707
		TO (5,000-ft. elev.@25C)	2,200	2,435
		A/S (SL elev./ISA)	1,800	2,510
		A/S (5,000-ft. elev.@25C)	2,400	3,117
		VMCA	66	66
		VDEC	NA	73
		VXSE	78	83
		VYSE	88	88
Climb		Time to Climb (min.)/Altitude	10/FL 100	7/FL 100
		Initial Engine-Out Rate (fpm)	240	253
		Initial All-Engine Gradient (ft./nm)	1,400	996
		Initial Engine-Out Gradient (ft./nm)	NA	173
Ceilings (ft.)		Certificated	20,000	25,000
		All-Engine Service	20,000	25,000
		Engine-Out Service	10,000	16,500
Cruise	Long Range	TAS	144	167
		Fuel Flow	104	108
		Altitude	FL 080	FL 230
		Specific Range	1.385	1.546
	Recommended	TAS	155	196
		Fuel Flow	125	144
		Altitude	FL 080	FL 250
		Specific Range	1.240	1.361
	High Speed	TAS	162	200
		Fuel Flow	150	156
		Altitude	FL 080	FL 230
		Specific Range	1.080	1.282
Range	Ferry	Nautical Miles	1,100	866
		Average Speed	145	160
		Trip Fuel	960	648
		Specific Range/Altitude	1.146/FL 080	1.336/FL 180
Missions (4 occupants)	200 nm	Runway	NA	1,520
		Block Time	1+28	1+10
		Fuel Used	260	213
		Specific Range/Altitude	0.769/FL 080	0.939/FL 120
	500 nm	Runway	NA	1,610
		Block Time	3+25	2+41
		Fuel Used	485	476
		Specific Range/Altitude	1.031/FL 080	1.050/FL 200
		Suggested Base Price	$877,500	$999,900
Remarks		Certification Basis	FAR 23, 1982 Garmin G950 glass cockpit; STEC 55X DFGS. *BCA* estimated data.	FAR 23, 1971/80/97 Garmin G1000 standard.

Single-Engine Turboprops

Manufacturer			Mahindra Aerospace	Textron Aviation	Piper Aircraft	Quest Aircraft	Textron Aviation
Model			Airvan 10 GA-10	Cessna Caravan CE-208	M500 PA-46-500TP	Kodiak Kodiak 100	Cessna Grand Caravan EX CE-208B
BCA Equipped Price			$999,500*	$1,950,000	$1,999,900	$2,454,725	$2,527,900
Characteristics		Seating	1+9/—	1+9/13*	1+4/5	1+6/9	1+9/13*
		Wing Loading	28.6	28.6	27.8	30.2	31.3
		Power Loading	10.56	11.85	10.18	9.67	10.16
		Noise (dBA)	79.0	79.0	76.8	84.4	84.1
External Dimensions (ft.)		Length	33.5	37.6	29.6	33.8	41.6
		Height	12.7	14.9	11.3	15.3	14.8
		Span	40.6	52.1	43.0	45.0	52.1
Internal Dimensions (ft.)		Length	16.1	12.7	12.3	15.8	16.7
		Height	3.8	4.5	3.9	4.8	4.5
		Width	4.2	5.3	4.1	4.5	5.3
Power		Engine	RR M250 B-17F/2	P&WC PT6A-114A	P&WC PT6A-42A	P&WC PT6A-34	P&WC PT6A-140
		Output (shp)/Flat Rating	450/ISA+31C	675/ISA+31C	500/ISA+55C	750/ISA+7C	867/ISA+24C
		Inspection Interval	3,500t	3,600t	3,600t	4,000t	3,600t
Weights (lb.)		Max Ramp	4,775	8,035	5,134	7,305	8,842
		Max Takeoff	4,750	8,000	5,092	7,255	8,807
		Max Landing	4,750	7,800	4,850	7,255	8,500
		Zero Fuel	4,182b	7,432b	4,850c	6,490c	8,152b
		BOW	2,475	4,930	3,634	4,417	5,510
		Max Payload	1,707	2,502	1,216	2,073	2,642
		Useful Load	2,300	3,105	1,500	2,888	3,332
		Max Fuel	1,025	2,224	1,160	2,144	2,246
		Available Payload w/Max Fuel	1,275	881	340	744	1,086
		Available Fuel w/Max Payload	594	604	284	815	691
Limits		V_{MO}	175	175	188	180	175
		V_A	150	150	127	143	148
		PSI	—	—	5.6	—	—
Airport Performance		TO (SL elev./ISA temp.)	1,600	2,055	2,438	1,468	2,160
		TO (5,000-ft. elev.@25C)	2,973	2,973	3,691	2,396	3,661
		V_{SO}	61	61	69	60	61
		V_X	90	90	95	73	86
		V_Y	107	107	125	101	108
Climb		Time to Climb (min.)/Altitude	9/FL 100	9/FL 100	19/FL 250	9/FL 100	9/FL 100
		Initial Gradient (ft./nm)	771	771	753	915	816
Ceilings (ft.)		Certificated	20,000	25,000	30,000	25,000	25,000
		Service	25,000	25,000	30,000	25,000	25,000
		Sea-Level Cabin	—	—	12,600	—	—
Cruise	**Long Range**	TAS	157	157	179	164	156
		Fuel Flow	281	281	135	251	328
		Altitude	FL 100	FL 100	FL 280	220	FL 100
		Specific Range	0.559	0.559	1.326	0.653	0.476
	High Speed	TAS	186	186	258	175	185
		Fuel Flow	379	379	242	335	437
		Altitude	FL 100	FL 100	FL 280	FL 120	FL 100
		Specific Range	0.491	0.491	1.066	0.522	0.423
NBAA IFR Ranges (100-nm alternate)	**Full Fuel** (with available payload)	Nautical Miles	965	288	834	1,005	291
		Average Speed	156	153	171	175	155
		Trip Fuel	1,795	581	748	2,130	676
		Specific Range/Altitude	0.538/FL 100	0.496/FL 100	1.115/FL 280	0.472/120	0.430/FL 100
	Ferry	Nautical Miles	970	970	834	1,236	816
		Average Speed	156	156	171	164	156
		Trip Fuel	1,800	1,800	748	2,130	1,772
		Specific Range/Altitude	0.539/FL 100	0.539/FL 100	1.115/FL 280	0.580/FL 200	0.460/FL 100
Missions (4 passengers)	**300 nm**	Runway	1,468	1,468	1,550	1,468	1,428
		Flight Time	1+40	1+40	1+22	1+47	1+41
		Fuel Used	648	648	379	587	750
		Specific Range/Altitude	0.463/FL 100	0.463/FL 100	0.792/FL 280	0.511/FL 120	0.400/FL 100
	600 nm	Runway	1,675	1,675	1,625	1,468	1,792
		Flight Time	3+17	3+17	2+32	3+30	3+19
		Fuel Used	1,260	1,260	660	1,140	1,462
		Specific Range/Altitude	0.476/FL 100	0.476/FL 100	0.909/FL 280	0.526/FL 120	0.410/FL 100
	1,000 nm	Runway	NP	NP	1,700	1,467	NP
		Flight Time	NP	NP	4+18	5+47	NP
		Fuel Used	NP	NP	985	1,878	NP
		Specific Range/Altitude	NP	NP	1.015/FL 280	0.532/FL 120	NP
		Suggested Base Price	NA	NA	$1,999,900	$2,075,000	NA
Remarks		Certification Basis	FAR 23, 1984/98 **BCA* estimated price. Garmin G1000 with GFC700 autopilot. 2016 data.	FAR 23, 1984/98 *Export only. Garmin G1000 with GFC700 autopilot.	FAR 23 A 52 *1,000 nm, 3 passengers. Garmin G1000 with SVS.	FAR 23, 2007 Normal category Includes Garmin G1000; GFC700 with coupled GA; Summit interior option.	FAR 23, 1986/2012 *Export only. Includes cargo pod, Garmin G1000 with GFC700 autopilot.

Single-Engine Turboprops

Manufacturer			**Piper Aircraft**	***Epic Aircraft***	**Daher**	**Daher**	**Pilatus**
Model			**M600 PA-46-600TP**	***Epic E1000***	**TBM 910 TBM 700 N**	**TBM 930 TBM 700 N**	**PC-12 NG PC-12/47E**
BCA Equipped Price			$2,899,000	$2,995,000	$3,683,260	$3,979,750	$4,923,000
Character-istics		Seating	1+4/5	1+5/6	1+5/6	1+5/6	1+7/10
		Wing Loading	28.7	36.9	38.2	38.2	37.6
		Power Loading	10.00	6.25	8.70	8.70	8.71
		Noise (dBA)	76.8	76.0	76.2	76.2	77.0
External Dimensions (ft.)		Length	29.6	35.8	35.2	35.2	47.3
		Height	11.3	12.5	14.3	14.3	14.0
		Span	43.2	43.0	42.1	42.1	53.3
Internal Dimensions (ft.)		Length	12.3	10.5	15.0	15.0	16.9
		Height	3.9	4.9	4.1	4.1	4.8
		Width	4.1	4.6	4.0	4.0	5.0
Power		Engine	P&WC PT6A-42A	P&WC PT6A-67A	P&WC PT6A-66D	P&WC PT6A-66D	P&WC PT6A-67P
		Output (shp)/Flat Rating	600/ISA+55C	1,200/ISA+35C	850/ISA+49C	850/ISA+49C	1,200/ISA+35C
		Inspection Interval	3,600t	3,500t	3,500t	3,500t	3,500t
Weights (lb.)		Max Ramp	6,050	7,500	7,430	7,430	10,495
		Max Takeoff	6,000	7,500	7,394	7,394	10,450
		Max Landing	5,800	7,500	7,024	7,024	9,921
		Zero Fuel	4,850c	5,400c	6,032c	6,032c	9,039c
		BOW	3,850	4,600	4,829	4,829	6,782
		Max Payload	1,000	800	1,203	1,203	2,257
		Useful Load	2,200	2,900	2,601	2,601	3,713
		Max Fuel	1,742	1,876	2,017	2,017	2,704
		Available Payload w/Max Fuel	458	1,024	584	584	1,009
		Available Fuel w/Max Payload	1,200	2,100	1,398	1,398	1,456
Limits		V_{MO}	250	280	266	266	240
		V_A	151	170	160	160	163
		PSI	5.6	6.7	6.2	6.2	5.8
Airport Perfor-mance		TO (SL elev./ISA temp.)	2,635	1,600	2,380	2,380	2,600
		TO (5,000-ft. elev.@25C)	3,998	NA	3,475	3,475	4,270
		V_{SO}	62	65	65	65	67
		V_X	95	124	100	100	120
		V_Y	122	144	124	124	130
Climb		Time to Climb (min.)/Altitude	21/FL 250	10/FL 250	13/FL 250	13/FL 250	20/FL 250
		Initial Gradient (ft./nm)	785	1,500	1,000	1,000	860
Ceilings (ft.)		Certificated	30,000	34,000	31,000	31,000	30,000
		Service	30,000	34,000	31,000	31,000	30,000
		Sea-Level Cabin	12,600	18,000	14,390	14,390	13,100
Cruise	**Long Range**	TAS	184	265	252	252	225
		Fuel Flow	155	268	241	241	268
		Altitude	FL 280	FL 280	FL 310	FL 310	FL 300
		Specific Range	1.187	0.989	1.046	1.046	0.840
	High Speed	TAS	274	330	330	330	285
		Fuel Flow	324	402	412	412	497
		Altitude	FL 280	FL 280	FL 260	FL 260	FL 200
		Specific Range	0.846	0.821	0.801	0.801	0.573
NBAA IFR Ranges (100-nm alternate)	**Full Fuel** (with available payload)	Nautical Miles	1,406	1,650	1,514	1,514	1,608
		Average Speed	179	265	252	252	261
		Trip Fuel	1,324	1,599	1,599	1,599	2,282
		Specific Range/Altitude	1.062/FL 280	1.032/FL 310	0.947/FL 310	0.947/FL 310	0.705/FL 300
	Ferry	Nautical Miles	1,406	1,594	1,594	1,594	1,650
		Average Speed	179	252	252	252	264
		Trip Fuel	1,324	1,598	1,598	1,598	2,294
		Specific Range/Altitude	1.062/FL 280	0.997/FL 310	0.997/FL 310	0.997/FL 310	0.719/FL 300
Missions (4 passen-gers)	**300 nm**	Runway	1,593	1,765	1,765	1,765	1,563
		Flight Time	1+21	1+00	1+00	1+00	1+10
		Fuel Used	429	440	440	440	549
		Specific Range/Altitude	0.699/FL 280	0.682/FL 280	0.682/FL 280	0.682/FL 280	0.546/FL 260
	600 nm	Runway	1,687	2,005	2,005	2,005	1,753
		Flight Time	2+31	1+55	1+55	1+55	2+16
		Fuel Used	735	830	830	830	975
		Specific Range/Altitude	0.816/FL 280	0.723/FL 280	0.723/FL 280	0.723/FL 280	0.615/FL 270
	1,000 nm	Runway	1,812	2,380	2,380	2,380	2,026
		Flight Time	4+06	3+10	3+10	3+10	3+46
		Fuel Used	1,142	1,320	1,320	1,320	1,520
		Specific Range/Altitude	0.876/FL 280	0.758/FL 290	0.758/FL 290	0.758/FL 290	0.658/FL 280
		Suggested Base Price	$2,899,000	NA	$3,658,336	$3,899,887	$4,095,000
Remarks		Certification Basis	FAR 23 A 62, 2016 Garmin G3000 with SVS and enhanced AFCS.	FAR 23 pending Garmin G1000 NXi.	FAR 23, 1990/2006/07/14 Pilot door standard; 5-blade propeller; G1000 NXi; AoA-ESP-USP; satcom; weather; 5-year system warranty.	FAR 23, 1990/2006/07/14 All features of TBM 900 plus advanced interior; Garmin G3000; 5-year system warranty.	FAR 23, 1996/2005/08 Honeywell APEX avionics; SmartView; ADS-B Out; BMW executive interior; Hartzell 5-blade propeller.

Multiengine Turboprops ≤12,500-LB. MTOW

Manufacturer			**Vulcanair SpA**	**Nextant Aerospace**	***Evektor***	**Textron Aviation**
Model			**Viator AP68TP-600**	**G90XT C90**	***Outback EV-55***	**Beechcraft King Air C90GTx C90GTi**
BCA **Equipped Price**			$2,485,900	$2,750,000	*$3,000,000*	$3,595,000
Characteristics		Seating	1+7/10	1+7/10	*1+9/14*	1+7/8
		Wing Loading	33.0	34.4	*37.4*	34.4
		Power Loading	10.08	9.55	*9.46*	9.53
		Noise (dBA)	71.7	71.7	*NA*	74.8
External Dimensions (ft.)		Length	37.0	35.5	*46.6*	35.5
		Height	11.9	14.3	*16.8*	14.3
		Span	39.4	NA	*53.2*	50.3
Internal Dimensions (ft.)		**Length:** OA/Net	11.9/17.2	12.4/12.4	*16.5/20.0*	12.4/12.4
		Height	4.1	4.8	*4.5*	4.8
		Width: Max/Floor	3.7/3.7	4.5/4.1	*5.3/4.7*	4.5/4.1
Power		Engines	2 RR 250 B17C	2 GE Czech H75-100	*2 P&WC PT6A-21*	2 P&WC PT6A-135A
		Output (shp each)/Flat Rating	328/ISA+25C	550/ISA+8C	*536/ISA+15C*	550/ISA+30C
		Inspection Interval	3,500t	4,000t	*3,600t*	3,600t
Weights (lb.)		Max Ramp	6,669	10,560	*10,207*	10,545
		Max Takeoff	6,613	10,500	*10,141*	10,485
		Max Landing	6,283	9,700	*10,141*	9,832
		Zero Fuel	5,621c	9,650c	*9,810c*	9,378c
		BOW	3,850	7,200	*5,965*	7,265
		Max Payload	1,771	2,450	*3,845*	2,113
		Useful Load	2,819	3,360	*4,242*	3,280
		Max Fuel	1,487	2,573	*3,413*	2,573
		Available Payload w/Max Fuel	1,332	787	*829*	707
		Available Fuel w/Max Payload	1,048	910	*397*	1,167
Limits		V_{MO}	200	208	*205*	226
		V_A	141	169	*140*	169
		PSI	—	5.0	*—*	5.0
Airport Performance		TO (SL elev./ISA temp.)	2,034	2,100	*1,378*	1,984
		TO (5,000-ft. elev.@25C)	2,950	2,800	*1,837*	3,375
		A/S (SL elev./ISA temp.)	2,034	3,800	*1,722*	3,690
		A/S (5,000-ft. elev.@25C)	2,953	5,100	*2,395*	5,855
		V_{MCA}	77	92	*66*	80
		V_{DEC}	85	97	*79*	97
		V_{XSE}	90	101	*92*	100
		V_{YSE}	105	111	*95*	108
Climb		Time to Climb (min.)/Altitude	7/FL 100	18/FL 250	*6/FL 010*	18/FL 250
		Initial Engine-Out Rate (fpm)	270	460	*290*	460
		Initial All-Engine Gradient (ft./nm)	1,500	1,900	*1,107*	1,900
		Initial Engine-Out Gradient (ft./nm)	180	260	*219*	260
Ceilings (ft.)		Certificated	25,000	30,000	*24,000*	30,000
		All-Engine Service	25,000	30,000	*24,000*	30,000
		Engine-Out Service	8,050	22,000	*15,420*	19,230
		Sea-Level Cabin	—	11,065	*—*	11,065
Cruise	**Long Range**	TAS	169	213	*180*	208
		Fuel Flow	261	292	*432*	332
		Altitude	FL 100	FL 280	*FL 010*	FL 260
		Specific Range	0.648	0.729	*0.417*	0.627
	High Speed	TAS	214	283	*220*	270
		Fuel Flow	375	578	*610*	612
		Altitude	FL 100	FL 240	*FL 200*	FL 200
		Specific Range	0.571	0.490	*0.361*	0.441
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	543	324	*NP*	260
		Average Speed	180	203	*NP*	229
		Trip Fuel	781	600	*NP*	620
		Specific Range/Altitude	0.695/FL 100	0.540/FL 220	*NP/—*	0.419/FL 270
	Max Fuel (with available payload)	Nautical Miles	837	1,300	*1,046*	1,026
		Average Speed	179	207	*217*	252
		Trip Fuel	1,220	1,782	*3,008*	2,044
		Specific Range/Altitude	0.686/FL 100	0.730/FL 280	*0.348/FL 100*	0.502/FL 270
	Full Fuel (with 4 passsengers)	Nautical Miles	837	1,290	*1,046*	975
		Average Speed	179	207	*217*	252
		Trip Fuel	1,220	1,769	*3,008*	1,949
		Specific Range/Altitude	0.686/FL 100	0.729/FL 280	*0.348/FL 100*	0.500/FL 270
	Ferry	Nautical Miles	837	1,369	*1,051*	1,045
		Average Speed	179	203	*218*	255
		Trip Fuel	1,220	1,850	*3,008*	2,053
		Specific Range/Altitude	0.686/FL 100	0.740/FL 280	*0.349/FL 100*	0.509/FL 270
Missions (4 passengers)	**300 nm**	Runway	1,247	3,010	*3,163*	3,004
		Flight Time	1+35	1+06	*1+26*	1+13
		Fuel Used	419	584	*943*	748
		Specific Range/Altitude	0.716/FL 100	0.514/FL 220	*0.318/FL 100*	0.401/FL 210
	600 nm	Runway	1,558	3,350	*1,289*	3,347
		Flight Time	3+18	2+12	*2+22*	2+22
		Fuel Used	866	1,162	*1,773*	1,353
		Specific Range/Altitude	0.693/FL 100	0.516/FL 280	*0.338/FL 100*	0.443/FL 230
	1,000 nm	Runway	NP	3,500	*1,565*	3,690
		Flight Time	NP	3+39	*4+ 36*	3+57
		Fuel Used	NP	1,938	*2,881*	1,990
		Specific Range/Altitude	NP/NP	0.516/FL 280	*0.347/FL 100*	0.503/FL 270
Remarks		Suggested Base Price	$2,485,900	NA	*NA*	NA
		Certification Basis	FAR 23, 1986 Garmin G950; STEC 2100 autopilot. *BCA* estimated data.	ST01902CH; SA3593NM; SA4010NM; SA3593NM; SA01902CH; SA01456WI-D; SA02133SE.	*EASA/FAR 23 pending 2016 data.*	CAR 3, 1959/2007 Pro Line Fusion standard.; STC SA10747SC weight increase; SA02054SE winglets; SA3593NM swept props; SA4010NM dual aft strakes; , 1,000-nm mission, 755-lb. pld.

Multiengine Turboprops ≤12,500-LB. MTOW

Manufacturer			Textron Aviation	Viking Air	Piaggio Aero Industries
Model			Beechcraft King Air 250 B200GT	400 Series DHC-6-400	Avanti Evo P180
***BCA* Equipped Price**			$5,995,000	$6,500,000	$7,695,000
Characteristics		Seating	1+8/10	1+11/19	1+7/9
		Wing Loading	40.3	29.8	70.3
		Power Loading	7.35	10.08	7.12
		Noise (dBA)	TBD	85.6	75.0
External Dimensions (ft.)		Length	43.8	51.8	47.3
		Height	14.8	19.5	13.0
		Span	57.9	65.0	46.0
Internal Dimensions (ft.)		**Length:** OA/Net	16.7/16.7	18.4/24.5	17.5/17.5
		Height	4.8	4.9	5.8
		Width: Max/Floor	4.5/4.1	5.4/4.4	6.1/3.5
Power		Engines	2 P&WC PT6A-52	2 P&WC PT6A-34	2 P&WC PT6A-66B
		Output (shp each)/Flat Rating	850/ISA+37C	620/ISA+27C	850/ISA+28C
		Inspection Interval	3,600t	3,600t	3,600t
Weights (lb.)		Max Ramp	12,590	12,525	12,150
		Max Takeoff	12,500	12,500	12,100
		Max Landing	12,500	12,300	11,500
		Zero Fuel	11,000c	11,655b	9,800c
		BOW	8,830	8,100	8,375
		Max Payload	2,170	3,555	1,425
		Useful Load	3,760	4,425	3,775
		Max Fuel	3,645	3,549	2,802
		Available Payload w/Max Fuel	115	876	973
		Available Fuel w/Max Payload	1,590	870	2,350
Limits		VMO	260	170	260
		VA	182	136	202
		PSI	6.5	—	9.0
Airport Performance		TO (SL elev./ISA temp.)	2,111	1,490	3,262
		TO (5,000-ft. elev.@25C)	3,099	NA	4,700
		A/S (SL elev./ISA temp.)	3,687	2,220	5,750
		A/S (5,000-ft. elev.@25C)	4,859	NA	7,400
		VMCA	86	66	100
		VDEC	94	NA	106
		VXSE	115	NA	132
		VYSE	121	NA	140
Climb		Time to Climb (min.)/Altitude	13/FL 250	NA/FL 100	10/FL 250
		Initial Engine-Out Rate (fpm)	682	340	670
		Initial All-Engine Gradient (ft./nm)	1,170	NA	1,106
		Initial Engine-Out Gradient (ft./nm)	364	NA	287
Ceilings (ft.)		Certificated	35,000	25,000	41,000
		All-Engine Service	35,000	26,700	39,400
		Engine-Out Service	26,000	11,600	23,800
		Sea-Level Cabin	15,293	—	24,000
Cruise	**Long Range**	TAS	256	NA	318
		Fuel Flow	430	NA	408
		Altitude	FL 350	FL 100	FL 410
		Specific Range	0.595	NA	0.779
	High Speed	TAS	310	180	400
		Fuel Flow	750	580	792
		Altitude	FL 260	FL 100	FL 310
		Specific Range	0.413	0.310	0.505
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	321	NP	1,070
		Average Speed	267	NP	315
		Trip Fuel	870	NP	1,715
		Specific Range/Altitude	0.369/FL 330	NP	0.624/FL 390
	Max Fuel (with available payload)	Nautical Miles	1,403	NA	1,450
		Average Speed	291	NA	311
		Trip Fuel	2,941	NA	2,167
		Specific Range/Altitude	0.477/FL 330	NA/FL 100	0.669/FL 410
	Full Fuel (with 4 passsengers)	Nautical Miles	1,038	NA	1,510
		Average Speed	288	NA	317
		Trip Fuel	2,225	NA	2,167
		Specific Range/Altitude	0.467/FL 330	NA/FL 100	0.697/FL 410
	Ferry	Nautical Miles	1,420	NA	1,530
		Average Speed	293	NA	318
		Trip Fuel	2,942	NA	2,167
		Specific Range/Altitude	0.483/FL 330	NA/FL 100	0.706/FL 410
Missions (4 passengers)	**300 nm**	Runway	3,504	NA	2,350
		Flight Time	1+03	NA	0+53
		Fuel Used	869	NA	688
		Specific Range/Altitude	0.345/FL 250	NA/FL 100	0.436/FL 310
	600 nm	Runway	3,587	NA	2,550
		Flight Time	2+03	NA	1+44
		Fuel Used	1,494	NA	1,144
		Specific Range/Altitude	0.402/FL 290	NA/FL 100	0.524/FL 350
	1,000 nm	Runway	3,677	NA	2,700
		Flight Time	3+28	NA	3+02
		Fuel Used	2,147	NA	1,603
		Specific Range/Altitude	0.466/FL 330	NA/FL 100	0.624/FL 390
		Suggested Base Price	NA	NA	$7,395,000
Remarks		Certification Basis	FAR 23, 1973/80/2008/11 Rockwell Collins Pro Line Fusion standard; Wi-Fi optional; STC SA02131SE.	EASA/FAR 23 A 57, 2010 2016 data.	EASA 23, 2014; FAR 23, 2015 Includes Rockwell Collins Pro Line 21 avionics; TCAS I; Iridium satcom; RVSM approved; optional 390-lb. capacity internal tank: $275,000.

Multiengine Turboprops >12,500-LB. MTOW

Manufacturer			Textron Aviation	Textron Aviation	Textron Aviation	Textron Aviation
Model			**Beechcraft King Air 250 EP B200GT**	**Beechcraft King Air 350i B300**	**Beechcraft King Air 350HW B300**	**Beechcraft King Air 350iER B300ER**
BCA **Equipped Price**			$6,231,025	$6,995,000	$7,329,055	$8,445,625
Characteristics		Seating	1+8/10	1+9/11	1+9/14	1+9/11
		Wing Loading	43.3	48.4	53.2	53.2
		Power Loading	7.89	7.14	7.86	7.86
		Noise (dBA)	85.3	72.1	81.5	81.5
External Dimensions (ft.)		Length	43.8	46.7	46.7	46.7
		Height	14.8	14.3	14.3	14.3
		Span	57.9	57.9	57.9	57.9
Internal Dimensions (ft.)		**Length:** OA/Net	16.7/16.7	19.5/19.5	19.5/19.5	19.5/19.5
		Height	4.8	4.8	4.8	4.8
		Width: Max/Floor	4.5/4.1	4.5/4.1	4.5/4.1	4.5/4.1
Power		Engines	2 P&WC PT6A-52	2 P&WC PT6A-60A	2 P&WC PT6A-60A	2 P&WC PT6A-60A
		Output (shp each)/Flat Rating	850/ISA+37C	1,050/ISA+10C	1,050/ISA+10C	1,050/ISA+10C
		Inspection Interval	3,600t	3,600t	3,600t	3,600t
Weights (lb.)		Max Ramp	13,510	15,100	16,600	16,600
		Max Takeoff	13,420	15,000	16,500	16,500
		Max Landing	12,500	15,000	15,675	15,675
		Zero Fuel	11,000c	12,500c	13,000c	13,000c
		BOW	8,865	9,955	9,290	10,215
		Max Payload	2,135	2,545	3,710	2,785
		Useful Load	4,645	5,145	7,310	6,385
		Max Fuel	3,645	3,611	3,611	5,192
		Available Payload w/Max Fuel	1,000	1,534	3,699	1,193
		Available Fuel w/Max Payload	2,510	2,600	3,600	3,600
Limits		MMO	0.58	0.58	0.58	0.58
		Trans. Alt. FL/VMO	FL 210/259	FL 210/263	FL 240/245	FL 240/245
		VA	182	182	182	182
		PSI	6.5	6.6	6.6	6.5
Airport Performance		TO (SL elev./ISA temp.)	4,005	3,300	4,057	4,057
		TOFL (5,000-ft. elev.@25C)	5,780	5,376	5,140	7,675
		Mission Weight	13,220	14,196	13,686	16,100
		NBAA IFR Range	1,430	1,549	1,445	2,257
		V2	109	109	111	111
		VREF	97	100	104	104
		Landing Distance	2,780	2,390	2,720	2,728
Climb		Time to Climb (min.)/Altitude	15/FL 250	15/FL 250	23/FL 250	18/FL 250
		*FAR 25 Initial Engine-Out Rate (fpm)	580	552	274	337
		FAR 25 Initial Engine-Out Gradient (ft./nm)	255	304	172	182
Ceilings (ft.)		Certificated	35,000	35,000	35,000	35,000
		All-Engine Service	35,000	35,000	35,000	35,000
		Engine-Out Service	24,400	21,500	17,100	17,100
		Sea-Level Cabin	15,293	15,293	15,293	15,293
Cruise	**Long Range**	TAS	233	235	232	238
		Fuel Flow	369	362	392	402
		Altitude	FL 350	FL 330	FL 330	FL 330
		Specific Range	0.631	0.649	0.592	0.592
	High Speed	TAS	308	312	303	303
		Fuel Flow	750	773	766	764
		Altitude	FL 260	FL 240	FL 240	FL 240
		Specific Range	0.411	0.404	0.396	0.397
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	802	896	1,254	1,316
		Average Speed	275	273	258	261
		Trip Fuel	1,802	1,891	2,838	2,880
		Specific Range/Altitude	0.445/FL 330	0.474/FL 350	0.442/FL 350	0.457/FL 350
	Max Fuel (with available payload)	Nautical Miles	1,393	1,485	1,260	2,223
		Average Speed	283	280	258	269
		Trip Fuel	2,947	2,944	2,884	4,528
		Specific Range/Altitude	0.473/FL 330	0.504/FL 350	0.437/FL 350	0.491/FL 350
	Full Fuel (with 4 passsengers)	Nautical Miles	1,414	1,533	1,437	2,271
		Average Speed	285	285	276	271
		Trip Fuel	2,950	2,951	2,930	4,533
		Specific Range/Altitude	0.479/FL 330	0.519/FL 350	0.490/FL 350	0.501/FL 350
	Ferry	Nautical Miles	1,442	1,560	1,473	2,338
		Average Speed	289	289	282	276
		Trip Fuel	2,956	2,958	2,942	4,543
		Specific Range/Altitude	0.488/FL 330	0.527/FL 350	0.501/FL 350	0.515/FL 350
Missions (4 passengers)	**300 nm**	Runway	3,524	2,586	2,634	2,795
		Flight Time	1+05	1+02	1+06	1+05
		Fuel Used	848	881	954	919
		Specific Range/Altitude	0.354/FL 250	0.341/FL 250	0.314/FL 250	0.326/FL 250
	600 nm	Runway	3,611	2,702	2,746	2,927
		Flight Time	2+05	2+02	2+07	2+07
		Fuel Used	1,472	1,470	1,561	1,529
		Specific Range/Altitude	0.408/FL 290	0.408/FL 290	0.384/FL 290	0.392/FL 290
	1,000 nm	Runway	3,702	2,827	2,883	3,048
		Flight Time	3+31	3+27	3+33	3+35
		Fuel Used	2,123	2,102	2,227	2,195
		Specific Range/Altitude	0.471/FL 330	0.476/FL 330	0.449/FL 330	0.456/FL 330
		Suggested Base Price	NA	NA	NA	NA
Remarks		Certification Basis	FAR 23, 1973/80/2008/11 Commuter category Rockwell Collins Pro Line Fusion; Wi-Fi optional; STC SA11103SC for IGW; 14,000-lb. MTOW also available.	FAR 23, 1989 Commuter category Rockwell Collins Pro Line Fusion; Wi-Fi standard; RVSM approved.	FAR 23, 1989/2007 Commuter category 17,500-lb. MTOW optional; Rockwell Collins Pro Line Fusion; Wi-Fi standard; factory-installed Slick interior available for special missions; RVSM approved.	FAR 23, 1989/2007 Commuter category Rockwell Collins Pro Line Fusion; Wi-Fi standard; RVSM approved.

Jets <10,000-LB. MTOW

Manufacturer			Cirrus Design	Eclipse Aerospace
Model			Vision SF-50	Eclipse 550 EA-500
BCA Equipped Price			$1,960,000	$2,995,000
Character-istics		Seating	1+4/6	1+4/5
		Wing Loading	30.7	41.0
		Power Loading	1.67	3.33
		Noise (EPNdB): Lateral/Flyover/Approach	NA/NA/NA	69.2/78.9/81.9
External Dimensions (ft.)		Length	30.7	33.5
		Height	10.9	11.0
		Span	38.7	37.9
Internal Dimensions (ft.)		**Length:** OA/Net	11.5/9.8	12.3/10.0
		Height/Dropped Aisle Depth	4.1/NA	4.2/NA
		Width: Max/Floor	5.1/3.1	4.7/3.0
Baggage		**Internal:** Cu. ft./lb.	24/NA	16/260
		External: Cu. ft./lb.	30/NA	NA/NA
Power		Engine(s)	1 Wms Intl FJ33-5A	2 P&WC PW610F
		Output (lb. each)/Flat Rating	1,800/ISA+10C	900/ISA+10C
		Inspection Interval/Manu. Service Plan Interval	3,500t/—	3,500t/—
Weights (lb.)		Max Ramp	6,040	6,034
		Max Takeoff	6,000	6,000
		Max Landing	5,550	5,600
		Zero Fuel	4,900c	4,922c
		BOW	3,772	3,923
		Max Payload	1,128	999
		Useful Load	2,268	2,111
		Max Fuel	2,000	1,680
		Available Payload w/Max Fuel	268	431
		Available Fuel w/Max Payload	1,140	1,112
Limits		MMO	0.530	0.640
		Trans. Alt. FL/VMO	FL 183/250	FL 200/285
		PSI	6.4	8.7
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	2,036	2,394
		TOFL (5,000-ft. elev.@25C)	3,679	4,171
		Mission Weight	6,000	5,893
		NBAA IFR Range	1,125	1,015
		V2	90	102*
		VREF	87	89
		Landing Distance	1,628	2,340
Climb		Time to Climb/Altitude	NA/FL 370	25/FL 370
		FAR 25 Engine-Out Rate (fpm)	NA	500
		FAR 25 Engine-Out Gradient (ft./nm)	NA	294
Ceilings (ft.)		Certificated	28,000	41,000
		All-Engine Service	28,000	41,000
		Engine-Out Service	NA	25,000
		Sea-Level Cabin	NA	21,500
Cruise	**Long Range**	TAS	256	334
		Fuel Flow	358	321
		Altitude	FL 280	FL 410
		Specific Range	0.715	1.040
	High Speed	TAS	300	369
		Fuel Flow	466	462
		Altitude	FL 280	FL 350
		Specific Range	0.644	0.799
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	550	530
		Average Speed	251	307
		Trip Fuel	845	677
		Specific Range/Altitude	0.651/FL 280	0.783/FL 410
	Max Fuel (with available payload)	Nautical Miles	1,167	1,125
		Average Speed	248	319
		Trip Fuel	1,602	1,254
		Specific Range/Altitude	0.728/FL 280	0.897/FL 410
	Four Passengers (with available fuel)	Nautical Miles	796	825
		Average Speed	250	317
		Trip Fuel	1,076	965
		Specific Range/Altitude	0.740/FL 280	0.855/FL 410
	Ferry	Nautical Miles	1,219	1,190
		Average Speed	218	312
		Trip Fuel	1,680	1,263
		Specific Range/Altitude	0.726/FL 280	0.942/FL 410
Missions (4 passen-gers)	**300 nm**	Runway	1,857	2,038
		Flight Time	1+10	0+58
		Fuel Used	568	456
		Specific Range/Altitude	0.528/FL 280	0.658/FL 350
	600 nm	Runway	2,171	2,258
		Flight Time	2+15	1+46
		Fuel Used	1,033	837
		Specific Range/Altitude	0.581/FL 280	0.717/FL 390
	1,000 nm	Runway	2,437	2,318
		Flight Time	3+36	3+04
		Fuel Used	1,642	1,137
		Specific Range/Altitude	0.609/FL 280	0.880/FL 410
Remarks		Certification Basis	FAR 23, 2016 Some data preliminary.	FAR 23, 2006/15 1,000-nm mission flown with 3 passengers. *V50 used in lieu of V2. 2016 data.

Jets <20,000-LB. MTOW

Manufacturer			Textron Aviation	Embraer	Textron Aviation	Honda Aircraft Co.	Nextant Aerospace
Model			**Cessna Citation Mustang CE-510**	**Phenom 100 EV EMB-500**	**Cessna Citation M2 CE-525**	**HondaJet HA-420**	**Nextant 400 XTi BE 400A**
BCA Equipped Price			$3,350,000	$4,495,000	$4,500,000	$4,850,000	$5,304,500
Character-istics		Seating	1+5/5/—	1+5/7/7	1+7/7/—	1+5/6/6	2+7/9/—
		Wing Loading/Power Loading	41.2/2.96	53.1/3.09	44.6/2.72	60.0/2.60	67.6/2.67
		Noise (EPNdB): Lateral/Flyover/Approach	73.9/85.0/86.0	70.4/81.4/86.1	85.9/73.2/88.5	85.4/72.9/87.5	76.9/91.5/88.8
External Dimensions (ft.)		Length	40.6	42.1	42.6	42.6	48.4
		Height	13.4	14.3	13.9	14.9	13.9
		Span	43.2	40.4	47.3	39.8	43.5
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	6.7/9.8/9.8	9.0/11.0/11.0	8.8/11.0/11.0	12.1/12.1/NA	15.5/15.5/—
		Height/Dropped Aisle Depth	4.5/0.3	4.9/0.3	4.8/0.4	4.8/NA	4.8/flat floor
		Width: Max/Floor	4.6/3.1	5.1/3.6	4.8/3.1	5.0/NA	4.9/4.0
Baggage		**Internal:** Cu. ft./lb.	6/98	10/99	—/—	NA/NA	27/410
		External: Cu. ft./lb.	57/620	60/418	46/725	66/500	26/450
Power		Engines	2 P&WC PW615F	2 P&WC PW 617F-E	2 Wms Intl FJ44-1AP-21	2 GE Honda HF-120-H1A	2 Wms Intl FJ44-3AP
		Output (lb. each)/Flat Rating	1,460/ISA+10C	1,730/ISA+8C	1,965/ISA+7C	2,037/ISA+10C	3,052/ISA+7C
		Inspection Interval/Manu. Service Plan Interval	3,500t/—	3,500t/—	3,500t/5,000	NA/—	5,000t/—
Weights (lb.)		Max Ramp	8,730	10,748	10,800	10,680	16,500
		Max Takeoff	8,645	10,703	10,700	10,600	16,300
		Max Landing	8,000	9,877	9,900	9,860	15,700
		Zero Fuel	6,750c	9,072c	8,400c	8,800c	13,000c
		BOW	5,600	7,298	6,990	7,279	10,950
		Max Payload	1,150	1,774	1,410	1,521	2,050
		Useful Load	3,130	3,450	3,810	3,401	5,550
		Max Fuel	2,580	2,804	3,296	2,845	4,912
		Available Payload w/Max Fuel	550	646	514	556	638
		Available Fuel w/Max Payload	1,980	1,676	2,400	1,880	3,500
Limits		MMO	0.630	0.700	0.710	0.720	0.780
		Trans. Alt. FL/VMO	FL 271/250	280/275	FL 305/263	FL 302/270	FL 290/320
		PSI/Sea-Level Cabin	8.3/21,280	8.3/21,280	8.5/22,027	8.8/23,060	9.1/24,000
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,110	3,199	3,210	3,934	3,821
		TOFL (5,000-ft. elev.@25C)	6,600	5,663	5,580	6,108	5,088
		Mission Weight	8,645	10,703	10,700	10,600	14,500p
		NBAA IFR Range	984	1,092	1,204	1,223	1,197
		V2	97	99	111	120	116
		VREF	88	95	101	105	105
		Landing Distance	2,137	2,473	2,340	2,795	2,960
Climb		Time to Climb/Altitude	20/FL 370	19/FL 370	18/FL 370	15/FL 370	16/FL 370
		FAR 25 Engine-Out Rate (fpm)	432	597	618	933	305
		FAR 25 Engine-Out Gradient (ft./nm)	267	316	334	400	158
Ceilings (ft.)		Certificated	41,000	41,000	41,000	43,000	45,000
		All-Engine Service	41,000	41,000	41,000	43,000	45,000
		Engine-Out Service	26,900	24,045	26,800	27,000	27,500
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	319/498	340/543	323/516	360/558	406/740
		Altitude/Specific Range	FL 390/0.641	FL 410/0.626	FL 410/0.626	FL 430/0.645	FL 450/0.549
	High Speed	TAS/Fuel Flow (lb./hr.)	339/609	406/955	401/920	420/972	447/968
		Altitude/Specific Range	FL 350/0.557	FL 330/0.425	FL 350/0.436	FL 330/0.432	FL 430/0.462
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	716	466	812	600	1,024
		Average Speed	294	325	361	347	367
		Trip Fuel	1,300	1,036	1,706	1,230	2,411
		Specific Range/Altitude	0.551/FL 410	0.450/FL 410	0.476/FL 410	0.488/FL 430	0.425/FL 450
	Max Fuel (with available payload)	Nautical Miles	1,141	1,194	1,357	1,282	1,895
		Average Speed	304	333	372	361	384
		Trip Fuel	1,947	2,196	2,675	2,273	3,953
		Specific Range/Altitude	0.586/FL 410	0.544/FL 410	0.507/FL 410	0.564/FL 430	0.479/FL 450
	Four Passengers (with available fuel)	Nautical Miles	963	1,092	1,183	1,065	1,801
		Average Speed	301	333	370	361	383
		Trip Fuel	1,664	2,038	2,352	1,976	3,706
		Specific Range/Altitude	0.579/FL 410	0.536/FL 410	0.503/FL 410	0.539/FL 430	0.486/FL 450
	Ferry	Nautical Miles	1,204	1,254	1,400	1,358	1,981
		Average Speed	315	329	378	358	381
		Trip Fuel	1,965	2,220	2,705	2,290	3,986
		Specific Range/Altitude	0.613/FL 410	0.565/FL 410	0.518/FL 410	0.593/FL 430	0.497/FL 450
Missions (4 passen-gers)	**300 nm**	Runway	2,498	2,909	2,625	3,564	3,015
		Flight Time	1+00	0+53	0+52	0+53	0+48
		Fuel Used	670	753	804	676	786
		Specific Range/Altitude	0.448/FL 370	0.398/FL 390	0.373/FL 370	0.444/FL 430	0.382/FL 390
	600 nm	Runway	2,700	3,121	2,692	3,732	3,044
		Flight Time	1+56	1+45	1+38	1+38	1+30
		Fuel Used	1,135	1,236	1,362	1,179	1,323
		Specific Range/Altitude	0.529/FL 390	0.485/FL 390	0.441/FL 390	0.509/FL 430	0.454/FL 430
	1,000 nm	Runway	3,110	3,179	3,009	3,909	3,101
		Flight Time	3+19	2+54	2+42	2+40	2+28
		Fuel Used	1,754	1,919	2,018	1,863	2,145
		Specific Range/Altitude	0.570/FL 410	0.521/FL 410	0.496/FL 410	0.537/FL 430	0.466/FL 450
Remarks		Certification Basis	FAR 23, 2006 1,000-nm mission flown with 713-lb. payload.	FAR 23, 2008	FAR 23, 2013	FAR 23, 2015	FAR 25, 1981/85 STC 02371LA; STC 10959SC; STC 03960AT

Jets <20,000-LB. MTOW

Manufacturer			Textron Aviation	Syberjet	*Pilatus Aircraft*	Embraer	Textron Aviation
Model			**Cessna Citation CJ3+ CE-525B**	**SJ30i SJ30-2**	***SVJ PC-24***	**Phenom 300 EMB-505**	**Cessna Citation CJ4 CE-525C**
BCA Equipped Price			$7,995,000	$8,306,452	*$8,900,000*	$8,995,000	$8,995,000
Characteristics		Seating	1+8/9/—	1+5/6/—	*1+8/11/NA*	1+7/10/10	2+8/9/—
		Wing Loading/Power Loading	47.2/2.46	73.2/3.03	*53.1/2.60*	60.0/2.74	51.8/2.36
		Noise (EPNdB): Lateral/Flyover/Approach	88.7/74.0/88.6	78.5/86.2/91.8	*NA/NA/NA*	69.9/88.8/88.5	92.8/75.6/89.5
External Dimensions (ft.)		Length	51.2	46.8	*55.2*	51.2	53.3
		Height	15.2	14.2	*17.3*	16.7	15.3
		Span	53.3	42.3	*55.8*	52.2	50.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	12.3/15.7/—	12.5/12.5/—	*NA/NA/23.0*	14.8/17.2/17.2	12.9/17.3/17.3
		Height/Dropped Aisle Depth	4.8/0.4	4.4/NA	*5.1/flat floor*	4.9/0.3	4.8/0.4
		Width: Max/Floor	4.8/3.1	4.8/2.8	*5.5/3.8*	5.1/3.6	4.8/3.3
Baggage		**Internal:** Cu. ft./lb.	—/—	6/100	*90/NA*	10/77	7/40
		External: Cu. ft./lb.	65/1,000	53/500	*NA/NA*	74/573	71/1,000
Power		Engines	2 Wms Intl FJ44-3A	2 Wms Intl FJ44-2A	*2 Wms Intl FJ44-4A*	2 P&WC PW 535E	2 Wms Intl FJ44-4A
		Output (lb. each)/Flat Rating	2,820/ISA+11C	2,300/ISA+8C	*3,400/NA*	3,360/ISA+15C	3,621/ISA+11C
		Inspection Interval/Manu. Service Plan Interval	4,000t/5,000	3,500t/—	*5,000t/NA*	5,000t/—	5,000t/5,000
Weights (lb.)		Max Ramp	14,070	14,050	*17,750*	18,497	17,230
		Max Takeoff	13,870	13,950	*17,650*	18,387	17,110
		Max Landing	12,750	12,725	*16,250*	17,042	15,660
		Zero Fuel	10,510c	10,500c	*NA*	14,220c	12,500c
		BOW	8,540	8,917	*NA*	11,583	10,280
		Max Payload	1,970	1,583	*2,500*	2,637	2,220
		Useful Load	5,530	5,133	*NA*	6,914	6,950
		Max Fuel	4,710	4,850	*5,965*	5,353	5,828
		Available Payload w/Max Fuel	820	283	*915*	1,561	1,122
		Available Fuel w/Max Payload	3,560	3,550	*NA*	4,277	4,730
Limits		MMO	0.737	0.830	*NA*	0.780	0.770
		Trans. Alt. FL/VMO	FL 293/278	FL 295/320	*NA/NA*	FL 263/320	FL 279/305
		PSI/Sea-Level Cabin	8.9/23,586	12.0/41,000	*NA/23,500*	9.4/25,560	9.0/24,005
Airport Performance		TOFL (SL elev./ISA temp.)	3,180	3,939	*2,690*	2,354	3,140
		TOFL (5,000-ft. elev.@25C)	4,750	8,784	*4,430*	5,400	5,180
		Mission Weight	13,870	13,125	*17,750*	18,387	16,788
		NBAA IFR Range	1,827	1,915	*NA*	2,019	1,948
		V2	114	112	*NA*	113	117
		VREF	99	104	*NA*	104	99
		Landing Distance	2,422	2,657	*NA*	2,220	2,281
Climb		Time to Climb/Altitude	15/FL 370	16/FL 370	*NA/FL 370*	15/FL 370	14/FL 370
		FAR 25 Engine-Out Rate (fpm)	808	312	*NA*	872	839
		FAR 25 Engine-Out Gradient (ft./nm)	425	167	*NA*	437	430
Ceilings (ft.)		Certificated	45,000	49,000	*45,000*	45,000	45,000
		All-Engine Service	45,000	44,000	*45,000*	45,000	45,000
		Engine-Out Service	26,250	25,800	*26,000*	30,137	28,200
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	352/624	436/684	*NA/NA*	383/757	377/812
		Altitude/Specific Range	FL 450/0.564	FL 450/0.637	*NA/NA*	FL 450/0.506	FL 450/0.464
	High Speed	TAS/Fuel Flow (lb./hr.)	415/1,197	475/1,188	*NA/NA*	444/1,312	442/1,470
		Altitude/Specific Range	FL 350/0.347	FL 360/0.400	*FL 300/NA*	FL 350/0.338	FL 370/0.301
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	1,172	1,635	*NA*	1,351	1,425
		Average Speed	368	402	*NA*	397	407
		Trip Fuel	2,552	2,908	*NA*	3,362	3,753
		Specific Range/Altitude	0.459/FL 450	0.562/FL 470	*NA/NA*	0.402/FL 450	0.380/FL 450
	Max Fuel (with available payload)	Nautical Miles	1,814	2,598	*NA*	1,883	1,913
		Average Speed	377	410	*NA*	406	413
		Trip Fuel	3,846	4,241	*NA*	4,469	4,904
		Specific Range/Altitude	0.472/FL 450	0.613/FL 490	*NA/NA*	0.421/FL 450	0.390/FL 450
	Four Passengers (with available fuel)	Nautical Miles	1,825	2,205	*NA*	1,936	1,927
		Average Speed	276	408	*NA*	411	416
		Trip Fuel	3,767	3,713	*NA*	4,510	4,920
		Specific Range/Altitude	0.484/FL 450	0.594/FL 490	*NA/NA*	0.429/FL 450	0.392/FL 450
	Ferry	Nautical Miles	1,900	2,667	*NA*	1,985	1,955
		Average Speed	383	411	*NA*	417	420
		Trip Fuel	3,872	4,246	*NA*	4,473	4,955
		Specific Range/Altitude	0.491/FL 450	0.628/FL 490	*NA/NA*	0.444/FL 450	0.395/FL 450
Missions (4 passengers)	**300 nm**	Runway	2,608	2,822	*NA*	2,613	2,429
		Flight Time	0+49	0+45	*NA*	0+47	0+46
		Fuel Used	969	846	*NA*	1,058	1,087
		Specific Range/Altitude	0.310/FL 370	0.355/FL 410	*NA/NA*	0.284/FL 390	0.276/FL 390
	600 nm	Runway	2,609	3,025	*NA*	2,747	2,444
		Flight Time	1+35	1+26	*NA*	1+29	1+27
		Fuel Used	1,571	1,313	*NA*	1,735	1,865
		Specific Range/Altitude	0.382/FL 410	0.457/FL 450	*NA/NA*	0.346/FL 410	0.322/FL 410
	1,000 nm	Runway	2,720	3,336	*NA*	2,808	2,490
		Flight Time	2+36	2+21	*NA*	2+26	2+23
		Fuel Used	2,315	1,980	*NA*	2,471	2,823
		Specific Range/Altitude	0.432/FL 430	0.505/FL 450	*NA/NA*	0.405/FL 450	0.354/FL 430
Remarks		Certification Basis	FAR 23, 2004/14 Commuter category Garmin G3000.	FAR 23 Commuter category	*EASA CS 23, FAR 23 Commuter category pending Pricing in 2017 dollars; FJ44-4 with quiet power mode APU function.*	FAR 23, 2009 Commuter category Performance-based upon optional increased weights.	FAR 23, 2010 Commuter category

Jets ≥20,000-LB. MTOW

Manufacturer			**Textron Aviation**	**Bombardier**	**Textron Aviation**	**Bombardier**	**Textron Aviation**
Model			**Cessna Citation X Elite CE-750**	**Learjet 70 Model 45**	**Cessna Citation XLS+ CE-560XL**	**Learjet 75 Model 45**	**Cessna Citation Latitude CE-680A**
BCA Equipped Price			$6,500,000	$11,300,000	$12,750,000	$13,800,000	$16,350,000
Character-istics		Seating	2+8/11/—	2+6/7/7	2+9/12/—	2+8/9/9	2+9/9/10
		Wing Loading/Power Loading	68.5/2.67	69.6/2.79	54.6/2.45	69.6/2.79	56.8/2.61
		Noise (EPNdB): Lateral/Flyover/Approach	83.8/71.2/90.3	87.4/74.3/93.4	86.8/72.2/92.8	87.4/74.3/93.4	87.7/73.5/87.7
External Dimensions (ft.)		Length	72.3	56.0	52.5	58.0	62.3
		Height	19.3	14.0	17.2	14.0	20.9
		Span	63.9	50.9	56.3	50.9	72.3
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.0/23.9/23.9	10.6/17.7/17.7	14.3/18.5/18.5	13.4/19.8/19.8	15.9/21.8/21.8
		Height/Dropped Aisle Depth	5.7/0.7	4.9/flat floor	5.7/0.7	4.9/flat floor	6.0/flat floor
		Width: Max/Floor	5.5/3.9	5.1/3.2	5.5/3.9	5.1/3.2	6.4/4.1
Baggage		**Internal:** Cu. ft./lb.	variable/variable	15/150	10/100	15/150	26/NA
		External: Cu. ft./lb.	82/775	50/500	80/700	50/500	100/1,000
Power		Engines	2 RR AE3007C1	2 Hon TFE731-40BR	2 P&WC PW545C	2 Hon TFE731-40BR	2 P&WC PW306D
		Output (lb. each)/Flat Rating	6,764/ISA+15C	3,850/ISA+23C	4,119/ISA+10C	3,850/ISA+23C	5,907/ISA+16C
		Inspection Interval/Manu. Service Plan Interval	4,500t*/—	6,000t/—	5,000t/—	6,000t/—	6,000t/—
Weights (lb.)		Max Ramp	36,400	21,750	20,400	21,750	31,050
		Max Takeoff	36,100	21,500	20,200	21,500	30,800
		Max Landing	31,800	19,200	18,700	19,200	27,575
		Zero Fuel	24,400c	16,000c	15,100c	16,000c	21,200c
		BOW	22,100	13,900	12,860	14,050	18,656
		Max Payload	2,300	2,100	2,240	1,950	2,544
		Useful Load	14,300	7,850	7,540	7,700	12,394
		Max Fuel	12,931	6,062	6,740	6,062	11,394
		Available Payload w/Max Fuel	1,369	1,788	800	1,638	1,000
		Available Fuel w/Max Payload	12,000	5,750	5,300	5,750	9,850
Limits		MMO	0.920	0.810	0.750	0.810	0.800
		Trans. Alt. FL/VMO	FL 307/350	FL 270/330	FL 265/305	FL 270/330	FL 298/305
		PSI/Sea-Level Cabin	9.3/25,230	9.4/25,700	9.3/25,230	9.4/25,700	9.7/25,400
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	5,140	4,440	3,560	4,440	3,580
		TOFL (5,000-ft. elev.@25C)	7,350	5,191	5,430	5,272	5,070
		Mission Weight	34,980p	20,632	20,200	20,782	30,675
		NBAA IFR Range	2,980	2,045	1,740	2,026	2,700
		V2	137	125	118	125	115
		VREF	112	112	106	113	95
		Landing Distance	2,730	2,326	2,740	2,338	2,085
Climb		Time to Climb/Altitude	18/FL 370	15/FL 370	15/FL 370	15/FL 370	15/FL 370
		FAR 25 Engine-Out Rate (fpm)	486	430	765	430	652
		FAR 25 Engine-Out Gradient (ft./nm)	213	207	389	207	340
Ceilings (ft.)		Certificated	51,000	51,000	45,000	51,000	45,000
		All-Engine Service	43,000	45,200	45,000	44,700	43,000
		Engine-Out Service	26,000	28,400	28,600	27,900	26,260
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	470/1,529	437/970	353/865	437/977	368/1,114
		Altitude/Specific Range	FL 470/0.307	FL 470/0.451	FL 450/0.408	FL 470/0.447	FL 430/0.330
	High Speed	TAS/Fuel Flow (lb./hr.)	513/2,229	452/1,080	431/1,238	451/1,079	432/1,765
		Altitude/Specific Range	FL 410/0.230	FL 470/0.419	FL 410/0.348	470/0.418	FL 390/0.245
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	2,703	1,728	1,150	1,728	2,135
		Average Speed	462	425	385	425	394
		Trip Fuel	9,973	4,575	3,663	4,575	7,901
		Specific Range/Altitude	0.271/FL 470	0.378/FL 470	0.314/FL 450	0.378/FL 470	0.270/FL 450
	Max Fuel (with available payload)	Nautical Miles	3,070	1,881	1,719	1,881	2,645
		Average Speed	462	426	395	426	401
		Trip Fuel	11,055	4,901	5,233	4,901	9,586
		Specific Range/Altitude	0.278/FL 490	0.384/FL 470	0.328/FL 450	0.384/FL 470	0.276/FL 450
	Four Passengers (with available fuel)	Nautical Miles	3,125	2,045	1,719	2,026	2,678
		Average Speed	463	426	395	427	401
		Trip Fuel	11,078	5,064	5,168	5,058	9,594
		Specific Range/Altitude	0.282/FL 490	0.404/FL 470	0.333/FL 450	0.401/FL 470	0.279/FL 450
	Ferry	Nautical Miles	3,221	2,150	1,785	2,129	2,731
		Average Speed	463	427	403	427	405
		Trip Fuel	11,118	5,099	5,268	5,093	9,628
		Specific Range/Altitude	0.290/FL 490	0.422/FL 490	0.339/FL 450	0.418/FL 490	0.284/FL 450
Missions (4 passen-gers)	**300 nm**	Runway	3,536	3,588	2,734	3,598	2,760
		Flight Time	0+41	0+45	0+46	0+45	0+46
		Fuel Used	1,837	1,072	1,246	1,075	1,610
		Specific Range/Altitude	0.163/FL 370	0.280/FL 470	0.241/FL 390	0.279/FL 470	0.186/FL 390
	600 nm	Runway	3,580	3,632	2,758	3,642	2,845
		Flight Time	1+16	1+24	1+29	1+23	1+29
		Fuel Used	2,855	1,805	2,094	1,810	2,573
		Specific Range/Altitude	0.210/FL 430	0.332/FL 470	0.287/FL 410	0.331/FL 470	0.233/FL 430
	1,000 nm	Runway	3,672	3,691	3,028	3,701	2,951
		Flight Time	2+03	2+18	2+26	2+18	2+25
		Fuel Used	4,469	2,787	3,211	2,792	3,989
		Specific Range/Altitude	0.224/FL 430	0.359/FL 470	0.311/FL 430	0.358/FL 470	0.251/FL 430
Remarks		Certification Basis	FAR 25, 1996/2002; JAR 25 1999/2002 *Engine flight hour inspection interval.	FAR/EASA CS 25	FAR 25, 2008	FAR/EASA CS 25	FAR 25, 2015 Garmin G5000.

Jets ≥20,000-LB. MTOW

Manufacturer			Embraer	Textron Aviation	Embraer	Textron Aviation	*Textron Aviation*
Model			**Legacy 450 EMB-545**	**Cessna Citation Sovereign+ CE-680**	**Legacy 500 EMB-550**	**Cessna Citation X+ CE-750**	***Cessna Citation Longitude CE-700***
***BCA* Equipped Price**			$16,570,000	$17,895,000	$19,995,000	$23,365,000	*$23,995,000*
Character-istics		Seating	2+7/9/9	2+9/12/12	2+8/12/12	2+9/12/—	*2+8/12/12*
		Wing Loading/Power Loading	74.0/2.73	56.7/2.60	79.4/2.73	69.4/2.60	*NA/NA*
		Noise (EPNdB): Lateral/Flyover/Approach	84.2/72.8/89.9	87.8/71.9/87.9	85.5/73.1/89.9	87.7/72.4/89.3	*NA/NA/NA*
External Dimensions (ft.)		Length	64.6	63.5	68.1	73.6	*73.2*
		Height	21.1	20.3	21.2	19.2	*19.4*
		Span	66.4	72.3	66.4	69.2	*68.9*
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.4/20.6/24.0	17.4/25.3/25.3	21.3/24.1/27.5	18.3/25.2/25.2	*16.5/25.2/28.1*
		Height/Dropped Aisle Depth	6.0/flat floor	5.7/0.7	6.0/flat floor	5.7/0.7	*6.0/flat floor*
		Width: Max/Floor	6.8/4.7	5.5/3.9	6.8/4.7	5.5/3.9	*6.4/4.1*
Baggage		**Internal:** Cu. ft./lb.	40/330	35/415	45/330	22/NA	*112/1,115*
		External: Cu. ft./lb.	110/882	100/1,000	110/882	82/775	*NA/NA*
Power		Engines	2 Hon HTF7500E	2 P&WC PW306D	2 Hon HTF7500E	2 RR AE3007C2	*2 Hon HTF7700L*
		Output (lb. each)/Flat Rating	6,540/ISA+18C	5,907/ISA+16C	7,036/ISA+18C	7,034/ISA+15C	*7,600/ISA+19C*
		Inspection Interval/Manu. Service Plan Interval	OC/—	6,000t/—	OC/—	4,500t*/—	*OC/—*
Weights (lb.)		Max Ramp	35,891	31,025	38,537	36,900	*NA*
		Max Takeoff	35,759	30,775	38,360	36,600	*NA*
		Max Landing	32,518	27,575	34,524	32,000	*NA*
		Zero Fuel	25,904c	21,000c	26,499	24,978c	*NA*
		BOW	22,983	18,235	23,699	22,114	*NA*
		Max Payload	2,921	2,765	2,800	2,864	*2,725*
		Useful Load	12,908	12,790	14,838	14,786	*NA*
		Max Fuel	12,108	11,390	13,058	12,931	*NA*
		Available Payload w/Max Fuel	800	1,400	1,780	1,855	*1,600*
		Available Fuel w/Max Payload	9,987	10,025	12,038	11,922	*NA*
Limits		MMO	0.830	0.800	0.830	0.935	*0.840*
		Trans. Alt. FL/VMO	FL 395/320	FL 298/305	FL 295/320	FL 307/350	*NA/NA*
		PSI/Sea-Level Cabin	9.7/26,520	9.3/25,230	9.7/26,520	9.3/25,230	*9.7/25,400*
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,907	3,530	4,084	5,250	*4,900*
		TOFL (5,000-ft. elev.@25C)	5,189	4,760	5,523	7,317	*NA*
		Mission Weight	35,759	30,250	38,360	35,645	*NA*
		NBAA IFR Range	2,919	3,093	3,131	3,396	*3,520*
		V2	117	117	120	139	*NA*
		VREF	101	96	102	116	*NA*
		Landing Distance	2,090	2,144	2,114	2,727	*NA*
Climb		Time to Climb/Altitude	14/FL 370	13/FL 370	14/FL 370	13/FL 370	*13/FL 370*
		FAR 25 Engine-Out Rate (fpm)	634	735	856	614	*NA*
		FAR 25 Engine-Out Gradient (ft./nm)	324	377	387	267	*NA*
Ceilings (ft.)		Certificated	45,000	47,000	45,000	51,000	*45,000*
		All-Engine Service	44,000	45,000	44,000	47,000	*45,000*
		Engine-Out Service	24,476	29,740	28,189	25,900	*27,500*
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	438/1,404	368/1,059	440/1,441	470/1,470	*457/1,591*
		Altitude/Specific Range	FL 450/0.312	FL 450/0.347	FL 450/0.305	FL 470/0.320	*FL 450/0.287*
	High Speed	TAS/Fuel Flow (lb./hr.)	462/1,621	448/1,756	467/1,741	520/2,453	*476/1,933*
		Altitude/Specific Range	FL 430/0.285	FL 390/0.255	FL 430/0.268	FL 410/0.212	*FL 430/0.246*
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	2,170	2,484	2,603	2,838	*3,074*
		Average Speed	428	396	438	463	*452*
		Trip Fuel	8,084	8,170	9,908	9,952	*11,600*
		Specific Range/Altitude	0.268/FL 450	0.304/FL 470	0.263/450	0.285/FL 490	*0.265/FL 450*
	Max Fuel (with available payload)	Nautical Miles	2,904	2,996	2,998	3,241	*3,422*
		Average Speed	431	400	440	464	*453*
		Trip Fuel	10,285	9,658	11,151	11,108	*12,763*
		Specific Range/Altitude	0.282/FL 450	0.310/FL 470	0.269/FL 450	0.292/FL 490	*0.268/FL 450*
	Four Passengers (with available fuel)	Nautical Miles	2,904	3,069	3,125	3,372	*3,500*
		Average Speed	431	402	433	465	*454*
		Trip Fuel	10,285	9,679	11,222	11,157	*12,787*
		Specific Range/Altitude	0.282/FL 450	0.317/FL 470	0.278/FL 450	0.302/FL 490	*0.274/FL 450*
	Ferry	Nautical Miles	2,973	3,138	3,153	3,463	*3,568*
		Average Speed	430	405	440	465	*454*
		Trip Fuel	10,313	9,708	11,250	11,195	*12,810*
		Specific Range/Altitude	0.288/FL 450	0.323/FL 470	0.280/FL 450	0.309/FL 490	*0.279/FL 450*
Missions (4 passen-gers)	**300 nm**	Runway	3,674	2,591	2,822	3,725	*2,744*
		Flight Time	0+45	0+45	0+45	0+41	*0+44*
		Fuel Used	1,543	1,506	1,545	1,827	*1,516*
		Specific Range/Altitude	0.194/FL 450	0.199/FL 390	0.194/FL 450	0.164/FL 370	*0.198/FL 450*
	600 nm	Runway	2,696	2,600	2,817	3,775	*2,880*
		Flight Time	1+26	1+26	1+26	1+16	*1+23*
		Fuel Used	2,478	2,404	2,478	2,937	*2,457*
		Specific Range/Altitude	0.242/FL 450	0.250/FL 430	0.242/FL 450	0.204/FL 430	*0.244/FL 450*
	1,000 nm	Runway	2,873	2,650	2,963	3,849	*3,025*
		Flight Time	2+21	2+21	2+21	2+02	*2+16*
		Fuel Used	3,710	3,750	3,750	4,680	*3,746*
		Specific Range/Altitude	0.270/FL 450	0.267/FL 430	0.267/FL 450	0.214/FL 430	*0.267/FL 450*
Remarks		Certification Basis	RBAC/FAR/EASA CS 25, 2015	FAR 25, 2013 Garmin G5000.	RBAC/FAR/EASA CS 25, 2014	FAR 25, 2014 Garmin G5000. *Engine flight hour inspection interval.	*FAR 25 pending Garmin G5000.*

Jets ≥20,000-LB. MTOW

Manufacturer			Gulfstream Aerospace	Embraer	Bombardier	Dassault	Bombardier
Model			**Gulfstream 280 G280**	**Legacy 650E EMB-135BJ***	**Challenger 350 BD-100-1A10**	**Falcon 2000S Falcon 2000EX**	**Challenger 650 CL-600-2B16**
***BCA* Equipped Price**			$24,500,000	$25,900,000	$26,673,000	$29,550,000	$32,350,000
Character-istics		Seating	2+9/10/19	2+13/14/19	2+10/11/19	2+10/10/19	2+12/13/19
		Wing Loading/Power Loading	80.0/2.60	97.2/2.97	77.6/2.77	77.7/2.93	98.6/2.61
		Noise (EPNdB): Lateral/Flyover/Approach	75.2/89.5/90.5	86.9/78.0/91.7	87.6/75.3/89.6	75.1/91.8/90.5	86.2/81.2/90.3
External Dimensions (ft.)		Length	66.8	86.4	68.7	66.3	68.4
		Height	21.3	21.8	20.0	23.2	20.7
		Span	63.0	69.5	69.0	70.2	64.3
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.7/25.8/32.3	30.3/42.4/49.1	16.6/25.2/28.6	17.1/26.2/31.0	15.4/25.6/28.3
		Height/Dropped Aisle Depth	6.1/4.5	6.0/2.5	6.0/flat floor	6.2/flat floor	6.0/flat floor
		Width: Max/Floor	6.9/5.4	6.9/5.2	7.2/5.1	7.7/6.3	7.9/6.9
Baggage		**Internal:** Cu. ft./lb.	154/1,980	286/1,441	106/750	131/1,600	112/900
		External: Cu. ft./lb.	—/—	—/—	—/—	8/92	—/—
Power		Engines	2 Hon HTF7250G	2 RR AE 3007A2	2 Hon HTF 7350	2 P&WC PW308C	2 GE CF34-3B
		Output (lb. each)/Flat Rating	7,624/ISA+17C	9,020/ISA+15C	7,323/ISA+15C	7,000/ISA+15C	9,220*/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	7,000c/—	OC/—
Weights (lb.)		Max Ramp	39,750	53,727	40,750	41,200	48,300
		Max Takeoff	39,600	53,572	40,600	41,000	48,200
		Max Landing	32,700	44,092	34,150	39,300	38,000
		Zero Fuel	28,200c	36,156c	28,200c	29,700c	32,000c
		BOW	24,200	31,217	24,800	24,750	27,250
		Max Payload	4,000	4,939	3,400	4,950	4,750
		Useful Load	15,550	22,510	15,950	16,450	21,050
		Max Fuel	14,600	20,600	14,045	14,600	19,852
		Available Payload w/Max Fuel	950	1,910	1,905	1,850	1,198
		Available Fuel w/Max Payload	11,550	17,571	12,550	11,500	16,300
Limits		MMO	0.850	0.800	0.830	0.862	0.850
		Trans. Alt. FL/VMO	FL 280/340	FL 276/320	FL 290/320	FL 250/370	FL 222/348
		PSI/Sea-Level Cabin	9.2/25,000	8.4/21,650	8.8/23,338	9.3/25,300	8.8/23,000
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	4,750	5,741	4,829	4,325	5,640
		TOFL (5,000-ft. elev.@25C)	7,320	7,979	6,451	6,055	9,233
		Mission Weight	39,600	53,572	39,495	39,950	47,802
		NBAA IFR Range	3,600	3,953	3,250	3,600	4,011
		V2	137	144	133	123	147
		VREF	115	115	111	106	117
		Landing Distance	2,373	2,346	2,302	2,295	2,365
Climb		Time to Climb/Altitude	14/FL 370	21/FL 370	14/FL 370	16/FL 370	21/FL 370
		FAR 25 Engine-Out Rate (fpm)	845	633	552	528	581
		FAR 25 Engine-Out Gradient (ft./nm)	371	259	249	257	237
Ceilings (ft.)		Certificated	45,000	41,000	45,000	47,000	41,000
		All-Engine Service	45,000	41,000	44,000	43,265	38,250
		Engine-Out Service	27,500	23,128	27,800	22,187	20,000
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	459/1,488	425/1,901	459/1,590	437/1,400	424/1,832
		Altitude/Specific Range	FL 450/0.308	FL 410/0.224	FL 450/0.289	FL 470/0.312	FL 410/0.231
	High Speed	TAS/Fuel Flow (lb./hr.)	482/1,925	459/2,570	470/1,832	482/2,075	470/2,448
		Altitude/Specific Range	FL 430/0.250	FL 370/0.179	FL 430/0.257	FL 410/0.232	FL 370/0.192
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	2,577	3,076	2,719	2,450	3,011
		Average Speed	448	417	447	426	417
		Trip Fuel	9,591	15,238	10,689	9,640	14,256
		Specific Range/Altitude	0.269/FL 450	0.202/FL 410	0.254/FL 450	0.254/FL 450	0.211/FL 410
	Max Fuel (with available payload)	Nautical Miles	3,636	3,839	3,235	3,445	3,974
		Average Speed	452	417	449	429	419
		Trip Fuel	12,757	18,380	12,206	12,740	17,939
		Specific Range/Altitude	0.285/FL 450	0.209/FL 410	0.265/FL 450	0.270/FL 470	0.222/FL 410
	Four Passengers (with available fuel)	Nautical Miles	3,646	3,919	3,250	3,540	4,011
		Average Speed	451	415	448	430	419
		Trip Fuel	12,761	18,422	12,212	12,740	17,953
		Specific Range/Altitude	0.286/FL 450	0.213/FL 410	0.266/FL 450	0.278/FL 470	0.223/FL 410
	Ferry	Nautical Miles	3,724	3,980	3,307	3,615	4,085
		Average Speed	452	414	450	430	419
		Trip Fuel	12,789	18,450	12,236	12,740	17,982
		Specific Range/Altitude	0.291/FL 450	0.216/FL 410	0.270/FL 450	0.284/FL 470	0.227/FL 410
Missions (4 passen-gers)	**300 nm**	Runway	2,957	3,346	3,611	2,795	3,389
		Flight Time	0+47	0+49	0+47	0+47	0+47
		Fuel Used	1,505	1,773	1,583	1,525	1,595
		Specific Range/Altitude	0.199/FL 450	0.169/FL 410	0.190/FL 450	0.197/FL 470	0.188/FL 410
	600 nm	Runway	2,997	3,518	3,656	2,855	3,421
		Flight Time	1+26	1+34	1+26	1+27	1+27
		Fuel Used	2,412	3,146	2,577	2,465	2,835
		Specific Range/Altitude	0.249/FL 450	0.191/FL 410	0.233/FL 450	0.243/FL 470	0.212/FL 410
	1,000 nm	Runway	3,136	3,573	3,718	2,920	3,483
		Flight Time	2+18	2+33	2+18	2+20	2+19
		Fuel Used	3,645	4,815	3,925	3,755	4,532
		Specific Range/Altitude	0.274/FL 450	0.208/FL 410	0.255/FL 450	0.266/FL 470	0.221/FL 410
Remarks		Certification Basis	FAR 25, 2012; EASA CS 25, 2013	FAR 25, 2011 *Factory modification DCA 145-000-00020/2008	FAR 25 A 98; JAR 25 Chg 15 Rockwell Collins Pro Line 21 Advanced.	FAR/EASA CS 25, 2013 EASy II flight deck; 2017 delivery price.	FAR 25, 1980/83/87/95/2006/15 Rockwell Collins Pro Line 21 Advanced. *9,220-lb. max takeoff; 8,729-lb. normal takeoff

Jets ≥20,000-LB. MTOW

Manufacturer			Dassault	Gulfstream Aerospace	Dassault	Gulfstream Aerospace
Model			Falcon 2000LXS Falcon 2000EX	Gulfstream 450 GIV-X	Falcon 900LX Falcon 900EX	Gulfstream 500 GVII-G500
BCA **Equipped Price**			$34,700,000	$43,150,000	$44,300,000	$44,650,000
Characteristics		Seating	2+8/10/19	2+14/16/19	2+12/12/19	2+13/19/19
		Wing Loading/Power Loading	81.2/3.06	78.4/2.69	92.9/3.27	80.9/2.54
		Noise (EPNdB): Lateral/Flyover/Approach	76.4/91.7/90.5	76.2/89.5/92.3	78.2/90.3/92.1	NA/NA/NA
External Dimensions (ft.)		Length	66.3	89.3	66.3	91.2
		Height	23.2	25.2	24.8	25.5
		Span	70.2	77.8	70.2	86.3
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.1/26.2/31.0	25.8/37.0/45.1	23.5/33.2/39.3	26.3/41.5/47.6
		Height/Dropped Aisle Depth	6.2/flat floor	6.0/flat floor	6.2/flat floor	6.2/flat floor
		Width: Max/Floor	7.7/6.3	7.0/5.4	7.7/6.3	7.6/6.1
Baggage		**Internal:** Cu. ft./lb.	131/1,600	169/2,000	127/2,866	230/2,250
		External: Cu. ft./lb.	8/92	—/—	—/—	—/—
Power		Engines	2 P&WC PW308C	2 RR Tay Mk 611-8C	3 Hon TFE731-60	2 P&WC PW814GA
		Output (lb. each)/Flat Rating	7,000/ISA+15C	13,850/ISA+15C	5,000/ISA+17C	15,144/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	7,000c/—	12,000t or OC/—	6,000c/—	OC/—
Weights (lb.)		Max Ramp	43,000	75,000	49,200	77,250
		Max Takeoff	42,800	74,600	49,000	76,850
		Max Landing	39,300	66,000	44,500	64,350
		Zero Fuel	29,700c	49,000c	30,864c	52,100c
		BOW	24,750	43,200	26,750	46,600
		Max Payload	4,950	5,800	4,114	5,500
		Useful Load	18,250	31,800	22,450	30,650
		Max Fuel	16,660	29,281	20,905	28,850
		Available Payload w/Max Fuel	1,590	2,519	1,545	1,800
		Available Fuel w/Max Payload	13,300	26,000	18,336	25,150
Limits		MMO	0.862	0.880	0.870	0.925
		Trans. Alt. FL/VMO	FL 250/370	FL 280/340	FL 250/370	NA/NA
		PSI/Sea-Level Cabin	9.3/25,300	9.6/26,700	9.6/25,300	10.7/31,900
Airport Performance		TOFL (SL elev./ISA temp.)	4,675	5,600	5,360	5,200
		TOFL (5,000-ft. elev.@25C)	6,840	8,200	7,615	7,930
		Mission Weight	42,010	74,600	48,255	76,850
		NBAA IFR Range	4,100	4,328	4,685	5,000
		V2	126	150	134	NA
		VREF	106	123	111	NA
		Landing Distance	2,295	2,663	2,455	NA
Climb		Time to Climb/Altitude	17/FL 370	16/FL 370	19/FL 370	15/FL 370
		FAR 25 Engine-Out Rate (fpm)	463	712	723	NA
		FAR 25 Engine-Out Gradient (ft./nm)	221	285	324	NA
Ceilings (ft.)		Certificated	47,000	45,000	51,000	51,000
		All-Engine Service	42,315	42,400	39,630	NA
		Engine-Out Service	21,010	25,000	24,980	NA
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	437/1,485	459/2,585	431/1,665	488/2,440
		Altitude/Specific Range	FL 450/0.294	FL 450/0.178	FL 430/0.259	FL 450/0.200
	High Speed	TAS/Fuel Flow (lb./hr.)	483/2,325	476/3,055	474/2,225	516/3,467
		Altitude/Specific Range	FL 390/0.208	FL 410/0.156	FL 390/0.213	FL 410/0.149
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	2,915	3,549	3,790	4,129
		Average Speed	427	452	422	478
		Trip Fuel	11,438	22,622	16,340	22,365
		Specific Range/Altitude	0.255/FL 450	0.157/FL 450	0.232/FL 430	0.185/FL 470
	Max Fuel (with available payload)	Nautical Miles	3,990	4,216	4,565	5,000
		Average Speed	430	453	421	480
		Trip Fuel	14,798	26,023	18,909	26,172
		Specific Range/Altitude	0.270/FL 470	0.162/FL 450	0.241/FL 430	0.191/FL 490
	Four Passengers (with available fuel)	Nautical Miles	4,065	4,328	4,650	5,075
		Average Speed	430	452	420	480
		Trip Fuel	14,798	26,087	18,909	26,200
		Specific Range/Altitude	0.275/FL 470	0.166/FL 450	0.246/FL 430	0.194/FL 490
	Ferry	Nautical Miles	4,155	4,382	4,740	5,137
		Average Speed	431	453	419	480
		Trip Fuel	14,798	26,116	18,909	26,222
		Specific Range/Altitude	0.281/FL 470	0.168/FL 450	0.251/FL 430	0.196/FL 490
Missions (4 passengers)	**300 nm**	Runway	2,795	3,225	2,730	NA
		Flight Time	0+47	0+46	0+47	0+45
		Fuel Used	1,525	2,599	1,595	2,274
		Specific Range/Altitude	0.197/FL 470	0.115/FL 450	0.188/FL 470	0.132/FL 490
	600 nm	Runway	2,855	3,258	2,865	NA
		Flight Time	1+27	1+25	1+27	1+22
		Fuel Used	2,465	4,113	2,625	3,561
		Specific Range/Altitude	0.243/FL 470	0.146/FL 450	0.229/FL 470	0.168/FL 490
	1,000 nm	Runway	2,920	3,304	2,880	NA
		Flight Time	2+20	2+18	2+20	2+12
		Fuel Used	3,755	6,176	4,070	5,313
		Specific Range/Altitude	0.266/FL 470	0.162/FL 450	0.246/FL 450	0.188/FL 490
Remarks		Certification Basis	FAR/EASA CS 25, 2013 EASy II flight deck; 2017 delivery price.	FAR/EASA CS 25, 2004	FAR/EASA 25, 1979/2010 EASy II flight deck; 2017 delivery price.	FAR/EASA 25 pending

Jets ≥20,000-LB. MTOW

Manufacturer			**Bombardier**	**Embraer**	**Dassault**	**Airbus**
Model			**Global 5000** **BD-700-1A11**	**Lineage 1000E** **ERJ 190-100 ECJ**	**Falcon 7X** **Falcon 7X**	**A320 Prestige** **A320-214**
BCA Equipped Price			$50,441,000	$53,000,000	$53,800,000	$95,000,000
Characteristics		Seating	3+13/15/19	3+13/19/19	3+12/14/19	4+18/179/—
		Wing Loading/Power Loading	90.6/3.14	120.7/3.25	92.0/3.64	130.3/3.18
		Noise (EPNdB): Lateral/Flyover/Approach	88.7/83.5/89.7	92.7/86.4/92.5	82.3/90.1/92.6	85.5/93.4/95.5
External Dimensions (ft.)		Length	96.8	118.9	76.7	123.3
		Height	25.5	34.7	25.7	38.6
		Span	94.0	94.2	86.0	111.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	27.2/40.7/45.7	67.2/76.6/84.3	26.2/39.1/46.5	90.3/90.3/—
		Height/Dropped Aisle Depth	6.2/flat floor	6.6/flat floor	6.2/flat floor	7.4/flat floor
		Width: Max/Floor	7.9/6.5	8.8/8.0	7.7/6.3	12.1/11.7
Baggage		**Internal:** Cu. ft./lb.	195/1,000	323/2,293	140/2,004	NA/NA
		External: Cu. ft./lb.	—/—	120/705	—/—	985/NA
Power		Engines	2 RR BR700-710A2-20	2 GE CF34-10E7-B	3 P&WC PW307A	2 CFMI CFM56-5B4/3*
		Output (lb. each)/Flat Rating	14,750/ISA+20C	18,500/ISA+15C	6,402/ISA+17C	27,000/ISA+29C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	7,200c/—	OC/—
Weights (lb.)		Max Ramp	92,750	120,593	70,200	172,850
		Max Takeoff	92,500	120,152	70,000	171,950
		Max Landing	78,600	100,972	62,400	145,500
		Zero Fuel	58,000c	80,469c	41,000c	137,800c
		BOW	50,861	70,548	36,600	109,000
		Max Payload	7,139	9,921	4,400	28,800
		Useful Load	41,889	50,045	33,600	63,850
		Max Fuel	38,959	48,217	31,940	53,450
		Available Payload w/Max Fuel	2,930	1,828	1,660	10,400
		Available Fuel w/Max Payload	34,750	40,124	29,200	35,050
Limits		MMO	0.890	0.820	0.900	0.820
		Trans. Alt. FL/VMO	FL 303/340	FL 289/320	FL 270/370	FL 250/350
		PSI/Sea-Level Cabin	10.3/30,125	8.8/23,190	10.2/29,200	8.3/NA
Airport Performance		TOFL (SL elev./ISA temp.)	5,540	6,076	5,710	6,920
		TOFL (5,000-ft. elev.@25C)	7,223	9,500	8,045	9,355
		Mission Weight	90,370	112,038	69,140	171,950
		NBAA IFR Range	5,475	3,965	5,795	4,300
		V2	133	140	133	NA
		VREF	107	110	106	NA
		Landing Distance	2,189	2,038	2,120	2,400
Climb		Time to Climb/Altitude	18/FL 370	29/FL 350	19/FL 370	23/FL 360
		FAR 25 Engine-Out Rate (fpm)	704	NA	597	NA
		FAR 25 Engine-Out Gradient (ft./nm)	318	NA	269	NA
Ceilings (ft.)		Certificated	51,000	41,000	51,000	39,000
		All-Engine Service	44,600	35,000	40,215	NA
		Engine-Out Service	20,600	19,178	25,480	NA
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	470/2,856	454/4,184	459/2,260	451/4,730
		Altitude/Specific Range	FL 450/0.165	FL 380/0.109	FL 430/0.203	FL 370/0.095
	High Speed	TAS/Fuel Flow (lb./hr.)	499/3,582	471/5,033	497/3,205	473/5,860
		Altitude/Specific Range	FL 410/0.139	FL 350/0.094	FL 390/0.155	350/0.081
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	4,920	3,493	5,000	2,100
		Average Speed	463	442	453	428
		Trip Fuel	33,374	35,569	26,820	27,936
		Specific Range/Altitude	0.147/FL 470	0.098/FL 400	0.186/FL 450	0.075/FL 350
	Max Fuel (with available payload)	Nautical Miles	5,486	4,532	5,670	3,852
		Average Speed	464	446	454	438
		Trip Fuel	35,723	43,962	29,560	46,930
		Specific Range/Altitude	0.154/FL 470	0.103/FL 410	0.192/FL 470	0.082/FL 390
	Four Passengers (with available fuel)	Nautical Miles	5,475	4,602	5,760	4,330
		Average Speed	463	446	454	438
		Trip Fuel	35,719	44,240	29,560	48,057
		Specific Range/Altitude	0.153/FL 470	0.104/FL 410	0.195/FL 470	0.090/FL 390
	Ferry	Nautical Miles	5,526	4,640	5,840	4,380
		Average Speed	464	446	454	438
		Trip Fuel	35,743	44,264	29,560	48,108
		Specific Range/Altitude	0.155/FL 470	0.105/FL 410	0.198/FL 470	0.091/FL 390
Missions (4 passengers)	**300 nm**	Runway	2,487	3,002	2,500	3,670
		Flight Time	0+46	0+48	0+46	0+55
		Fuel Used	2,773	3,426	2,075	4,265
		Specific Range/Altitude	0.108/FL 450	0.088/FL 390	0.145/FL 450	0.070/FL 350
	600 nm	Runway	2,575	3,133	2,515	3,700
		Flight Time	1+23	1+26	1+25	1+34
		Fuel Used	4,445	5,862	3,285	7,080
		Specific Range/Altitude	0.135/FL 490	0.102/FL 410	0.183/FL 470	0.085/FL 390
	1,000 nm	Runway	2,697	3,251	2,640	3,760
		Flight Time	2+13	2+20	2+17	2+28
		Fuel Used	6,752	9,063	4,945	10,970
		Specific Range/Altitude	0.148/FL 470	0.110/FL 410	0.202/FL 470	0.091/FL 390
Remarks		Certification Basis	FAR 25, 1998/2004; EASA 25, 2004 Global Vision flight deck	FAR/EASA 25, 2008	FAR/EASA 25, 2007 EASy II flight deck; DFCS; 2017 delivery price.	FAR 25, 1999 *Also available with 26,500-lbf IAEV2527M-A5 engines; includes 2 additional center tanks and VIP cabin. *BCA* estimated data.

Ultra-Long-Range Jets

Manufacturer			*Gulfstream Aerospace*	Dassault	Gulfstream Aerospace	Bombardier	Gulfstream Aerospace
Model			***Gulfstream 600 GVII-600***	**Falcon 8X Falcon 7X**	**Gulfstream 550 GV-SP**	**Global 6000 BD-700-1A10**	**Gulfstream 650 GVI**
BCA Equipped Price			*$56,200,000*	$58,400,000	$61,500,000	$62,310,000	$67,400,000
Characteristics		Seating	*4+16/19/19*	3+12/14/19	4+16/18/19	4+13/15/19	4+16/19/19
		Wing Loading/Power Loading	*78.9/2.92*	95.9/3.62	80.1/2.96	97.5/3.37	77.6/2.95
		Noise (EPNdB): Lateral/Flyover/Approach	*NA/NA/NA*	81.5/88.9/90.6	79.3/90.2/90.8	88.7/83.5/89.7	77.5/89.8/88.3
External Dimensions (ft.)		Length	*96.1*	80.2	96.4	99.4	99.8
		Height	*25.3*	26.1	25.8	25.5	25.7
		Span	*94.1*	86.3	93.5	94.0	99.6
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	*30.2/45.2/51.3*	29.8/42.7/50.1	30.3/42.6/50.1	27.3/43.3/48.3	32.7/46.8/53.6
		Height/Dropped Aisle Depth	*6.2/flat floor*	6.2/flat floor	6.0/flat floor	6.2/flat floor	6.3/flat floor
		Width: Max/Floor	*7.6/6.1*	7.7/6.3	7.0/5.4	7.9/6.5	8.2/6.7
Baggage		**Internal:** Cu. ft./lb.	*230/2,250*	140/2,004	226/2,500	195/1,000	235/2,500
		External: Cu. ft./lb.	*—/—*	—/—	—/—	—/—	—/—
Power		Engines	*2 P&WC PW815GA*	3 P&WC PW307D	2 RR BR700-710C4-11	2 RR BR700-710A2-20	2 RR BR700-725A1-12
		Output (lb. each)/Flat Rating	*15,680/ISA+15C*	6,722/ISA+17C	15,385/ISA+15C	14,750/ISA+20C	16,900/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	*OC/—*	7,200c/—	8,000t or OC/—	OC/—	10,000t/—
Weights (lb.)		Max Ramp	*92,000*	73,200	91,400	99,750	100,000
		Max Takeoff	*91,600*	73,000	91,000	99,500	99,600
		Max Landing	*76,800*	62,400	75,300	78,600	83,500
		Zero Fuel	*57,440c*	41,000c	54,500c	58,000c	60,500c
		BOW	*51,440*	36,800	48,700	52,560	54,500
		Max Payload	*6,000*	4,200	5,800	5,440	6,000
		Useful Load	*40,560*	36,400	42,700	47,190	45,500
		Max Fuel	*38,760*	35,141	40,994	44,716	44,200
		Available Payload w/Max Fuel	*1,800*	1,259	1,706	2,474	1,300
		Available Fuel w/Max Payload	*34,560*	32,200	36,900	41,750	39,500
Limits		MMO	*0.925*	0.900	0.885	0.890	0.925
		Trans. Alt. FL/VMO	*NA/NA*	FL 270/370	FL 270/340	FL 303/340	FL 290/340
		PSI/Sea-Level Cabin	*10.7/31,900*	10.4/30,300	10.2/29,200	10.3/30,125	10.7/31,900
Airport Performance		TOFL (SL elev./ISA temp.)	*5,700*	5,880	5,910	6,476	5,858
		TOFL (5,000-ft. elev.@25C)	*NA*	8,555	9,070	7,880	9,000
		Mission Weight	*91,600*	72,591	91,000	94,513p	99,600
		NBAA IFR Range	*6,200*	6,415	6,738	5,594	6,912
		V2	*NA*	138	147	142	146
		VREF	*NA*	107	112	110	114
		Landing Distance	*NA*	2,245	2,240	2,243	2,680
Climb		Time to Climb/Altitude	*17/FL 370*	20/FL 370	18/FL 370	21/FL 370	19/FL 370
		FAR 25 Engine-Out Rate (fpm)	*NA*	774	594	474	NA
		FAR 25 Engine-Out Gradient (ft./nm)	*NA*	339	242	200	NA
Ceiling (ft.)		Certificated	*51,000*	51,000	51,000	51,000	51,000
		All-Engine Service	*42,700*	40,075	42,700	42,400	42,700
		Engine-Out Service	*25,000*	26,645	25,820	18,000	25,000
Cruise	**Long Range**	TAS	*488*	459	459	470	488
		Fuel Flow	*2,769*	2,254	2,563	3,046	2,825
		Altitude	*FL 450*	FL 430	FL 450	FL 450	FL 450
		Specific Range	*0.176*	0.204	0.179	0.154	0.173
	High Speed	TAS	*516*	480	488	499	516
		Fuel Flow	*3,891*	2,508	3,228	3,796	3,136
		Altitude	*FL 410*	FL 430	FL 430	FL 410	FL 450
		Specific Range	*0.133*	0.191	0.151	0.131	0.165
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	*5,286*	5,555	5,767	5,882	5,934
		Average Speed	*481*	452	452	464	481
		Trip Fuel	*31,622*	29,507	33,993	40,415	36,285
		Specific Range/Altitude	*0.167/FL 450*	0.188/FL 470	0.170/FL 490	0.146/FL 470	0.164/FL 490
	Max Fuel (with available payload)	Nautical Miles	*6,200*	6,325	6,698	6,200	6,981
		Average Speed	*481*	453	454	464	482
		Trip Fuel	*35,918*	32,558	38,202	41,472	41,129
		Specific Range/Altitude	*0.173/FL 490*	0.194/FL 470	0.175/FL 490	0.149/FL 470	0.170/FL 510
	Eight Passengers (with available fuel)	Nautical Miles	*6,217*	6,235	6,708	6,124	6,912
		Average Speed	*481*	453	453	464	481
		Trip Fuel	*35,924*	32,204	38,205	41,437	40,820
		Specific Range/Altitude	*0.173/FL 490*	0.194/FL 470	0.176/FL 490	0.148/FL 470	0.169/FL 510
	Ferry	Nautical Miles	*6,353*	6,475	6,853	6,233	7,105
		Average Speed	*481*	454	454	464	482
		Trip Fuel	*35,966*	32,653	38,251	41,487	41,168
		Specific Range/Altitude	*0.177/FL 490*	0.198/FL 470	0.179/FL 510	0.150/FL 470	0.173/FL 510
Missions (8 passengers)	**1,000 nm**	Runway	*NA*	2,685	3,436	2,852	3,241
		Flight Time	*2+12*	2+17	2+20	2+13	2+10
		Fuel Used	*5,728*	4,994	5,599	6,842	5,942
		Specific Range/Altitude	*0.175/FL 490*	0.200/FL 470	0.179/FL 490	0.146/FL 470	0.168/FL 510
	3,000 nm	Runway	*NA*	3,540	3,599	3,858	3,591
		Flight Time	*6+19*	6+39	6+42	6+20	6+17
		Fuel Used	*16,060*	14,122	15,474	19,538	16,280
		Specific Range/Altitude	*0.187/FL 490*	0.212/FL 470	0.194/FL 490	0.154/FL 470	0.184/FL 510
	6,000 nm	Runway	*NA*	5,645	5,277	6,293	5,241
		Flight Time	*12+29*	13+12	13+15	12+39	12+28
		Fuel Used	*34,432*	30,729	33,428	41,053	34,622
		Specific Range/Altitude	*0.174/FL 490*	0.195/FL 470	0.179/FL 490	0.146/FL 490	0.173/FL 510
Remarks		Certification Basis	*FAR, EASA CS 25 pending*	FAR/EASA 25, 2016 EASy III flight deck; DFCS; 2017 delivery price.	FAR 25, 1997/2003; EASA 25 CS, 2004	FAR 25, 1998/2003; JAR 25 BEVS and new Global Vision flight deck standard.	FAR, EASA CS 25, 2012

Ultra-Long-Range Jets

Manufacturer			**Gulfstream Aerospace**	**Boeing**	**Airbus**	***Boeing***	***Boeing***
Model			**Gulfstream 650ER GVI**	**BBJ 737-700IGW**	**ACJ319 A319-133**	***BBJ MAX8 737-8***	***BBJ MAX9 737-9***
BCA **Equipped Price**			$69,400,000	$79,000,000	$87,000,000	*$95,300,000*	*$103,300,000*
Characteristics		Seating	4+16/19/19	4+19/55/149	4+19/19/156	*4+19/71/189*	*4+19/75/220*
		Wing Loading/Power Loading	80.7/3.07	127.5/3.13	127.8/3.12	*135.1/3.24*	*145.2/3.48*
		Noise (EPNdB): Lateral/Flyover/Approach	78.7/89.6/88.3	85.4/94.9/95.8	85.4/94.6/94.2	*NA/NA/NA*	*NA/NA/NA*
External Dimensions (ft.)		Length	99.8	110.3	111.0	*129.7*	*138.3*
		Height	25.7	41.2	38.6	*40.3*	*40.3*
		Span	99.6	117.4	111.8	*117.8*	*117.8*
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	32.7/46.8/53.6	72.7/79.2/—	78.0/78.0/—	*91.9/98.5/98.5*	*100.6/107.2/107.2*
		Height/Dropped Aisle Depth	6.3/flat floor	79.3/flat floor	7.4/flat floor	*7.1/flat floor*	*7.1/flat floor*
		Width: Max/Floor	8.2/6.7	11.6/10.7	12.2/11.6	*11.6/10.7*	*11.6/10.7*
Baggage		**Internal:** Cu. ft./lb.	235/2,500	NA/NA	160/NA	*NA/NA*	*NA/NA*
		External: Cu. ft./lb.	—/—	159/NA	NA/NA	*713/NA*	*874/NA*
Power		Engines	2 RR BR700-725A1-12	2 CFMI CFM56-7B27E	2 CFMI CFM56-5B7/3*	*2 CFMI LEAP-1B*	*2 CFMI LEAP-1B*
		Output (lb. each)/Flat Rating	16,900/ISA+15C	27,300/ISA+15C	27,000/ISA+29C	*28,000/ISA+15C*	*28,000/ISA+15C*
		Inspection Interval/Manu. Service Plan Interval	10,000t/—	OC/—	OC/—	*OC/—*	*OC/—*
Weights (lb.)		Max Ramp	104,000	171,500	169,530	*181,700*	*195,200*
		Max Takeoff	103,600	171,000	168,650	*181,200*	*194,700*
		Max Landing	83,500	134,000	137,790	*152,800*	*163,900*
		Zero Fuel	60,500c	126,000c	128,970c	*145,400c*	*156,500c*
		BOW	54,500	98,040	96,450**	*110,000*	*118,080*
		Max Payload	6,000	27,960	32,520	*35,400*	*38,420*
		Useful Load	49,500	73,460	73,080	*71,700*	*77,120*
		Max Fuel	48,200	71,737	72,560	*69,814*	*73,325*
		Available Payload w/Max Fuel	1,300	1,723	520	*1,886*	*3,795*
		Available Fuel w/Max Payload	43,500	45,500	40,560	*36,300*	*38,700*
Limits		MMO	0.925	0.820	0.820	*0.820*	*0.820*
		Trans. Alt. FL/VMO	FL 290/340	FL 260/340	FL 250/350	*FL 260/340*	*FL 260/340*
		PSI/Sea-Level Cabin	10.7/31,900	9.0/24,000	8.3/22,000	*9.0/24,000*	*9.0/24,000*
Airport Performance		TOFL (SL elev./ISA temp.)	6,299	6,085	6,170	*6,630*	*8,200*
		TOFL (5,000-ft. elev.@25C)	11,139	10,330	8,360	*NA*	*NA*
		Mission Weight	103,600	171,000	168,650	*NA*	*NA*
		NBAA IFR Range	7,437	6,297	6,000	*NA*	*NA*
		V2	148	141	137	*NA*	*NA*
		VREF	114	117	111	*122*	*124*
		Landing Distance	2,680	2,360	2,220	*2,440*	*2,570*
Climb		Time to Climb/Altitude	21/FL 370	25/FL 370	22/360	*24/FL 350*	*26/FL 330*
		FAR 25 Engine-Out Rate (fpm)	NA	NA	NA	*NA*	*NA*
		FAR 25 Engine-Out Gradient (ft./nm)	NA	NA	NA	*NA*	*NA*
Ceiling (ft.)		Certificated	51,000	41,000	41,000	*41,000*	*41,000*
		All-Engine Service	41,000	NA	36,000	*NA*	*NA*
		Engine-Out Service	25,000	NA	18,000	*NA*	*NA*
Cruise	**Long Range**	TAS	488	452	447	*455*	*457*
		Fuel Flow	2,883	4,679	4,695	*NA*	*NA*
		Altitude	FL 450	FL 390	FL 370	*FL 380*	*FL 360*
		Specific Range	0.169	0.097	0.095	*NA*	*NA*
	High Speed	TAS	516	470	470	*471*	*471*
		Fuel Flow	3,136	5,550	5,830	*NA*	*NA*
		Altitude	FL 450	FL 370	FL 370	*FL 360*	*FL 360*
		Specific Range	0.165	0.085	0.081	*NA*	*NA*
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (with available fuel)	Nautical Miles	6,459	3,306	2,679	*2,692*	*2,628*
		Average Speed	481	437	434	*NA*	*NA*
		Trip Fuel	40,285	39,508	33,677	*NA*	*NA*
		Specific Range/Altitude	0.160/FL 490	0.084/FL 390	0.080/FL 370	*NA/FL 370*	*NA/FL 350*
	Max Fuel (with available payload)	Nautical Miles	7,507	6,285	6,134	*6,521*	*6,300*
		Average Speed	482	443	442	*NA*	*NA*
		Trip Fuel	45,129	66,854	66,673	*NA*	*NA*
		Specific Range/Altitude	0.166/FL 510	0.094/FL 410	0.092/FL 410	*NA/FL 390*	*NA/FL 390*
	Eight Passengers (with available fuel)	Nautical Miles	7,437	6,270	6,002	*6,555*	*6,376*
		Average Speed	482	443	442	*NA*	*NA*
		Trip Fuel	44,820	66,723	65,558	*NA*	*NA*
		Specific Range/Altitude	0.166/FL 510	0.094/FL 410	0.092/FL 410	*NA/FL 390*	*NA/FL 410*
	Ferry	Nautical Miles	7,636	6,348	6,200	*6,619*	*6,441*
		Average Speed	482	442	442	*NA*	*NA*
		Trip Fuel	45,168	66,886	67,207	*NA*	*NA*
		Specific Range/Altitude	0.169/FL 510	0.095/FL 410	0.092/FL 410	*NA/FL 390*	*NA/FL 410*
Missions (8 passengers)	**1,000 nm**	Runway	3,241	3,485	4,075	*NA*	*NA*
		Flight Time	2+10	2+27	2+26	*NA*	*NA*
		Fuel Used	5,942	10,478	10,370	*NA*	*NA*
		Specific Range/Altitude	0.168/FL 510	0.095/FL 410	0.096/FL 410	*NA/NA*	*NA/NA*
	3,000 nm	Runway	3,591	4,290	4,280	*NA*	*NA*
		Flight Time	6+17	6+54	6+54	*NA*	*NA*
		Fuel Used	16,280	29,534	30,070	*NA*	*NA*
		Specific Range/Altitude	0.184/FL 510	0.102/FL 410	0.100/FL 410	*NA/NA*	*NA/NA*
	6,000 nm	Runway	5,241	5,855	6,160	*NA*	*NA*
		Flight Time	12+28	13+34	13+35	*NA*	*NA*
		Fuel Used	34,622	63,311	65,528	*NA*	*NA*
		Specific Range/Altitude	0.173/FL 510	0.095/FL 410	0.092/FL 410	*NA/NA*	*NA/NA*
Remarks		Certification Basis	FAR 25, 2014	FAR 25 A 77, 1967/98 Split scimitar winglets. 2016 data.	FAR 25, 1999 *Also available with 26,500-lbf IAEV2527M-A5 engines; includes 6 additional center tanks plus VIP cabin. **Spec weight. *BCA* estimated data.	*FAR 25 A TBD All data preliminary. 2016 data.*	*FAR 25 A TBD All data preliminary. 2016 data.*

When they added the new M600 to the corporate stable, productivity jumped. Wait. The logical next step after a jet is a turboprop? Go figure: The average business jet flies around 400 hours a year, spending 300 hours on regional trips that could easily be made with a Piper M600 at 70% lower cost. Hey, flight department – congratulations on your promotions. Don't let the competition see this: **piper.com/M600**.

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M-CLASS: M350 / M500 / M600

*Comparison of overall annual operating costs of a Cessna XLS+ with those of a Piper M600, using the Conklin & de Decker Aircraft Cost Evaluator.

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Gulfstream G550

Price/performance **sweet spot** in large-cabin class

FOR AS LITTLE AS $14 MILLION, YOU CAN BUY AN EARLY SERIAL number 2003 Gulfstream G550, a large-cabin business aircraft that's capable of flying 8 passengers more than 6,700 nm. These jets sold new for more than $45 million, so that's a heady loss of resale value for an aircraft that flies only 425 hr. per year on average. Late model aircraft, however, command more than $45 million at resale time as they incorporate all the latest upgrades, along with having low-time airframes and engines, plus factory fresh paint and interiors.

The G550 is a 2003 amendment to the 1997 GV type certificate. It's known by FAA as the GV-SP and it's actually the sixth iteration of the GII, which was first certified in 1967. Compared to the GV, the G550 has four main improvements: Enhanced takeoff performance, several drag reduction details that boost range by 250 nm and increase fuel efficiency, better cabin space utilization and the PlaneView flight deck featuring Honeywell Primus Epic avionics.

GULFSTREAM AEROSPACE

Additionally, a seventh pair of windows was added to the fuselage and the entry door is moved 2-ft. forward to increase usable cabin length and boost net cabin volume by 58 cu. ft. More net storage capacity is available in the aft baggage bay due to the installation of conformal water tanks and relocated vacuum lav waste tank.

Max ramp weight and MTOW are increased by 500 lb. to provide more tanks-full payload. Typically equipped, the aircraft can carry 8 passengers with full fuel. But that's with a lean 106 lb. allowance for tableware, galley stores, multiple meals, beverages, water and cabin supplies.

Most aircraft are configured with a forward galley, crew rest area and lavatory. Seating configurations accommodate 12 to 16 passengers. The main passenger cabin has three sections, usually including a forward, four-chair club section and a variety of different layouts in the mid and aft cabin that can be configured with a four-seat conference grouping, credenza, four-place divans and pairs of facing chairs, among other furnishings. The cockpit features, four, 14-in., landscape configuration flat panel displays with optional synthetic vision PFDs. This was the first Gulfstream to be fitted with cursor control devices. But rather than using track balls in the center console, Gulfstream developed side-wall mounted CCDs with integral arm rests, ergonomically angled handholds and thumb-operated force transducers that control the cursors on screen.

G550 also has a standard Rockwell Collins HGS-6250 head up guidance system and second-generation Elbit EVS II IR enhanced vision system, significantly improving situational awareness in reduced visibility conditions, according to operators.

Gulfstream quotes 48,700 lb. as the average basic operating weight, providing a 1,700 lb. full-fuel payload. Actual BOWs range between 48,103 lb. and 48,800 lb., operators tell *BCA*. But they also say it's easy to balloon up to 49,300 lb., or more, if the galley is chock-full and the aircraft is carrying supplies and spares needed for the longest international missions.

Initial cruise altitude is FL 400 or FL 410 on long-range missions. Most operators plan on a first hour fuel burn of 4,500 to 5,000 lb., dropping to 3,000 lb. for the second hour and decreasing to 2,400 lb .for the last hour of the mission. Many operators routinely fly their aircraft at Mach 0.83 to 0.85 on missions shorter than 12 hr. Such cruise speeds enable them to fly non-stop between most city pairs in North America and Europe, and one-stop between most cities in the Western Pacific and North America. Anchorage is a popular technical stop between Asia and the U.S. where operators refuel and change flight and cabin crews. On shorter-range missions, crews say they plan on 5,000 lb. for the first hour, 4,000 lb. for the second hour and 3,000 lb. per hour for the remainder of the flight.

These aircraft are not inexpensive to operate. Budget 500 to 550 gal. per hour for fuel, $700 to $950 per hour for engine reserves and 2.5 maintenance hours per flight hour for inspections, plus another $250 per hour for parts. Having the aircraft enrolled in Rolls-Royce CorporateCare or JSSI engine care programs is a big plus at resale time.

With FAA's Jan. 1, 2020 ADS-B deadline looming large, G550 buyers should look for aircraft having ASC 84B (Certification Foxtrot) enhanced navigation packages that include WAAS GPS receivers and ASC 105 ADS-B-compliant Honeywell Primus II XS-858A Mode S transponders. Also, check time in service since the last 96-month major airframe inspection. This event requires at least three weeks down time, not including squawks. If the ADS-B modification hasn't been accomplished, that inspection is an opportune time to schedule the upgrade.

The G550's main competitors are Bombardier's Global 6000, which has a more spacious cross section, but less range and higher direct operating costs, and the Dassault Falcon 7X offering a wider but shorter cabin, considerably better fuel efficiency and fly-by-wire flight controls. Considering G550's price-versus-performance blend, it's one of the most desirable large-cabin aircraft on the pre-owned market, especially in light of Gulfstream's stellar product support. **BCA**

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On Duty

Edited by Jessica A. Salerno *jessica.salerno@penton.com*

News of promotions, appointments and honors involving professionals within the business aviation community

▶ **Air Berlin, Berlin, Germany,** named **Goetz Ahmelmann** chief commercial officer — a position from which he was ousted two years ago — to support the company's pivot toward a hub-and-spoke model. The company also has hired **Carsten Schaeffer** as senior vice president of commercial strategy and distribution.

▶ **Air France-KLM USA** promoted **Stephane Ormand** to vice president and general manager. He had been vice president of pricing and revenue management for short- and medium- haul operations.

▶ **Alliance for Safety System of UAS through Research Excellence (Assure**), Starkville, Mississippi, named **Marty Rogers** director of the FAA's Center of Excellence for Unmanned Aircraft Systems at Mississippi State University. Rogers most recently was Assure's interim director and was the business director for the Alaska Center for Unmanned Aircraft Systems Integration and the Pacific UAS Test Range Complex, part of the University of Alaska Fairbanks.

▶ **Avcorp Industries, Delta, British Columbia,** announced that **Ed Merlo** the company's chief financial officer, has been appointed to the company's board of directors following the resignation of **Ray Castelli.** Castelli joined the board in July 2010. He resigned to focus on Weatherhaven, which he manages, after the company was awarded a large multiyear contract. Merlo will hold office until Avcorp's 2017 annual general meeting, which will determine board nominees for the year.

▶ **Avinode, Göteborg, Sweden,** promoted **Annika Abraham** to managing director of Europe, Middle East, Africa and Asia division. Abraham has worked for Avinode as chief financial officer for six years.

▶ **C&L Aviation Group, Bangor, Maine,** announced that **Robert Brega** has joined the company as regional sales manager. Brega most recently served as northeast regional sales manager at Duncan Aviation.

▶ **Dassault Falcon Jet, Teterboro, New Jersey,** appointed **Chris Hancock** regional sales manager for the New York Metropolitan area and Robert Friedlander will serve as regional sales manager for the New England territory, including upstate New York and Eastern Pennsylania. They report to Jim Hurley, senior vice president, Eastern U.S. and Canadian Sales.

▶ **Duncan Aviation, Lincoln, Nebraska**, named **Nate Darlington** to the position of paint department manager for the company's Battle Creek, Michigan, facility. Darlington has 16 years of experience. **Jason Burhoop** has been named project manager at Duncan's Lincoln, Nebraska, location. Burhoop joined Duncan in 1999 and most recently served as engine team leader.


CHRIS HANCOCK


ROBERT FRIEDLANDER


NATE DARLINGTON


MATT SARGENT


ADRIANNE BEASLEY


MIKE MARIE

▶ **Elliott Aviation, Moline, Illinois,** has hired **Mike Menard** as vice president of Operations at their headquarters. Most recently Mike was with Ace Precision Machining serving as vice president. He also held vice president positions at StandardAero and Dassault Aircraft Services.

▶ **European Regions Airline Association, Lightwater, Surrey, UK,** named **Angus von Schoenberg** named vice chairman of the Chief Financial Officers Group. Von Schoenberg is chief investment officer for TrueNoord, a regional aircraft leasing company in Amsterdam and London.

▶ **Flying Colours Corp., Peterborough, Ontario,** Canada, appointed **Dave Stewart** vice president and general manager of its USA facility in St. Louis, where he is working to grow the site and adding engineers, production and maintenance employees. Stewart most recently served as director of operations for the company.

▶ **General Aviation Manufacturers Association (GAMA), Washington, D.C.**, announced that **Sarah McCann** has joined the organization as communications director. She replaces **Mary Lynn Rynkiewicz**. McCann comes to GAMA from the National Air Traffic Controllers Association where she served as senior communications and public affairs associate.

▶ **Global Jet Capital, Boca Raton, Florida,** announced that **Violet Kwek** has joined the company as sales director of Greater China and North Asia. She will be based in the company's Hong Kong office. Most recently, Kwek served as deputy head of corporate banking for China Minsheng Banking Corp. in Hong Kong.

▶ **MAAS Aviation, Mobile, Alabama,** appointed **Geoffrey Myrick** chief operating officer. Before joining MAAS, Myrick served as vice president of sales for Certified Aviation Services.

▶ **Mecaer Aviation Group Inc., Borgomanero, Italy,** has hired **Gary Brown** as director of maintenance, overseeing the FAA Part 145 technicians at Northeast Philadelphia Airport, which maintains many helicopter types and is a Leonardo service facility.

▶ **National Transportation Safety Board, Washington,**

(continued on page 110)

If you would like to submit news of hires, promotions, appointments or awards for possible publication in On Duty, send email to jessica.salerno@penton.com *or call* (520) 577-5124.

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Products & Services Previews

By Jessica A. Salerno jessica.salerno@penton.com

1. Signature Updates BLUESky AvGas and TailWins Programs

Signature Flight Support has added new features and benefits to its TailWins rewards program specifically for AvGas users. Pilots are now rewarded for their AvGas purchases with 10 TailWins rewards points for every gallon purchased. They are instantly redeemable for cash-equivalent gift cards including a virtual Visa card, Amazon, Lowes, Home Depot and over 40 other options. The app can be downloaded free from the Apple iTunes store or Google Play marketplace.

Signature Flight Support
www.signatureflight.com

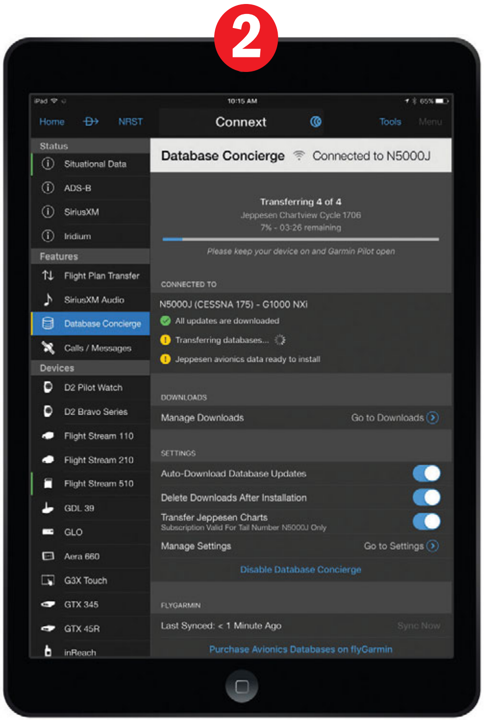
2. Garmin, Jeppesen Expand Garmin Plot App

Garmin and Jeppesen announced new wireless data transfer capabilities for Jeppesen terminal charts that are accessed through select Garmin avionics and the iOS-based Garin Pilot app. Pilots using the GTN 650/750 or the G1000 NSi with Flight Stream 510 will be able to wirelessly transfer Jepp terminal charts through the iOS-based Garmin app to their avionics systems The Flight Stream 510 MultiMediaCard (MMC) from Garmin includes Database Concierge.

Jeppesen
www.jeppesen.com/garminpilot

Garmin
www.garmin.com/aviation

2



Database Concierge Connected to N5000J

Transferring 4 of 4
Jeppesen Chartview Cycle 1706
7% - 03:26 remaining

Please keep your device on and Garmin Pilot open

CONNECTED TO
N5000J (CESSNA 175) - G1000 NXi
All updates are downloaded
Transferring databases...
Jeppesen avionics data ready to install

DOWNLOADS
Manage Downloads — Go to Downloads

SETTINGS
Auto-Download Database Updates ●
Delete Downloads After Installation ●
Transfer Jeppesen Charts ●
Subscription Valid For Tail Number N5000J Only
Manage Settings — Go to Settings
Disable Database Concierge

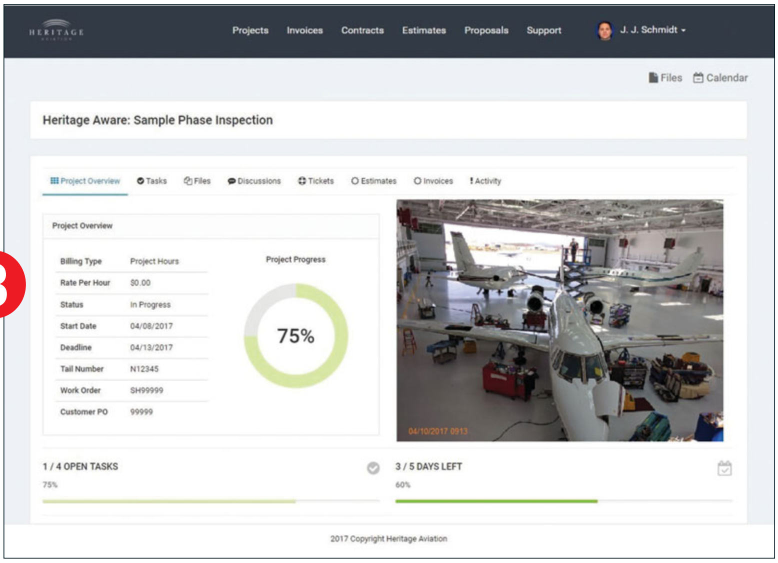
FLYGARMIN
Last Synced: < 1 Minute Ago — Sync Now
Purchase Avionics Databases on flyGarmin

3. Heritage Develops Maintenance Reporting Portal

Heritage Aviation announced the development of Heritage Aware, a remote aircraft maintenance-monitoring portal that allows customers real-time access to updates and work-in-progress reporting. Proprietary software allows customers to check the status of the aircraft through a computer or a smart hand-held device through a customized dashboard providing top line overviews with the ability to drill down to the smallest detail.

Heritage Aviation
Burlington, Vermont
800) 781-0773
www.flyheritage.com

3



Heritage Aware: Sample Phase Inspection

Project Overview

Billing Type	Project Hours
Rate Per Hour	$0.00
Status	In Progress
Start Date	04/08/2017
Deadline	04/13/2017
Tail Number	N12345
Work Order	SH99999
Customer PO	99999

1 / 4 OPEN TASKS
75%

3 / 5 DAYS LEFT
60%

2017 Copyright Heritage Aviation

4. RocketRoute Launches Loyalty Program

RocketRoute is now offering a new loyalty program called RocketRoute Rewards. From ground handling and fuel to ground transportation and flight concierge services, customers can earn cash rewards that can be redeemed against any product or service within the RocketRoute shop. Also, the reward can be taken as cash back.

RocketRoute
www.rocketroute.com

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On Duty

D.C., announced that Board Member **Robert L. Sumwalt** will again serve as the agency's vice chairman following his designation as vice chairman by President Donald Trump.

▶ **OCV Control Valves, Tulsa, Oklahoma,** appointed **Megan Sutton** logistics and customer service manager responsible for overseeing import and export trade compliance, manage domestic and international shipment routings and work with its sales team. Most recently, Sutton served on OVC's executive administration team.

▶ **Pro Star Aviation, Londonderry, New Hampshire,** announced that **Matt Sargent** is joining the company's Challenger maintenance program at Manchester-Boston Regional Airport. Matt has nearly 30 years of corporate aviation maintenance experience.

▶ **Ross Aviation, Thermal, California,** named **Tim Goulet** general manager. Most recently, Goulet served as business development manager of Universal Weather and Aviation and is a board member of the Southern California Business Aviation Association.

▶ **San Diego County Regional Airport Authority, San Diego, California,** announced that **Kimberly Becker** has been named president and CEO. She will begin her position May 1, succeeding **Thella Bowens,** who is retiring on March 31. **Angela Shafer-Payne,** vice president of operations, will serve as interim president and CEO.

▶ **South Carolina Council on Competitiveness, Columbia, South Carolina,** named **Adrianne Beasley** has been named to replace Deborah Cameron as director of aerospace initiatives.

▶ **The Midlands Aerospace Alliance (MAA), Coventry, UK,** elected **Peter Smith,** chief executive and chairman of Nasmyth Group, vice chairman. The MAA is a regional aerospace alliance.

▶ **Universal Avionics, Tucson, Arizona,** announced that **Mike Marie** has been appointed to the position of regional sales manager for the Central U.S. Mike is based in Columbus, Ohio area. He has held positions with Sandel Avionics, DAC International, Avidyne and Ryan International. **Bruce Bunevich** now will represent the Southeast region. **BCA**

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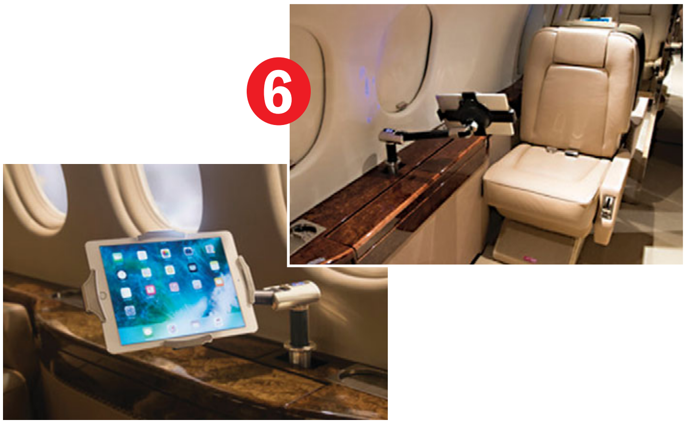
5. Universal Aviation to Provide Service and Training at PGGS

Universal Aviation Thailand will provide customer service and ramp safety training to PGGS, the dedicated ground handler for Koh Samui International Airport (VTSM). Universal will have team member based in Samui supporting PGGS. All invoices will continue coming from PGGS to avoid confusion in the market. The new parking and customer service changes will be implement by the end of May. Universal Aviation is also expanding its presence in the Asia-Pacific regional with the addition of Universal Aviation Maldives, a join venture with Inner Maldives. The base will be at Male International Airport (VRMM) and will begin operation by summer. Universal Aviation Maldives will provide ground support and supervision throughout the Maldives, including Male and Gan.

Universal Weather & Aviation
www.uni-wea.com

6



6. West Star Gets an STC for Falcon 900/900EX

West Star Aviation received an STC for the installation of Universal Serial Bus (ISB) cabin charging ports on Innov8 Cabin Solutions Cabin FLEX (CFLEX) Charge systems that features a USB charging option and a unique design that is interchangeable for all major PED devices with flexible solutions for corporate, personal, charter, fractional and VIP missions, with top and side ledge mounting options.

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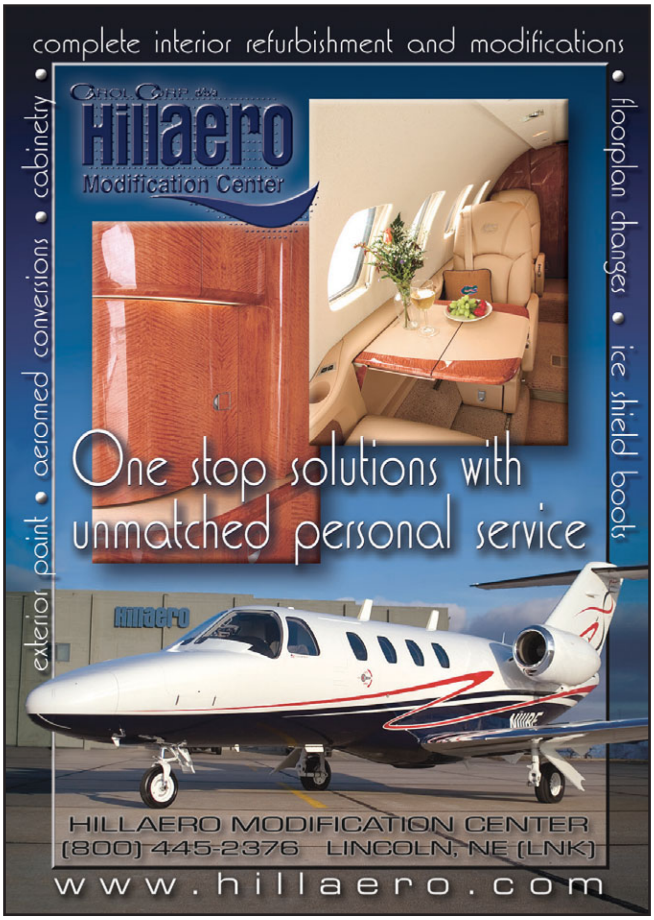

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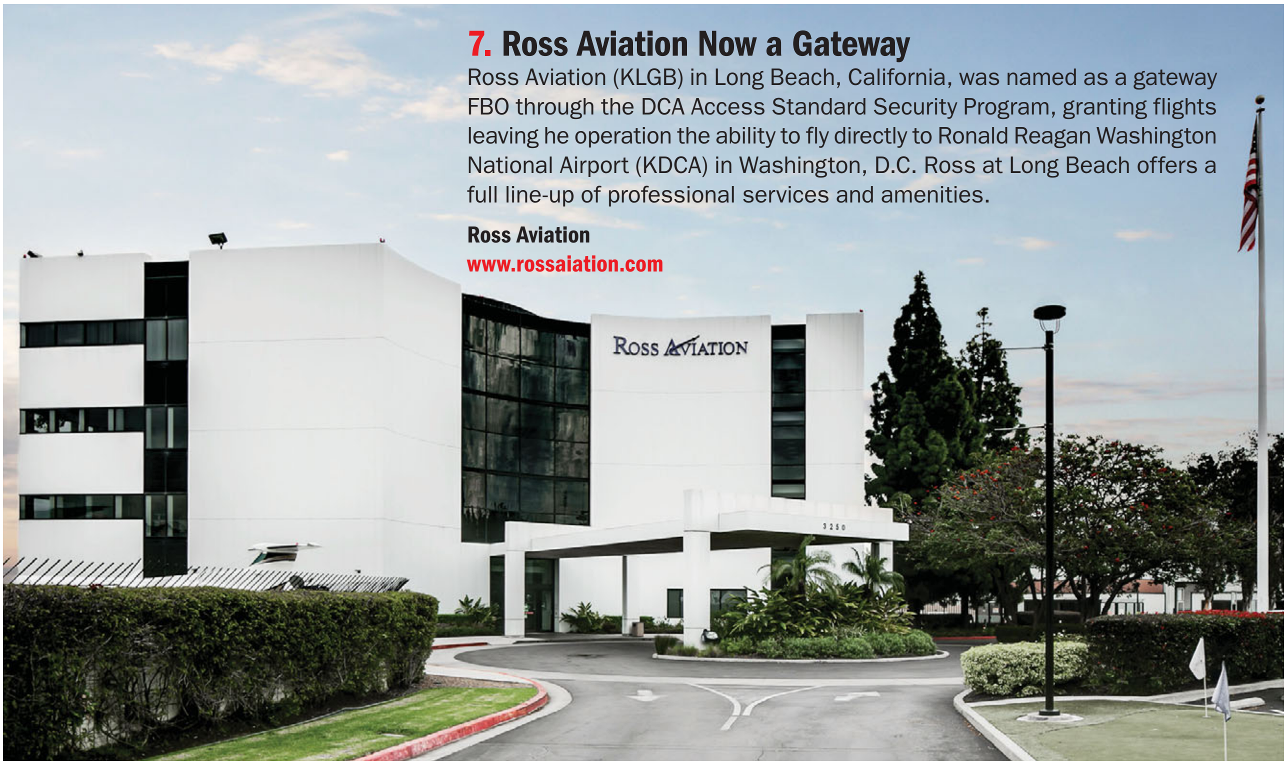
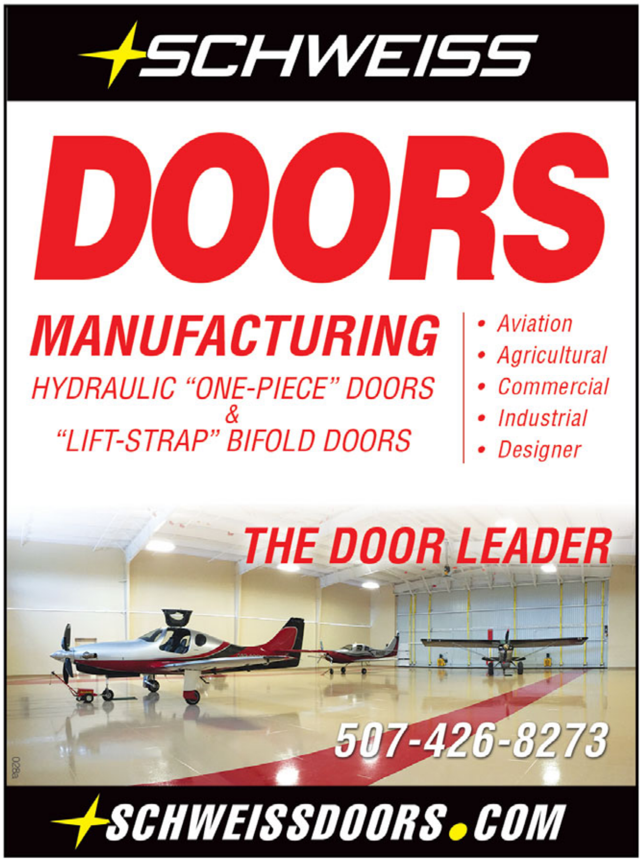


7. Ross Aviation Now a Gateway

Ross Aviation (KLGB) in Long Beach, California, was named as a gateway FBO through the DCA Access Standard Security Program, granting flights leaving he operation the ability to fly directly to Ronald Reagan Washington National Airport (KDCA) in Washington, D.C. Ross at Long Beach offers a full line-up of professional services and amenities.

Ross Aviation
www.rossaiation.com



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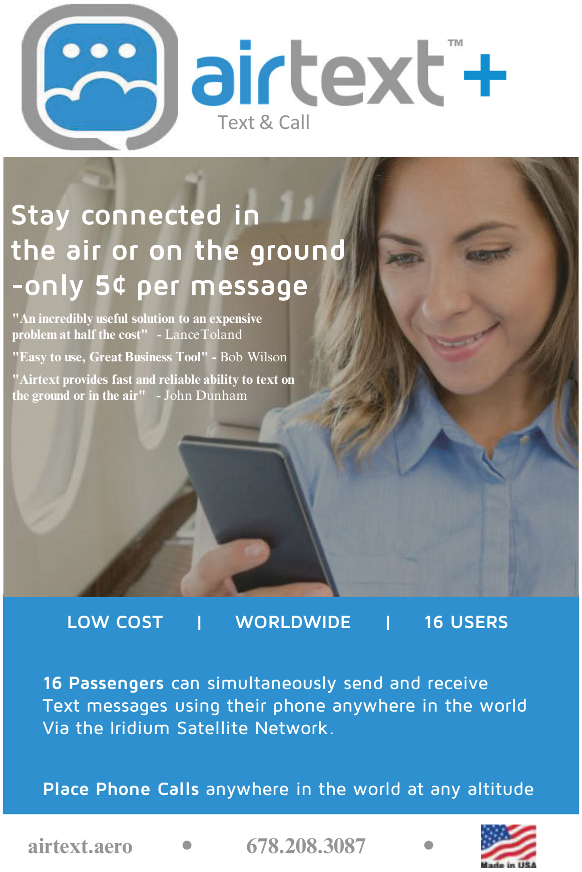
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May 1967 News

Our intent is not to use ***Time*** as a whipping boy. Other leading news media have also **been unjust in their treatment** of general aviation. . . .

Edited by Jessica A. Salerno *jessica.salerno@penton.com*

> **. . . General aviation if it is to fare well in the assemblies of public opinion better start reaching these men with the whole truth. We have a good story. Let's tell it**! – *BCA Staff*

Gates Rubber Co. of Denver has purchased controlling interest of Lear Jet with the acquisition of common stock owned by Bill Lear, some 60% of total outstanding. Unsubstantiated reports say $14 million, with $100,000 per year retainer to Bill Lear. It was also rumored that $5 million in bonds were involved in deal to settle the company's debts. Lear Jet was founded in 1962.

Cessna's Tandem Twin Super Skymaster, takes on turbocharging for 1967 with its new model that is priced at $49,950 offering top speed of 232 mph at 20,000 ft., service ceiling of 31,000 ft. New version has 4 passengers (5-6 passengers in air taxi configuration). Cessna uses the Lycoming TSIO-360-A/Bs, 210 hp each with max horsepower from sea level to 12,000 ft.

Business jet lease plan is offered by Remmert-Werner, distributor for North American Sabreliner. Termed "Investment Credit Lease," the intent is to make jets available on a trial/lease basis for long or short terms.

The first Riley Turbo Heron was certificated March 3. Bought by Robert Reed, former publisher of *Business & Commercial Aviation (BCA)*, the new plane is being leased to Virgin Islands Airways for routes connecting St. Croix, San Juan, Puerto Rico and St. Thomas.

Helicopter service from Teterboro and Westchester is now in operation. Fourteen flights daily fly between Teterboro and the Pan Am Building in Manhattan (a 5-min. flight) Fare is $6.00. Seventeen flights daily between Teterboro and JFK ($12.00). There are four daily flights between Westchester and JFK. **BCA**

THE ARCHIVE


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Business & commercial Aviation

STRETCHED SABRELINER

NEW HAPPENINGS IN GROUND TRAINERS
BUSINESS JETTING TO HAWAII
GULFSTREAM II PROGRESS
MERLIN II REPORT

Stretched Sabreliner, Series 60 from North American, is captured in flight through the window of a smaller Series 40 Sabreliner. Series 60 will be offered along with standard model, but using P&WC 3,300-lb. JT12A-8 turbojets. Stretched model weighs 20,000 lb. at takeoff, offers 25% more cabin room, 900 lb. more payload. Fully equipped price for Model Series 60 is around $1.3 million.


The new Cessna 310L for 1967

TWIN TRAILBLAZER

ack in the mid-fifties Cessna oneered the most advanced light in-engine airplane the world had er seen—the Cessna 310 for business d personal use. Now in its second cade, this ultramodern twin is more an ever the trailblazer . . . more an ever ahead with design refinements and innovations.

provements in the new 310L include ch things as a one-piece windshield. strument white panel lighting. New nding gear design softens landings d taxiing and allows gear extension t aircraft speeds up to 160 mph. olor-coded airspeed indicator for fast, curate scanning. Larger entrance eps. And much, much more!

The new 310L again has features that time and competition have never caught. It's the only twin in its class with Wing Lockers for carrying 240 lbs. of extra baggage outside the cabin . . . Stabila-tip fuel tanks . . . Vista-view side windows. It has the classic speed lines known throughout the world; interiors are unrivaled for comfort and handsome styling.

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The new Cessna 310L for 1967. Improvements in the new model include a one-piece windshield and white instrument panel lighting. The new landing gear design softens landings and taxiing, and allows gear extension at aircraft speeds up to 160 mph.

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