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Business & Commercial Aviation

CONTENTS MAY 2016

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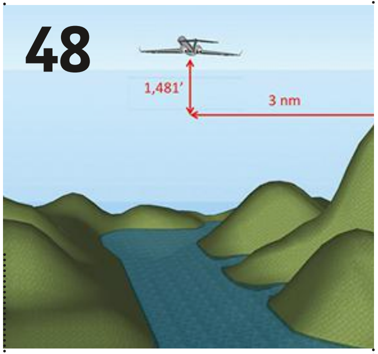
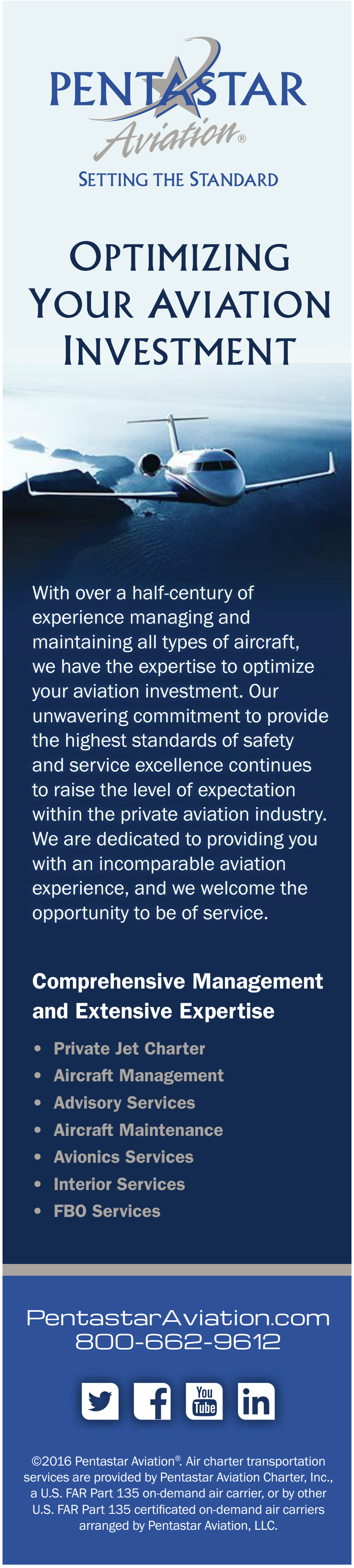


DEPARTMENTS



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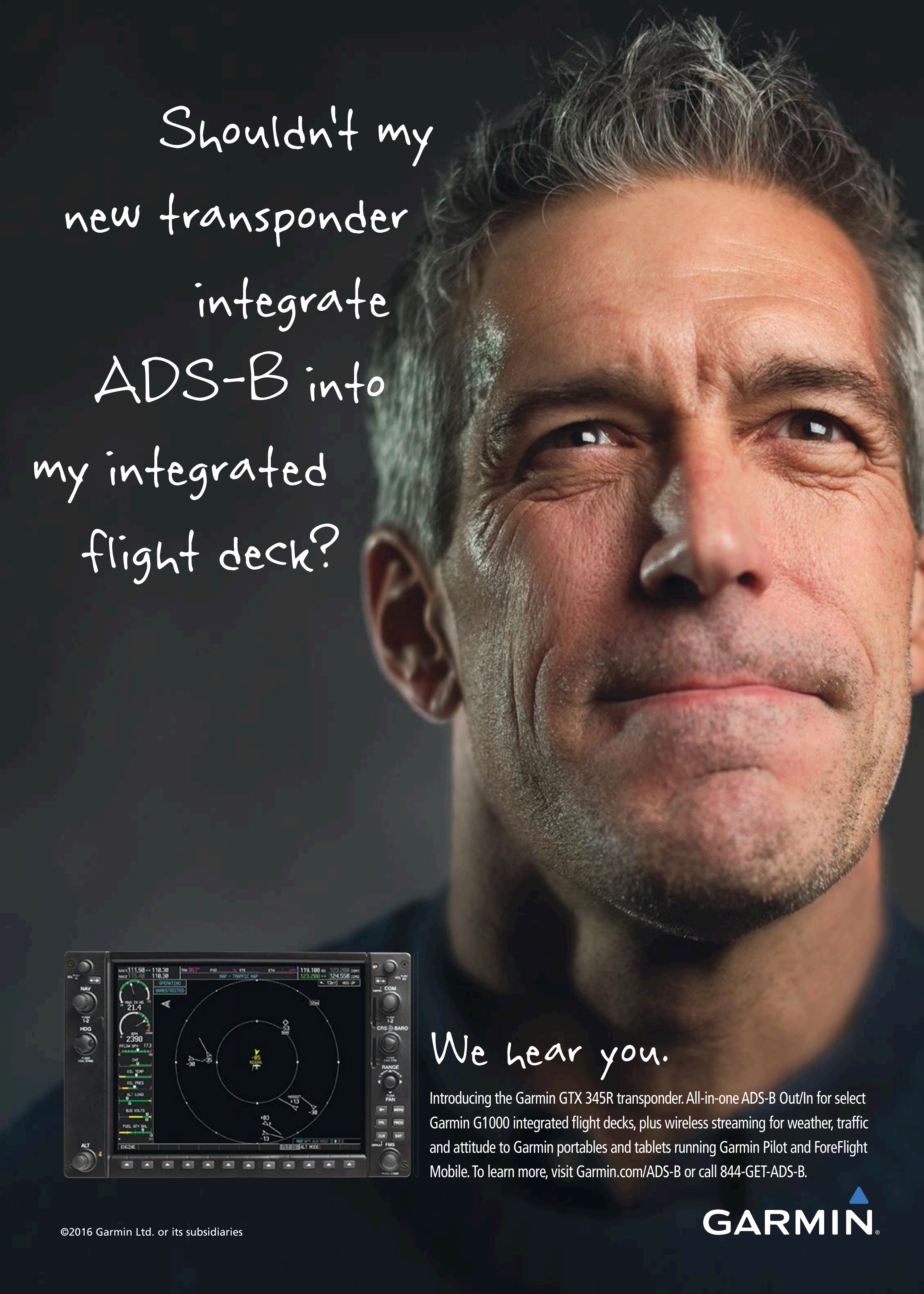

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my integrated
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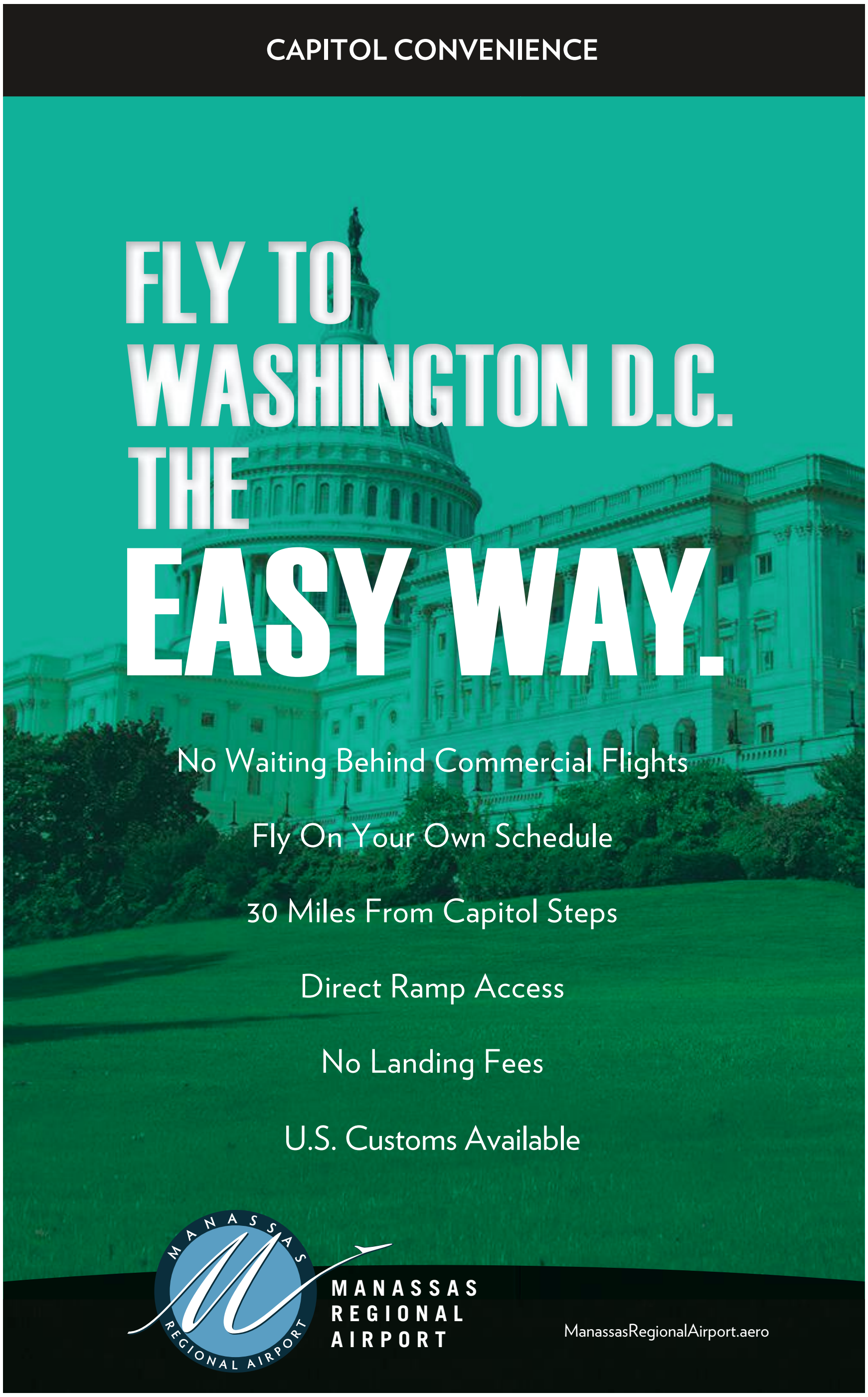

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The Opportunists

It's time for the **next great thing**

Tablemates (l to r): Ron Guerra, Bruce Whitman, Jim Waugh, Arne Louison, Peter McBride, Bill Watt, Matt Weisman, Joe Carfagna, author, Dick Van Gemert.

RECENTLY, I WAS ASKED TO identify business aviation's most significant aircraft. Impossible, I thought. But then adhering to the simple confines of the question, I finally posited that the first pressurized, turbine-powered aircraft designed specifically for executive travel was the true progenitor all that followed, and thus Leroy Grumman's "Gulfstream" was the one.

A logical choice, perhaps, but I suspected others might disagree. I polled our writers who made it abundantly clear that I was dead wrong, as did our readers when we posted the question on line. Their choices spanned from the Howard 500 to Gulfstream V and a host of models in between.

However, the clear favorite — by a lot — was Bill Lear's Model 23 (which traces its inception to Switzerland, by the way). That was the aircraft that stirred the public, simultaneously symbolizing speed, elegance, independence and, well, cool. "Learjet" became the generic name applied to all business jets (much to chagrin of its competitors and betters), and helped usher the second great event of business aviation, the embrace of turbine power.

The first was the arrival of those World War II veterans of the air battles over Europe and Asia who, for a variety of reasons, reentered civilian life as pilots of the oddball collection of converted military aircraft that served as the business community's nascent air fleet. Despite cantankerous radials, and an IFR system built upon radio ranges and the ADF, they created a new form of on-demand, private, aerial transportation that was surprisingly reliable and safe. It was these pioneers who set the stage for the business jets that followed. Everyone in business aviation today owes this group, most now gone, their enduring thanks.

Fortunately, one of them is not only still very much among the living, but was celebrated at a recent lunch hosted by FlightSafety International President Bruce Whitman at his company's Teterboro training center, and at which I was a guest.

The war over, B-25 pilot William B. "Bill" Watt was en route to a banking job in Oregon when an International Telephone & Telegraph representative invited him to stop by their New York office to discuss the new ILS technology, which he had helped test prior to his deployment overseas. The bank job went to someone else; ITT had a better offer. Watt became chief pilot of a flight operation with no airplanes, pilots or mechanics. He started from scratch.

"Business aviation hardly existed then," Watt, now 97, recalls, "But I could see it could have a huge future. Somebody had to try, and so I did. And it worked."

Fast forward to 1967. Then chief pilot for AT&T, Watt was approached by Matt Weisman, a 26-year-old fresh from the University of Pennsylvania School of Law, who had a passion for aviation and a big idea. Mainframe computers were then being leased and shared by different users. Weisman believed business jets could be managed similarly, increasing their utility, but he needed a business aviation vet to handle the operational details. Would Watt take the job?

Despite his age, 48, and with a daughter in medical school, a son in college, and holding one of the most coveted jobs in business aviation, Watt considered: Weisman was smart, eager, a good salesman and had a potent idea. He saw it as business aviation's next great thing. And he said, "Yes."

Although Watt was initially regarded as a turncoat by many chief pilots worried that Weisman's Executive Air Fleet (EAF) would kill their operations, those fears proved largely unfounded. By the time Weisman and company sold EAF to PHH (which subsequently sold to Jet Aviation) in 1982, its scores of clients included some of the most prestigious corporations in the U.S. — many new to aircraft ownership. As significant, the high standards and higher pay that EAF promoted ultimately helped boost those very things across the whole community.

Presently, another smart young man with another new idea for broadening the user base and upping aircraft utilization came on the scene. Richard Santulli's NetJets disrupted business aviation's status quo, causing worry among those who viewed fractional ownership as a threat, but providing a way in for hundreds of companies attracted by the tax and price appeal of shared ownership. In time the structure proved so popular that NetJets built the largest fleet of business jets in history. That growth was further expanded a decade later by another disruptive, high-utilization concept originating with entrepreneur Kenny Dichter — the "jet card."

It seems to me the time is ripe for business aviation's next great idea. Supersonic travel? By-the-seat charter? Uber aviation? Drones? I've not a clue. However, it is likely to have two characteristics — it will increase aircraft utilization, and worry those who fail to see the opportunity. **BCA**

Readers' Feedback

NTSB Decision Puzzling

I just finished reading "Icing and Failed Equipment" **(Cause & Circumstance, April 2016)** and while I seldom disagree with the National Transportation Safety Board (NTSB) as their investigation depth is second to none, in this case I have to say that their probable cause decision is puzzling.

I don't have a lot of Citation time, but I've logged a lot of hours in King Airs and Turbo Commanders — enough to think that airframe icing at altitude is probably not a large factor in this accident. While icing is a valid consideration as to workload, I cannot see how it alone would be enough in this particular airplane to cause departure from controlled flight.

One exception would be failure of an engine due to icing with improper pilot responses, but the article indicated that both engines were still running.

Another exception might be a stall/spin event due to perhaps an attempt to exceed climb capability in an effort to climb out of the icing conditions. But in this case the wing loading was so high, that according to the article, the wing separated from the fuselage. That speaks to very high airspeeds and inability to properly correct the situation. A stall/spin or the classic graveyard spiral? Either way, the wing goes down, the nose goes down, airspeed spikes then up elevator is applied to try to correct the excessive airspeed.

What caught my eye were evidently multiple flight instrument malfunctions that were inadequately addressed. That there were so many problems with both left- and right-side instruments, I have to think that the fault was not one particular instrument, but some unresolved problem in the entire flight instrument system.

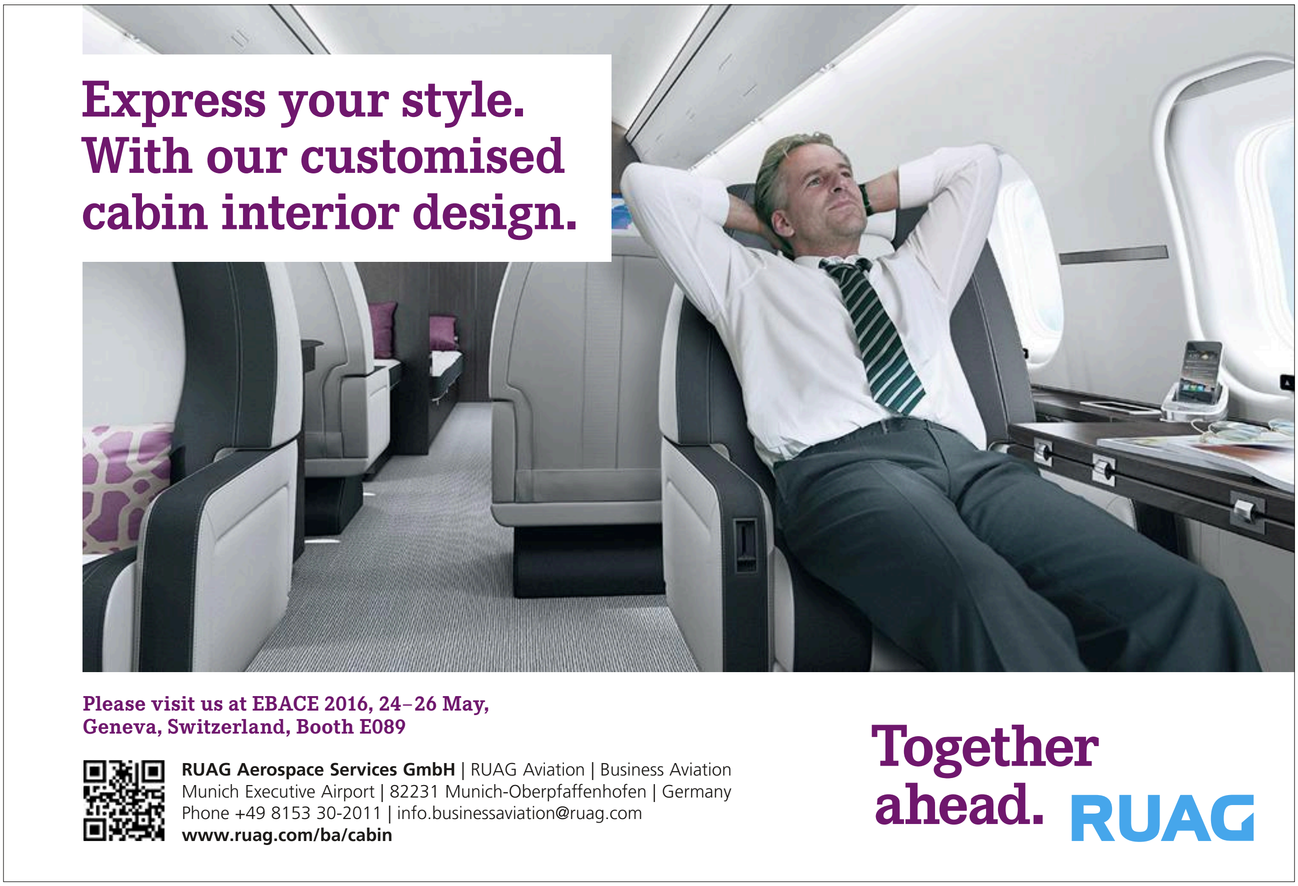
As the underlying cause of such multiple malfunctions was never identified, I think it quite likely that the pilot encountered a failure of one or both artificial horizons and outside adequate visual reference was not available.

It's likely that he lost the left-side horizon and did not adequately cross reference with the right-side horizon, or even worse, could have lost BOTH of the horizons because of an unidentified underlying system fault.

I did not see any evidence of a standby horizon in the published photo. I would assume that there was a Turn and Bank instrument in the airplane, but that can be an inadequate reference if not practiced on a regular basis -- especially in a high performance airplane.

Failure of multiple essential flight instruments being the primary reason for spatial disorientation makes much more sense to me.

Over 30 years ago I was repositioning a King Air 200 from Portland to Seattle for maintenance. The problem was that the pilot-side ADI (horizon) was totally missing from the airplane. I did have an operating autopilot and an operating



right-side horizon. But even though it was a clear summer day, I found that without the pilot-side horizon to provide reference, it was extremely difficult to fly the airplane well when above about 10,000 feet, even in VFR conditions.

On my last B767 recurrent, they gave me a double engine failure at 1,000 ft. AGL. Surprisingly, there was enough energy to make a 180 turn and get back on the ground.

However, when the generators went down, we lost both left and right ADI's. The battery-powered standby horizon was still working, but even though I had been looking at the thing for thousands of hours, I found it very difficult to transition to that little instrument in the middle of the panel, and very difficult to fly precisely. While it was always in our scan, it was not something we ever practiced.

That's a good lesson for having three attitude sources, and I think, in high-performance airplanes, and that means MORE than the old T&B as the third source.

Now, there are a lot of apps for smart phones and iPADs that will generate a horizon, something to think about when flying an airplane with known or suspected instrument problems. They all take time to generate — something lacking if the problem occurs in IFR during climb-out. But again, you have to be thinking about it ahead of time.

Once the wing goes down and he nose follows, bad things happen quite rapidly.

Mike Ward
Captain, Delta Airlines (Ret.)
Award Aviation Consulting
Orcas Island, Washington

Author's response: I have to agree with your analysis. In reading the full report and the docket I came away thinking that the initiating factor was the failure of the attitude sensor/display some time before the accident flight and the operator's apparent failure to address that malfunction with appropriate maintenance, inspection and post-maintenance testing. Once he made the decision to depart with known attitude instrument problems, he was stacking the deck against himself during his subsequent encounter with challenging, single-pilot IMC. You are correct, I think, in assuming that the airplane exceeded structural limits after the upset due to overspeed near the end of the descent or due to overload during an attempt to pull up once he became visual. I was never that proficient at making a rapid, comfortable transition from big glass to the peanuts. The only time I had to do it in anger was with an inverter failure in a small jet. Fortunately, it was shortly after takeoff in reasonably easy IFR.

Hate Stunts

"Showtime" (**Viewpoint, April 2016**) was a nice editorial. I recall watching some kid kill himself trying a car-to-plane transfer. He got as far as getting on the rope ladder and then froze, eventually lost his hold and fell. There was nothing about it that advanced the state of the art. Then I just missed seeing Gordie McCollum, Joe Hughes's wing walker, get killed at Reno; he was atop the inverted airplane when it sank and hit the runway. His wife was watching as were tens of thousands.

So, I'm all for display aerobatics, but I hate stunts.

George Larson
Goose Creek, South Carolina

Expectations?

Well done on "Showtime" (**Viewpoint, April 2016**). Since reading it, I have been wracking my feeble brain to think of just one spectator sport that folks go to see without any expectation of witnessing someone win, lose, experience the unexpected, get hurt, avoid getting hurt etc. etc. The only difference between today's spectacles and those of Roman times is that at the end the Emperor does not officially give a thumbs up, or down!

Robert Baugniet
Savannah, Georgia

Great Learning Experience

"Crunch Time in the Cockpit Tests CRM" (**Cause & Circumstance, February, 2016**) is an excellent article and would be of great benefit to all professional aviators. The event that it recounts is a tremendous story of teamwork, cool headedness under intense pressure and very impressive professionalism. Your article does this compelling story justice and provides a great learning experience for us all.

Capt. Charles Cox
Member, National Training Committee
Allied Pilots Association
American Airlines
Ft. Worth, Texas

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INTELLIGENCE

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NEWS / ANALYSIS / TRENDS / ISSUES

THE FAA HAS SELECTED TWO UNLEADED aviation fuels for further testing as it works to develop an acceptable lead-free "drop-in" replacement for 100LL avgas. **The new fuel formations for Phase 2 testing are from Shell and Swift Fuels.** The test data will help the companies acquire an ASTM International Production Specification for the fuels. It also will eventually allow the FAA to authorize the existing general aviation fleet to use the unleaded replacement. Testing will begin this summer and conclude in 2018. Some 167,000 general aviation aircraft currently rely on 100LL, and constitute the only vehicles still requiring leaded fuel. The lead additive creates the high-octane levels required for high performance aircraft. The Piston Aviation Fuels Initiative (PAFI) is a government and industry partnership that is facilitating the development and deployment of an unleaded aviation fuel. **Congress has appropriated $7 million for the fiscal year 2016 budget to support the test program at the FAA Tech Center in New Jersey.** In June 2013, the FAA requested fuel producers to submit their replacement fuel proposals for evaluation. As a result, it received 17 formulations from six companies. It then evaluated the fuels according to their impact on the existing fleet, the production and distribution infrastructure, impact on the environment, toxicology and the cost of aircraft operations. In 2014, the agency chose four fuel formulations for the PAFI Phase 1 test program. That testing concluded last December. The FAA said that after reviewing the Phase 1 data, it selected the two fuels that would have the least impact on the general aviation fleet, and on fuel production and distribution infrastructure. **General Aviation Manufacturers Association President and CEO Pete Bunce called the program "critical to the future of general aviation."** Ultimately the transition to an unleaded fuel, he said, "will mean the continued safety and utility of the fleet, a reduced environmental impact, and lower economic transition costs for our industry."

APRIL 1ST, BOMBARDIER ANNOUNCED it had received a firm order for **20 Challenger 350 jets,** but declined to identify the buyer "for competitive reasons." Based on the 2016 list prices for standard-equipped aircraft, the firm order is **valued at approximately US$534 million.** David Coleal, president, Bombardier Business Aircraft, noted the popular model's lead in the super midsize class, adding, "It's simply one of the best business jets in the market."

IN EARLY APRIL, BELL HELICOPTER SIGNED A LETTER OF INTENT (LOI) with PT Whitesky Aviation of Indonesia for **30 Bell 505 Jet Ranger X helicopters.** The aircraft will be used for air taxi operations throughout the nation which is made up of more than 14,000 islands. **PT Whitesky CEO Denon Prawiraatmadja said, "The Bell 505 allows us to safely, reliably and comfortably transport our customers at a very competitive cost throughout Indonesia, the fastest growing economy in Southeast Asia."** Based in Jakarta, the charter operator's current fleet consists of three Bell 429s and three Bell 407s. The Bell 505 cruises at 125 kt. (232 km/h), has a range of 360 nm (667 km) and a 1,500 lb. useful load. It features a Garmin G1000H cockpit and is powered by a Turbomeca Arrius 2R engine with dual channel Full Authority Digital Engine Control (FADEC). Bell reports 380 LOIs for the new aircraft, which is priced around $1 million, from corporate, VIP and utility operators around the world.

Jet-A and Avgas Per Gallon Fuel Prices

April 2016

Jet-A

Region	*High*	*Low*	*Average*
Eastern	$7.60	$3.55	$5.32
New England	$6.60	$3.08	$4.52
Great Lakes	$7.30	$2.78	$4.75
Central	$6.99	$2.50	$3.99
Southern	$7.73	$3.25	$5.26
Southwest	$6.43	$2.35	$4.41
NW Mountain	$6.78	$2.70	$4.49
Western Pacific	$7.19	$2.95	$4.97
Nationwide	**$7.08**	**$2.90**	**$4.71**

Avgas

Region	*High*	*Low*	*Average*
Eastern	$9.31	$4.20	$6.24
New England	$7.45	$3.95	$5.33
Great Lakes	$9.26	$3.90	$5.90
Central	$7.80	$3.60	$5.14
Southern	$8.75	$3.20	$5.71
Southwest	$8.32	$3.10	$5.23
NW Mountain	$8.43	$4.55	$5.63
Western Pacific	$8.62	$4.30	$6.18
Nationwide	**$8.49**	**$3.85**	**$5.67**

The tables above show results of a fuel price survey of U.S. fuel suppliers performed in April 2016. 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.

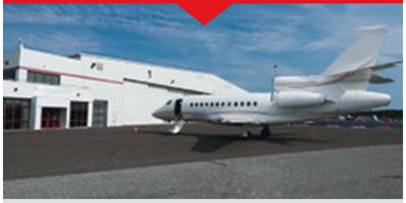
For additional information, contact Aviation Research/U.S. Inc. at (513) 852-5110 or on the Internet at www.aviationresearch.com

For the latest news and information, go to **www.bcadigital.com**

Executive AirShare Moving Kansas City Headquarters

Executive AirShare is moving its headquarters to a 10,000-sq.-ft. facility in Lenexa, Kansas, to accommodate growing flight operations, sales, accounting and executive teams, the company said. Executive AirShare's aircraft, pilots and maintenance teams for Executive AirShare and its subsidiary Executive Flight Services, an aircraft management and charter company, will continue to operate out of the Atlantic Aviation's fixed base operations at Charles B. Wheeler Downtown Airport in Kansas City. They employ nearly 200 workers, including 96 pilots. "Coupled with our ongoing presence at Wheeler Airport and locations in Oklahoma, Texas and New York, we feel well positioned for a continued upward business trajectory," says Harry Mitchel, Executive AirShare's chief operating officer.

BBA Aviation Sheds Six FBOs



BBA Aviation, the biggest U.S. operator of business jet service facilities, has sold six fixed base operations for $190 million to affiliates of KSL Capital Partners, a private equity firm. The sale allows BBA Aviation to satisfy U.S. Department of Justice requirements for regulatory approval of the acquisition of its U.S. competitor, Landmark Aviation. BBA will use the proceeds from the sale of the FBOs to repay debt. In September 2015, BBA announced the deal to buy Landmark from the Carlyle Group for $2.1 billion, which doubles its size.

ACCORDING TO THE 2016 GLOBAL FLEET & MRO MARKET ASSESSMENT released at a Capitol Hill briefing by the Aeronautical Repair Station Association, the U.S. civil aviation maintenance industry — often an unseen part of the aviation industry — **employs more than 270,000 people and generates $43.1 billion in economic activity.** The March event was part of ARSA's annual Legislative Day and headlined by House Aviation Subcommittee member Carlos Curbelo (R-Fla.). It was attended by aviation maintenance industry executives and congressional staff. More than 3,800 U.S. firms throughout all 50 states perform maintenance, repair and overhaul services, the report says. About 90% of the firms are small-to-medium-size businesses that employ 50 or fewer people. "For policymakers, the major takeaway from this report is that, although you may not know it, the aviation maintenance industry is part of your state's economy," ARSA Executive Vice President Christian Klein says. "There are important issues looming in the House and Senate FAA bills that will affect maintenance businesses and their hundreds of thousands of employees nationwide. Each member of Congress needs to pay attention and be mindful of the consequences." Repair stations face important challenges over the next decade. "Repair stations will have to manage continually increasing cost scrutiny from air carriers and other operators and find ways to leverage new technologies in materials, production, flight data and maintenance techniques," ARSA says. **The new generation of aircraft coming into the market over the next 10 years means MROs around the world will need to adapt to new technology to maintain profitable margins,** says Steve Douglas, vice president of CAVOK, a division of Oliver Wyman. "Data sharing will become very important with new-generation aircraft and the self-monitoring of systems and components, resulting in gigabytes of data generated on each flight," Douglas says. "Properly leveraged, this data is capable of alerting the operators and the MRO of the health of the aircraft systems."

A NEW FORECAST BY THE FAA PREDICTS that the number of turboprops, business jets and rotorcraft in the active general aviation fleet will increase over the next two decades, although the largest segment of the fleet, fixed-wing piston aircraft, is expected to shrink. The agency said the long-term outlook for general aviation is favorable, though the active fleet **should increase by just 0.2% per year from 2015 to 2036. It expects that count to grow from last year's 203,880 to 210,695 in 2036, or fewer than 7,000 aircraft in 20 years.** The number of active turboprops is expected to grow from 9,570 aircraft in 2015 to 12,635 in 2026, an increase of 3,065. Meanwhile, business jets are projected to grow from 12,475 to 20,770, up 8,295 aircraft. The number of piston aircraft, however, is forecast to drop from 138,135 in 2015 to 118,855 by 2036, a decline of almost 20,000 airplanes. Not surprisingly, the agency believes the roster of active general aviation pilots will continue to decline — by about 5,000 per year through the next two decades. That's 100,000 pilots gone. However, offsetting that is a forecast increase of air transport pilots by 13,600 per year.

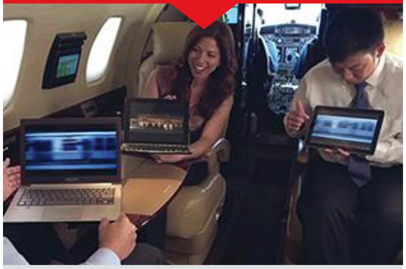
FIVE YEARS AGO, THE FAA FORECAST THE NUMBER of small unmanned aerial systems (UAS) operating in U.S. airspace would grow to 25,000 by 2020 and 30,000 by 2030. In its latest forecast, the agency revised that number somewhat. Now it expects sales of some **7 million small hobby and commercial drones a year by 2020.** At the same time, the FAA has released is latest update on UAS sightings by pilots, controllers and the public. The 583 reports submitted between Aug. 22, 2015, and Jan 31, 2016, represent a substantial increase in the daily rate of sightings over the 765 between Nov. 13, 2014, and Aug. 15, 2015.


75
CHALLENGER 650
GLOBAL 6000

Cessna Makes AOA Standard 172 Equipment

Cessna Aircraft announced that it is now making Safe Flight's angle-of-attack system standard equipment on all Cessna Skyhawk 172 aircraft and optional on its Skylane 182 and Turbo Stationair 206.

Clay Lacy Aviation Partners With SmartSky



Clay Lacy Aviation has partnered with SmartSky Networks to offer hardware sales, certification and installation of the SmartSky 4G network on Gulfstream G200, GIV-SP and GV aircraft. SmartSky's technology delivers a secure signal that locks onto each aircraft in the network, the company said. Passengers will be able to stream, chat, call, game and video conference. Visit: **http://smartskynetworks.com/earlybird2016/**

▶ **SAFRAN'S NEARLY THREE-YEAR DELAY** in development and certification of the Silvercrest engine has slowed Dassault's Falcon 5X considerably, but **Cessna says it's had no impact on its Hemispheres program.** The new engine has been in the running to power Textron Aviation's newest Citation. But in a statement, a spokeswoman says while it has not yet announced an engine provider, the Hemisphere program is on schedule, with first flight expected in 2019. Initially planned for the beginning of 2015, Silvercrest engine certification is now not expected until 2018. Difficulties with the engine, designed for business jets in the super midsize category, were discovered during testing. Among other concerns, high temperatures caused engine-case distortion. Announced at the 2006 National Business Aviation Association convention, the engine is designed for 9,500-12,000 lb. of thrust, is expected to have 15% better fuel consumption than current engines in its class, will increase range by 30% and reduce noise and emissions.

▶ **THE POTENTIAL MAINLAND CHINESE BUSINESS** aircraft market is perhaps six times as large as the current fleet, research based on the buying and chartering capacity of the country's rich people suggests. **Already, 1,420 people in mainland China have the potential to own business aircraft,** according to estimates gathered by luxury publisher and rich-list compiler Hurun Report and Minsheng Financial Leasing. The purchasing potential of those people is 1,750 aircraft, the companies say. In addition, 9,000 Chinese mainlanders could charter business aircraft. Their potential demand amounts to 205,000 flight hours annually, which works out to 680 more jets if averaging 300 hr. of usage a year. The implied total of 2,430 aircraft — used by their owners or available for charter — compares with 300 business aircraft in mainland China at the end of 2015, as estimated by Hong Kong consultancy Asian Sky Group. A further 166 business aircraft were based in Hong Kong, Macau and Taiwan, many belonging to mainlanders. Importantly, since the figures are based entirely on estimates of personal wealth, they cannot include corporate purchases and charters for transporting managers other than rich proprietors. That potential element may not be large, however. So far in China, aircraft are predominantly used to transport business principals. **Among mainland China's 100 richest people, 32 have business aircraft**, according to the report.

▶ **SUSAN SHEETS BROGAN, WHO SERVED FOR 20 YEARS AS PRESIDENT** of the National Aircraft Resale Association and as a business aviation advocate in Washington, died April 7 after a short battle with cancer. She was 63. Brogan worked in collaboration with the National Business Aviation Association and other Washington trade groups to advance the interests of aircraft owners and pilots. A proud private pilot and a former French and Latin teacher, she began her aviation career in 1980 with French aircraft manufacturer Aerospatiale, now Airbus Helicopters. A well regarded, personable and energetic aviation insider, she also served as president of the International Aviation Club, president of the Aero Club of Washington and secretary of the International Aviation Women's Association. Most recently, she was director of special programs for Jetnet IQ, the forecasting and advisory service for aircraft research firm Jetnet. And she had her own consulting firm. She is survived by her husband, Mike.

JetSuite Adds to Its Charter Fleet

Light jet charter operator JetSuite is adding 10 Embraer ERJ 135LR aircraft to its fleet of Embraer Phenom 100 and Cessna Citation CJ3 jets. The first of the 30-seat ERJ 135s has been delivered by Embraer, with the rest to follow by mid-2017. The aircraft will be available for booking, with charter flights beginning this month. The new jets can be chartered for $8,000 per hour plus sales tax, which equates to less than $300 hourly per seat for 30 passengers.

Blackhawk Authorizes Wipaire As Dealer

Blackhawk Modifications in Waco, Texas, has appointed Wipaire's Leesburg, Florida, facility as an authorized dealer and installation center for Blackhawk XP series engine upgrades. The facility recently completed the installation of Blackhawk's newly FAA-certified engine upgrade, the 867-shp PT6A-140 engine upgrade for the Cessna Caravan.

▶ **ON APRIL 14, THE CORPORATE ANGEL NETWORK** (CAN) launched its 50,000th flight, carrying one-year-old cancer patient Baron Yerbe and his parents back to Atlanta after receiving his treatments at Memorial Sloan Kettering in New York. Diagnosed with retinoblastoma, a rare form of eye cancer, at three months of age, the little boy has been undergoing treatment available only at Sloan Kettering. The flight, conducted by NCR, flew from Teterboro Airport in New Jersey to Cobb County International Airport - McCollum Field. Founded in 1981 and based at Westchester County Airport in White Plains, New York, CAN's sole mission is to provide otherwise unoccupied seats aboard business jets to cancer patients traveling to and from treatment centers. **Today, 530 companies have pledged those seats to the organization, which in turn provides them to 225-250 patients per month.**

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▶ **NEARLY TWO YEARS AFTER THE LAST** E-4B flew from Boeing's Wichita, Kansas facility — along with Boeing — a new large aircraft completions center has opened inside the former Boeing hangar. **Emerald Aerospace is leasing two of three large hangar bays where Boeing employees once performed modification and maintenance** on commercial and military aircraft, including E-4Bs and VC-25s, or Air Force One — all military versions of the civilian 747. And as it grows, Emerald intends to lease the third hangar bay. The company plans to specialize in VIP, Head-of-State and executive fleet completions and has already received FAA Part 145 certification. "Our core business is Boeing and Airbus aircraft," Ahmed Bashir, Emerald's chairman, CEO and majority owner. According to Bashir, Emerald has its first customer for interior completions work on an international head-of-state aircraft. Eventually, it plans to expand into defense and special mission work, such as modifications for intelligence, surveillance, maritime patrol, interdiction, medical evacuation and airborne mapping and photography. The company has hired 26 employees so far, the majority of them former Boeing Wichita employees experienced in all aspects of modifications of Boeing commercial and military aircraft. "We didn't have to reinvent the wheel," said Bashir, who himself has spent 27 yr. in the completions industry. In five years, Emerald hopes to grow annual revenue to $200-$300 million and employ 600 to 700 people. Expansion into military work would increase those figures, Bashir said. Boeing announced in 2012 that after more than 85 years it was exiting Wichita and putting its 413-acre site with 1.9 million sq. ft. of manufacturing, office, storage and hangar space up for sale. Local investors formed Air Capital Flight Line and purchased the facilities in late 2014.

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▶ **GULFSTREAM AEROSPACE HAS WON FAA APPROVAL** to install mandated avionics upgrades, called Future Air Navigation System (FANS) 1/A+, on Gulfstream GIV-SP aircraft. FANS 1/A+ uses automation and satellite-based technology to improve aviation communication, surveillance and traffic management. **The active fleet of GIV-SP aircraft totals 325.** "Like our solution for GV aircraft, this system was developed by Gulfstream and Honeywell to fully integrate the GIV-SP flight deck," says Derek Zimmerman, Gulfstream Product Support president. "It is not a stand-alone system. The full functionality of the flight management system — autothrottle, autopilot, vertical navigation — is retained." **After Jan. 30, 2020, aircraft without FANS 1/A+ will not be allowed to operate in Minimum Navigation Performance Specification airspace,** which includes most North Atlantic routes. The installation on a GIV-SP requires new hardware, including a communications management unit, a transceiver and a cockpit voice recorder with data link recording ability.

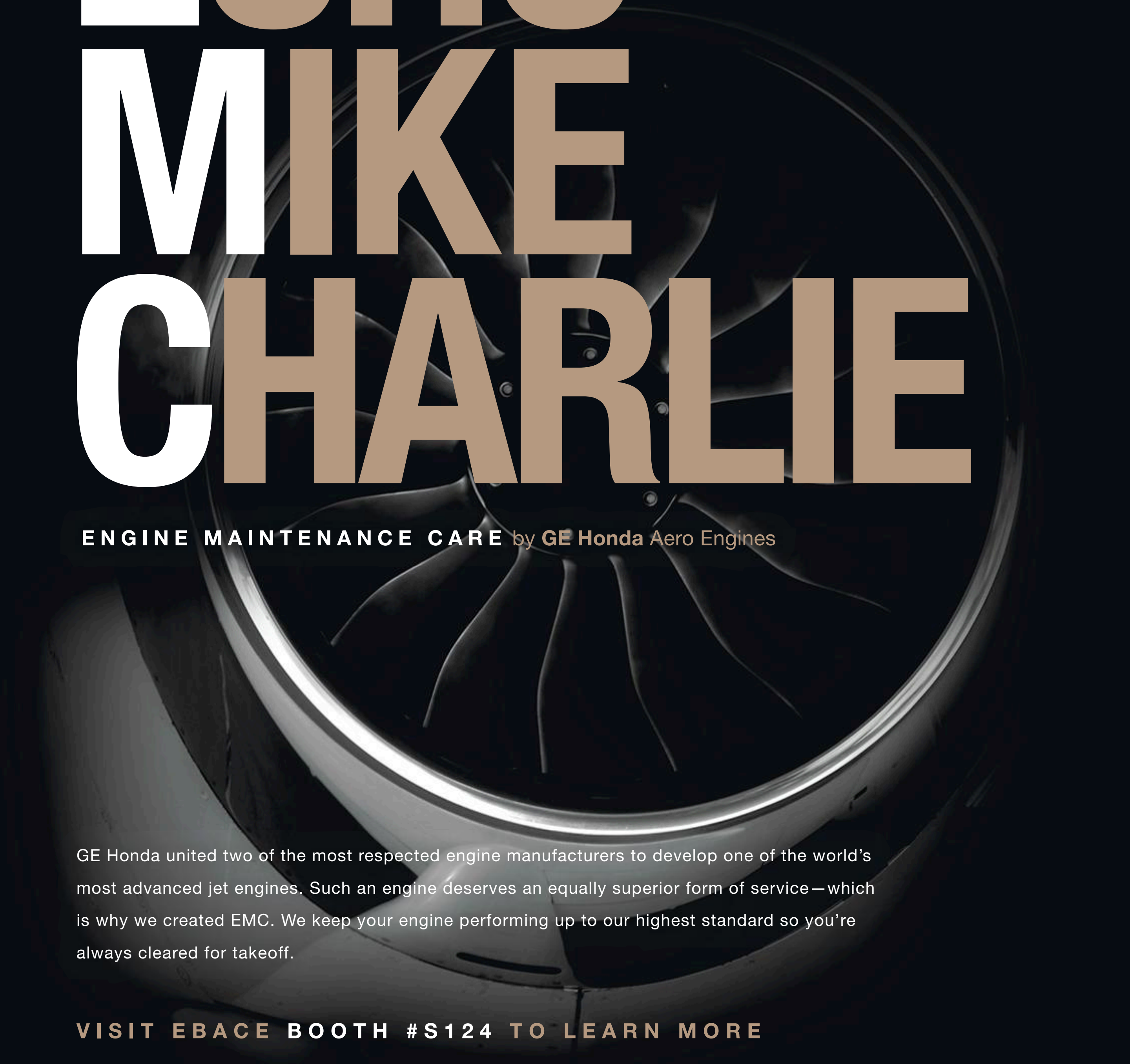
Carter Looking for Partners

Carter Aviation Technologies, LLC *wants to build a larger, twin-turbofan version of its slowed rotor/compound helicopter, which it believes can break the rotorcraft world records for speed, range, and altitude. "We expect to achieve speeds in excess of 400 kt., distances greater than 2,000 nautical miles, and altitudes of over 50,000 ft.," says Jay Carter, president and CEO of Carter Aviation Technologies. To achieve this performance, the aircraft would be fitted with two Honeywell TFE731-20 turbofans, which deliver enough power to enable the aircraft to break the time to climb record for rotorcraft as well. According to Carter, the configuration will make an ideal VTOL business jet that could provide point-to-point transportation for up to six passengers and cruise at 400+ kt. for up to 2,000 mi. Based in Wichita Falls, Texas, Carter says it is looking for partners to help complete the detailed design, fabrication of the aircraft, to be followed by "the record-breaking demonstration of this exciting new CarterCopter configuration."*

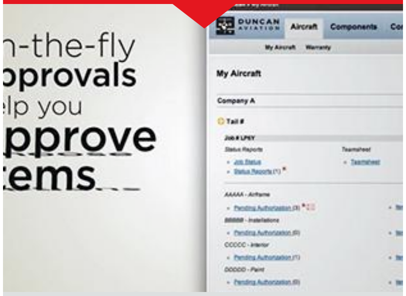
▶ **GOGO INC. HAS ROLLED OUT NEW** hourly pricing plans for turboprop and light jet operators, which the company says will make connectivity affordable and predicable for all aircraft operators. **The new service plans start at $39 per hour and do not require the purchase of block hours have no minimum monthly fee.** After paying for the first hour, customers then pay only for what they use and incur fees only when the service is being used. "After speaking with owners in the turboprop and light jet markets, the feedback we received was that predictable pricing plans are important," said Andy Geist, senior vice president of sales for Gogo Business Aviation. "So we created the new hourly plans with the customer in mind to offer plans with predictability and no overages." Two service plans will be available starting July 15: the ATG 1000, which enables high-performance email with attachments, voice and text, at $39 per hour, and the ATG 2000, which facilitates inflight Web browsing and email, as well as most apps, at $99 per hour.

▶ **THE NUMBER OF AIRPORTS WITH** Controller-Pilot Data Link Communications (CPDLC) technology is growing rapidly and initial results of the digital service are impressive. **Universal Avionics' Cessna Citation VII, outfitted with the company's Future Air Navigation System (FANS) 1/A+ system, recently tested the new CPDLC capability at Kentucky's Louisville International Airport-Standiford Field (SDF). After logging on to the tower, the pilots received a full ATC clearance in 22 seconds.** Not only does the capability save time and eliminate the chance of simultaneous transmissions blocking each other or confusion over what's being said, it can hasten movement. As Carey Miller, Universal's manager of Business Development explains, if a wind shift causes a runway change, "All of the aircraft in line for departure will have to receive a new voice clearance which can take quite a bit of time, whereas with CPDLC-DCL, you receive the new clearance via data link and you're ready to go."

▶ **GEN. J. R. JACK DAILEY, DIRECTOR OF THE SMITHSONIAN'S** National Air and Space Museum, took the wraps off a larger than **life-size bronze statue of R. A. "Bob" Hoover at a private reception at the Steven F. Udvar-Hazy Center on April 2, 2016.** "Bob Hoover has been an eye witness to the history of aviation. He's the only pilot ever to taxi his (Aero Commander Shrike) airplane into this hangar. And that's a record we intend to let stand forever," Dailey said. The event honoring the famed World War II fight pilot and pioneering test and show pilot marked the culmination of a two-year effort by Greg Herrick, president of the Aviation Foundation of America, to design, build and fund a lasting tribute to a man who many regard as the foremost ambassador of the aviation industry. "Jimmy Doolittle called him the 'greatest stick-and-rudder man who ever lived,'" Herrick recalled. "He's known as the pilot's pilot. To all of us in this room, Bob Hoover is simply the man we love — he is our hero. This statue is oversized to show how much we honor this man." Aerobatic champion Sean D. Tucker was the first person to contribute to the Bob Hoover statue fund drive. "There's never going to be another Bob Hoover," Tucker said. "He makes us better human beings. We're all Bob Hoover's air force." The AOPA, among other organizations, also is funding a Bob Hoover trophy to be awarded **annually to "a living aviator who exhibits the airmanship, leadership, and passion for aviation and life** demonstrated by R.A. 'Bob' Hoover during his distinguished career as a pilot and aviation advocate while also serving as a source of inspiration and encouragement for current and prospective aviators."

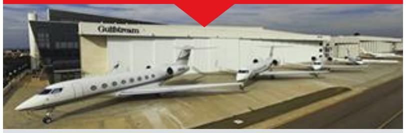


Duncan Launches New Feature to myDuncan



Duncan Aviation has launched an electric logbook feature to myDuncan, a web-based project management system. The feature allows customers to view logbook entries in real-time and categorized by airframe or engine and communicate with inspectors through the system. Duncan, introduced in 2006, allows customers to monitor the progress of maintenance or upgrades through email alerts, job status reports and updates with hour and cost estimates.

Gulfstream Brazil Services First Argentine-Registered Aircraft



Gulfstream Aerospace Corp.'s service center in Sorocaba, Brazil, has performed maintenance on its first Argentina-registered aircraft, a large-cabin Gulfstream business jet. Gulfstream Brazil was awarded maintenance authorization approval from Argentina's Administracion Nacional de Aviacion Civil in August. Last year, Gulfstream Brazil performed work on 92 aircraft.

DASSAULT AVIATION'S FALCON 8X ultra-long-range business jet is entering the final stages of its flight test and certification program as the company prepares for initial delivery. FAA and European Aviation Safety Agency (EASA) certification of the trijet is expected by midyear, with entry-into-service by late summer, Dassault said. **Three aircraft are in the flight test program, have flown more than 650 hr. in 325 flights and have nearly completed all certification test requirements.** In the meantime, production and support activities are ramping up. The 21st Falcon 8X has moved into final assembly in Bourdeaux-Merignac, France, and six aircraft are in completion in Little Rock, Arkansas. Dassault Aviation has completed work on a new hangar in Little Rock to handle Falcon 8X completions, and has started work on a new six-bay hangar at Bourdeaux-Merignac in order to provide additional maintenance and repair for 8X and 7X aircraft. The third Falcon 8X flight test aircraft, s.n. 03, is beginning a global test campaign to demonstrate aircraft operational reliability and performance in different conditions of flight. In the next 30 days, the aircraft will travel through Europe, the Middle East and North and South America. **The campaign will include more than 60 missions representing the extremes of what Falcon 8X customers might expect to face in the aircraft's operational life, it said.** It will pay particular attention to cabin equipment and functionalities, and other high-speed communications systems during long, intercontinental flights and flights over remote areas. "We are delighted and thrilled with the way the Falcon 8X program is proceeding," said Eric Trappier, chairman and CEO of Dassault Aviation. "The flight test campaign has been flawless and the aircraft will be in initial customers' hands this summer, just as planned when we launched development three years ago." The Falcon 8X, announced in May 2014, is a derivative of the Falcon 7X. It flew for the first time on Feb. 6, 2015.

ITALY'S TECNAM HAS ROLLED OUT THE P2012 TRAVELLER, a piston twin aimed at meeting demand for a new small airliner to replace types such as the Cessna 402Cs operated by Cape Air. Capua-based Tecnam says Cape Air will be the launch customer for the new model, but adds that details of the Nantucket, Massachusetts airline's commitment are confidential until the first flight, expected this summer. According to Tecnam, Cape Air has been involved in joint development of the 11-seat aircraft and members of its leadership team were present at the roll-out on April 1. **The Traveller is powered by two Lycoming TEO-540-C1A piston engines and features a Garmin class cockpit.** Cape Air operates 83 Cessna 402Cs, and has a requirement for a next-generation twin-piston aircraft able to carry nine passengers and their bags at least 200 nm. at a cruise speed of at least 180 kt. A new aircraft will cost more, but Cape Air expects the higher ownership cost to be offset by lower fuel burn, reduced maintenance and higher utilization requiring fewer spare aircraft. The airline says 67% of its scheduled commuter flights are less than 100 nm.

Walter Da Costa, Stan Bernstein, Giovanni Pascale, Paolo Pascale, Jim Goddard

BOMBARDIER BUSINESS AIRCRAFT'S BOMBARDIER WAVE, Wireless Access Virtually Everywhere, has been awarded a supplemental type certificate from Transport Canada. Bombardier WAVE is a high-speed Ka-band Wi-Fi service for Global 5000 and Global 6000 aircraft. Certification follows extensive flight hours and rigorous testing aboard Global business jets, the company said. The equipment allows passengers to stage a video conference, browse the Internet or stream online shows.

INTERVIEW BY **WILLIAM GARVEY**

Questions for Rhett Ross

Rhett Ross

President and CEO
Continental Motors Group, Ltd.
Mobile, Alabama

A mechanical and nuclear engineering graduate (ME and BS) of the University of Florida, Ross served as a U.S. Navy submarine officer for six years before joining the civilian world where he helped develop fuel cells and other alternate energy technologies for use on earth and in space. He was installed as president of Teledyne Energy Systems in 2001 and six years later assumed the same post at Teledyne Continental Motors, a major producer of avgas-fueled aircraft engines. When China's AVIC acquired Continental for $186 million in 2011, it not only retained Ross but added to his responsibilities two years later when it bought bankrupt Thielert Aircraft Engines, the German diesel maker, rebranding it Technify and putting it under Continental, along with three MROs. Although a private pilot, Ross spends most of his flying time in airliners to visit customers and colleagues in Continental's growing global network.

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

1

What concerns have you, if any, regarding FAA's push for a lead-free replacement for 100LL avgas?

Ross: Technically, I don't worry about the science of it. Changing the chemical nature of a fuel is complex. We've got to look at all the angles — materials, compatibility, vaporization and more. But it can be done. My concerns involve ensuring all the things are in place when we finally bring it to the marketplace. What happens at an airport once a leaded tank goes empty, for example? And we need to teach pilots about the differences regarding the new fuel: what if there's avgas in one wing and the new fuel in the other?

2

Will this new fuel impact diesel engines and their desirability?

Ross: I view the benefits of diesel as totally independent from getting the lead out of gasoline. Diesel's appeal is as a true global fuel. Any reasonably significant airport, even grass strips, have Jet A. Not so with avgas. In addition, everybody's driving for better efficiency and lower emissions. While diesel doesn't zero out emissions — I'm a heretic in some circles for saying that — it can reduce them. And it burns less fuel than avgas engines for the same result. It's more efficient. While avgas is relatively cheap in the U.S., it's two to three times more expensive than diesel fuel in Europe, and in Africa and Asia avgas can cost as much as $50 a gallon, if available at all. Furthermore, we believe the [fuel] economics in the U.S. are starting to shift. Our diesels are gaining traction in the marketplace.

3

There's a good bit of experimentation underway with electric power. Could that succeed in aviation?

Ross: As we try to find ways to further reduce emissions, the solutions might not be as viable as people think. I began in fuel cells in 1993 working on contracts with Ford, GM, Honda, Fiat and others. Fast-forward to 2016 and I still can't buy a fuel cell-powered car. The technology works, but it's expensive and complex and there are compromises in the fuel. A zero-emissions electric airplane is a desirable goal, but not likely with the current near and mid term power cycle mix. The primary source of battery power comes from nuclear, coal or natural gas-fed powerplants. So, while that airplane may not be polluting at the airport, it's simply putting those emissions into the atmosphere at a different location. And there are emissions involved in making the batteries. You have to look at the total cycle.

4

Some saw AVIC's acquisition of Continental and Thielert as signaling imminent explosion of general aviation in China. Hasn't happened.

Ross: China doesn't have a lot of general aviation pilots and it's extraordinarily concerned about safety. They don't want the industry to get a black eye. Nothing really moves fast there, but when it does start to take off, it's something. When I first went to China 15 years ago, there were bikes everywhere and relatively few cars. By the beginning of this decade, however, you couldn't find a bike and there were traffic jams everywhere. Aviation will be the same. Continental has a decent fleet, both gas and diesel, there now and sales and parts capability. Next, we'll probably establish an MRO partnership and there's a growing need for production in China to serve the companies developing aircraft there. In China, a company has got to be first, and be a big dog. That's what we intend.

5

So, how's your Mandarin?

Ross: Unfortunately, I'm a language idiot. I took lessons and can follow conversations well enough. What I can't do is effectively speak it. However, my Chinese boss has challenged me to become fluent, so I'm going to give it one last college try. **BCA**

Switzerland Aloft

Perhaps inspired by their mountains, the **Swiss** have proven to be **aeronautical innovators**

BY **PATRICK VEILLETTE** jumprsaway@aol.com

From legendary STOL aircraft linking remote communities to a round-the-world quest in a flying machine powered on nothing but the sun's rays, the innovations of Swiss engineers, pilots and explorers have done much to improve our collective quality of life on this planet.

Switzerland ranked first in the World Economic Forum's "Global Competitiveness Report 2015-2016," and first in the Global Innovation Index in 2015.

If one considers the relatively small country's considerable aeronautical advances, it's natural to ponder if there is an entrepreneurial, educational and innovative spirit in Switzerland that places special value on bold exploration of technological possibilities.

Solar Circumnavigation

Born into a dynasty of explorers and scientists, physician/aeronaut Bertrand Piccard dreamt of combining science and adventure to tackle one of the greatest challenges of our times — sustainability. From this dream emerged the idea of a round-the-world aircraft powered solely by the sun.

In 2002, he presented the concept to the Ecole Polytechnique de Lausanne (EPFL), whereupon engineer and professional pilot Andre Borschberg immediately agreed to launch a feasibility study. Undeterred by critics who predicted such an aircraft would be "too big, too light and impossible to control," a multi-disciplinary team of 80 engineers and technicians spent the next 12 years transforming the dream into the reality of the Solar Impulse 2.

Spanning 72 meters — 40 ft. more than a Boeing 747-400's — the wing is blanketed with monocrystalline silicon solar cells, as are the fuselage and horizontal tailplane — 17,248 of them. An ultrathin polymer layer protects the photovoltaic cells from water and UV radiation. Energy efficiency had to achieve remarkable levels for the thing to work. The solar cells are 23% efficient, which is to say that 23% of the solar energy hitting the surface is transformed into direct current electricity. By comparison, the average efficiency of solar cells currently being installed on residences ranges from 11 to 15%.

Four motors, each generating 17.4 hp, are fitted with a reduction gear limiting

SCUBALUNA/ISTOCK PHOTO

SOLAR IMPLUSE

Bertrand Piccard (left) and Andre Borschberg with Solar Impluse.

the rotation speed of the 4-meter diameter propeller to 525 rpm. The motors are 97% efficient, versus 70% for standard internal combustion engines.

In order to achieve the lightest weight possible, engineers used a combination of carbon fiber covering a honeycomb core of alveolate foam in the entire frame of the airplane. Insulation made from the foam protects the cockpit and the pods housing the motors and batteries.

Even the aircraft's flight profile is designed to save energy. During daylight the aircraft climbs to 8,500 meters (27,887 ft.) as the solar cells provide sufficient energy not only for the steady energy consumption by the propellers but also for battery charging. When daylight fades the motors are throttled down and the plane starts to glide down to 1,500 meters (4,921 ft.), consuming almost no electricity in 4 hr. At that point the pilot powers up the motors again, drawing energy from the batteries until daybreak when solar energy again feeds power to the motors and recharges the batteries.

Since pressurization would be too costly in weight, the aircraft carries supplemental oxygen. However, with outside air temperatures ranging from -40C (-40F) to +40C (+104F), the cockpit structure features high-density thermal insulation to help moderate temperature swings from -20C (-4F) to +35C (+95F). Throughout, the pilot is strapped into the confines of a tight space for many days and nights while enduring these uncomfortable (and potentially life-threatening) conditions. Adding further to the difficulty is the need for the pilot to have exceptional stamina to control this plane, which is sensitive to turbulence because of the light loading of its vast wing.

The pilot is in contact by satellite with the Monaco Mission Control Center, where a team of weathermen, mathematicians, air traffic controllers, planning engineers and flight director gather to monitor the aircraft's performance and condition in real time and to devise flight strategies. Preparation for the flight, during which the solo pilot has to endure days of confinement, included hypnosis, meditation and yoga, along with simulator and free-fall training.

The first leg started on March 9, 2015, at Abu Dhabi, UAE, to Muscat, Oman. The 13-hr., 1-min. flight was flown by Borschberg. Subsequent stops included Ahmedabad and Varanasi, India; Mandalay, Myanmar; Chongqing and Nanjing, China; Nagoya, Japan; and then in its longest leg to date, onward to Kalaeloa, Hawaii, in an astounding 117-hr., 52-min. flight. That Pacific leg smashed a number of longstanding records, including the longest duration solo, nonstop flight ever made and the longest solar-powered flight, both in terms of duration and distance.

The preparation for the record-setting leg started a chain of events that grounded the aircraft in Hawaii and necessitated a redesign, causing a delay that put its next leg outside of the acceptable weather for making the second Pacific leg. While in Nagoya, the Solar Impulse 2 encountered harsh weather on the runway, and the team prudently decided to conduct a test flight before attempting the trans-Pacific leg. In retrospect, more time was needed to cool the lithium polymer batteries between flights. A high climb rate and over-insulation of the motor gondolas caused the battery temperature to rise during the record flight.

Demanding such performance out of the batteries revealed the necessity for an automatic cooling and manual backup system. The redesigned system has a safety backup so that if the automatic system fails, the pilot can control the air inlet so that it does not stay fully open and freeze the batteries, or stay closed causing an overheat.

Engineers arrived in Hawaii last winter to install the new batteries along with the revised ventilation and cooling system. On Feb. 26, 2016 test pilot Markus Scherdel completed a 1-hr., 33-min. flight from Kalaeloa, climbing to 8,000 feet to check the aircraft stabilization and cooling systems. At the time of writing this report, takeoff was tentatively scheduled for April 2016 with Piccard at the controls for the 100-hr. flight from Hawaii to Phoenix.

Obviously, the Solar Impulse 2 is an utterly impractical, experimental flying machine, but that was never really its purpose. Rather, says Piccard, its intent is "to convey messages."

"We do not plan to revolutionize the

The Pilatus PC-12 has attracted a large group of customers who currently operate over 1,300 airplanes worldwide. The PC-21 includes the same tandem-seating configuration of its predecessors and features a full glass cockpit.

aviation industry," he explains, "but instead to demonstrate that the actual alternative energy sources and new technologies can achieve what some consider impossible."

The project's website further notes, "If an airplane can fly day and night without fuel, everybody could use these same technologies on the ground to halve our world's energy consumption, save natural resources and improve our quality of life."

Visit: **http://www.solarimpulse.com**

Parabolic Flights Leading to Medical Discoveries

Modern science has done wonders to improve the quality of life, but diseases and the aging process continue to negatively affect human health. One of the tools being employed to further our knowledge base is parabolic flights since these enable researchers to observe phenomena in physiology, biology, material science, fluid science, combustion and atomic physics that are otherwise "masked" by the effects of gravity.

For 10 years faculty members at the University of Zurich, an institution that has produced 12 Nobel laureates, have participated in weightless experiments organized by Novespace, a subsidiary of CNES, the French space agency. Novespace owns and operates a highly modified Airbus A310 "Zero-G" transport used by customers worldwide to conduct research under microgravity. Since 1989, 10,000 scientists have been involved in such flight programs.

During a parabolic flight maneuver, once the aircraft is in steady horizontal flight at 503 mph (437 kt.), the pilots begin a 1.5- to 1.8-g pull-up for 20 sec. When the aircraft reaches 404 mph (351 kt.) at roughly 47 deg. of nose-up pitch, the pilots push over into a "zero g" flight path. When the aircraft reaches the apex of the flight path at approximately 242 mph (211 kt.), the pilots begin a nose-down pitch. Upon again reaching 403 mph (351 kt.) and 47 deg. of nose-down pitch, the pilots begin to pull out of the dive. The aircraft is in a zero-g state for approximately 20 sec.

Previously, all of the parabolic flights had been conducted in France with research organizations working with CNES, ESA (European Space Agency) and DLR (German Aerospace Center). In September 2015, the Zero-G aircraft was re-located to the Dubendorf Air Base near Zurich as the operating base for two flights to conduct experiments for the University of Zurich and other Swiss universities and research institutions. On Sept. 22, 2015, the Zero-G aircraft flew 15 parabolic maneuvers. Not only was this flight campaign the first to be flown outside of France, but it also was the first time it formed a partnership with a foreign university.

What endemic human health problems are the Swiss hoping to solve? Organ and tissue loss is a costly medical problem, and researchers are looking for alternative means for growing complex tissues in a much faster manner. In a microgravity environment tissues such as heart cells, cartilage and nerve regeneration have grown more rapidly. Medical research in microgravity is also advancing knowledge in toxicology, eye irritation, skin corrosion/irritation and vaccine development.

Plasma particles grown in a laboratory under the effect of gravity develop a strictly two-dimensional layer. However, under microgravity, plasma crystals grow in a three-dimensional condition, allowing the use of physical plasmas in novel therapeutic applications. For example, they are capable of killing bacteria without damaging the surrounding tissue and have been shown to stimulate tissue regeneration. The research teams are exploring how this novel field can develop future antimicrobial therapies.

Microgravity allows researchers to study aging, bone and muscle degeneration, cardiovascular deconditioning, balance disorders, disturbed circadian rhythms and reduced immune response. Bone loss during long duration space flights is a serious risk. Microgravity research is necessary for the identification of preventive interventions.

The Swiss project's main sponsor is H. Moser & Cie., a manufacturer of "haute horlogerie" watches. Additional funding was raised by selling weightless "discovery flights" to the general public. Those monies helped enable the University of Zurich scientific teams to conduct their experiments on board the Zero-G Airbus.

The findings from these parabolic flights will hopefully some day contribute to a better quality of life for us all.

Versatile Aircraft in Austere Environments

The Pilatus Aircraft product line underscores Chairman Oscar J. Schwenk's belief that "You can only succeed in this market if you are innovative in all sectors." The Stans, Switzerland, manufacturer has been building rugged, versatile aircraft since 1939 and today tallies nearly 3,500 of them in active service throughout the world. (The company's headquarters sits at the base of the mountain for which it was named — Mount Pilatus.)

Pilatus' heritage traces back to the gathering storm that became World War II. Adamantly neutral, the country's military authorities felt it important to create a native airplane maintenance and manufacturing facility deliberately located in central Switzerland, well away from its borders. Workers at the fledgling enterprise developed the SB-2 Pelican in 1940, designed primarily for use in mountainous regions such as their own.

It wasn't until 1959 that Pilatus broke onto the international market with its rugged Pilatus Porter PC-6, initially powered by a 360-shp piston engine. Though ungainly in appearance, the Porter provided short takeoff and landing (STOL) capabilities from all types of unprepared, rough and short airstrips, in all weather, at high altitudes and in all climates. In 1961, a turboprop engine replaced the piston mill, thereby creating the Turbo Porter. A vivid in-cockpit flight video of a Pilatus Turbo Porter landing and taking off from remote villages in Indonesia can be seen at **https://www.youtube.com/watch?v=ik32TsceQHY**.

Pilatus equipped the Porter with low-pressure tires, twin-clipper disc brakes and an undercarriage with high bump absorption to withstand operations on rough terrain, but it could also be modified to accommodate sandy, stony, soft, muddy, snow or water operations as well. Operators of the Pilatus Porter prize its 3-cu.-meter cabin, which is easily accessed through two large, sliding doors on both sides. Those also permit easy removal of passenger seats.


AIRBUS

A highly modified Airbus A310 "Zero-G" transport is used by customers worldwide to conduct research under microgravity.

The Turbo Porter holds the world record for highest landing by a fixed-wing aircraft at 18,865 ft. (5,750 meters) on the Dhaulagiri glacier in Nepal. The model remains in active use by many militaries and law enforcement agencies around the world, as well as civil operators,

Jetman

If you haven't yet seen the video of Yves Rossy and Vince Reffet flying formation alongside an Emirates Airbus A380 at 4,000 ft. over Dubai on Oct. 13, 2015, stop reading this now and go immediately to **http://www.jetman.com**. This extraordinary aerial ballet will make your day.

The flight was led by an aviation professional with impressive credentials — and a much higher sense of adventure than most of us. Rossy was trained as a fighter pilot in the Swiss Air Force, where he flew the Dassault Mirage III, Northrop F-5 Tiger II and Hawker Hunter. He subsequently piloted Boeing 747s for Swissair and later for Swiss International Air Lines. An avid parachutist, Rossy began experimenting with a wing-suit concept in 1999. This ultimately evolved into the current design, which employs a carbon-fiber, 120-lb. wing. Thrust is provided by four tiny jet engines. At the conclusion of the flight, a parachute deploys from the wing's center section.

The daring aeronaut is not shy attempting noteworthy flights. On Sept. 26, 2008, he leapt out of a helicopter at 8,200 ft. over Calais, France. Reaching speeds of over 125 mph, he made the 22-mi. flight over the English Channel in 13 min., celebrating the achievement with a series of celebratory loops.

In November 2009, he leapt from a small plane at 6,500 ft. above Tangier, Morocco, attempting to cross the Strait of Gibraltar. Strong winds and cloud banks forced Rossy to ditch in the water just 3 mi. from the Spanish coast. He was in the water unhurt for 10 min. when his support helicopter picked him up.

On May 7, 2011, Rossy leapt from a helicopter and flew for more than 8 min. above the canyon rims on the Hualapai Reservation in the Grand Canyon. It took several years to gain the authorizations to conduct the flight, which got the final green light only an hour prior to launch.

Formerly sponsored by Breitling and often photographed in formation with the Breitling Jet Team, he is now sponsored by Dubai and has renamed himself "Jetman Dubai." **BCA**


PILATUS

particularly those who specialize in providing humanitarian service to remote locations. Recent upgrades including installation of Garmin G950 avionics provide improved situational awareness while reducing workload.

Training military aviators for highly demanding maneuvers and tactics requires an aircraft with exceptional performance but an affordable price. The Pilatus PC-7 tandem-seat high-performance trainer powered by the Pratt & Whitney Canada PT6A series was first flown in 1978 and has proven to be a popular training aircraft for both civil and military pilots. A total of approximately 450 aircraft have been sold to customers in 21 countries.

In 1961, a turboprop engine replaced the piston mill, thereby creating the Pilatus Turbo Porter.

In 1986, Pilatus launched the PC-9. Equipped with the 950-shp PT6A-62, the 5,180-lb. aerobatic aircraft has a sea level rate of climb of 3,880 fpm. With structural limitations of +7.0 g to -3.5 g and the latest version equipped with a dual glass cockpit, the aircraft's excellent performance and agile handling make it a capable platform for training student pilots in basic maneuvers and advanced flight training. Instructor pilots sitting in the rear seat have an elevated seating position to give them better forward vision. Over 260 advanced trainer PC-9/PC-9 M aircraft have been sold to 15 air forces around the world.

In 1995, a modified version of the PC-9 was jointly selected by the U.S. Navy and Air Force to serve as their primary pilot training aircraft. Designated the T6A/B Texan II, it is built and marketed independently by Beechcraft through an agreement with Pilatus. More than 500 T6A/B trainers have been delivered and in addition to the U.S. military, the aircraft is now flying with the militaries of Canada, Greece, Israel, Iraq, Mexico, Morocco, New Zealand and the U.K.

During a June 2015 site visit to Stans, I had the opportunity to watch Swiss Air Force pilots fly the Pilatus PC-21, its latest generation turbine trainer, and readily admit to being envious. It is a vast improvement from the noisy, steam-gauge-equipped T-37 "Tweet" I flew in the brain-baking heat of Columbus, Mississippi. The PC-21 includes the same tandem-seating configuration of its predecessors and features a full glass cockpit with three large, color LCDs, head-up displays, hands-on-throttle-and-stick (HOTAS) controls and zero-zero ejection seats. The PC-21 is such a capable platform that new Swiss pilots transition straight from it to the Boeing F/A-18. It is currently utilized as a highly effective training platform for pilots in the air forces of Switzerland, Singapore, United Arab Emirates, Saudi Arabia and Qatar. These diverse operating environments include desert

World's Highest Helicopter Rescue

"Challenging" would be an understatement for helicopter rescue operations in the alpine environment. Constantly unpredictable winds, high altitudes, the quick changing nature of mountain weather and hover-out-of-ground all combine to shave safety margins razor thin.

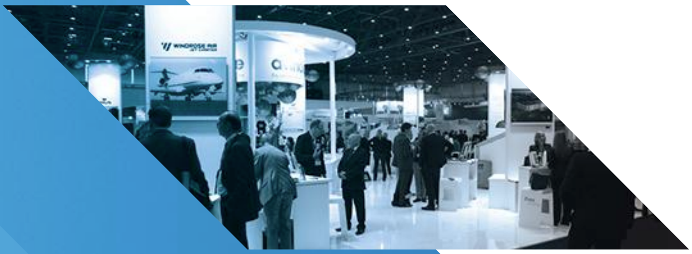
Since 1968, Air Zermatt has been rescuing stranded mountaineers from alpine peaks and out of crevasses near the Matterhorn. The extreme conditions of these rescues required innovative solutions that Air Zermatt rescue service has developed and refined.

One of these methods is known as the "long line." What this involves is delivering a rescuer to the site while dangling from a long cable attached to the bottom of the rotorcraft. For an exciting display of this method (warning for acrophobes . . . this video will trigger your adrenalin), search YouTube for the title "Longline Rescue of Alpinists by Air Zermatt" shot by the Swiss Television Schweizer Fernsehen for a documentary (**https://www.youtube.com/watch?v=7PaGJgeMYiw**).

The video shows rescuer Kurt Lauber suspended by a longline as the Lama helicopter above deftly carried him to a precipice where mountaineers are stranded. It is an impressive visual illustration of remarkable airmanship . . . not to mention Lauber's cool confidence while dangling thousands of feet in the air! This method has enabled rescue of climbers and snow sport enthusiasts from nearly impossible-to-reach locations.


AIR ZERMATT

An Air Zermatt crew performed the highest helicopter rescue in history on April 29, 2010, when pilot Daniel Aufdenblatten and mountain rescue specialist Richard Lehner took off in their Ecureuil AS350 B3 to pluck a stranded three-person mountaineering team from 23,000 ft. up on Annapurna in Nepal. The rescue took three attempts in part because Lehner suffered a lack of oxygen while suspended on the rescue line during the 10-min. flight to the accident site. But they prevailed and saved three lives. For this extraordinary achievement the rescuers received *Aviation Week & Space Technology*'s Laureate for Heroism Award the following year. **BCA**



climates with temperatures climbing to 45C (113F) and wind-blown fine grains of sand, conditions that are unfriendly to high-performance turbine equipment, austere conditions for which Pilatus engineers have developed plenty of expertise.

The wing of the PC-24 is of advanced design to enable the jet to cover the range of performance requirements from short takeoffs and landings to operating efficiently at 45,000 ft.

PILATUS

The highly capable PC-12 is popular in many roles around the globe, including executive transport, cargo, air ambulance, airline and government special missions. The aircraft's large cabin, single-pilot operations, long range, low operating costs, high speeds and short-field capability have attracted a large group of customers who currently operate over 1,300 PC-12s. The 330-cu.-ft. cabin is an iconic feature of the aircraft, aided by ease of exit and entry through the 52-in.-by-53-in. cargo door. The latest version is the PC-12 NG, which features a Honeywell Primus Apex avionics suite and SmartView, a synthetic vision system that displays a natural 3-D rendering of terrain, providing a view that pilots normally see only on a clear day. The value of SmartView is tremendous when executing the tricky approaches and departures into mountainous airports.

Recent drag reduction efforts by Pilatus engineers have increased the PC-12 NG's maximum speed to 285 kt. The new five-blade graphite composite propeller designed specifically for the PC-12 NG by Hartzell reduces cabin noise levels, improves takeoff and climb performance, reduces life cycle maintenance costs and is easily repairable in the field. At maximum gross takeoff weight, the aircraft can climb to a cruise altitude of 28,000 ft. 10% quicker, and maximum range has been extended to 1,840 nm with four passengers and VFR fuel reserves.

One of the best examples of the aircraft's utility is in the service of the Royal Flying Doctor Service of Australia (RFDS). The organization uses its fleet of PC-12s to provide life-saving emergency medical services to remote, unimproved locations in the Australian Outback. The RFDS, which is supported by governments, as well as generous donations from communities and corporations, transports an average of 148 patients at remote isolated locations each day. **(See the PC-12 NG Pilot Report on page 56.)**

The volume of the PC-12 cabin allows it to be configured with two patient litters and three passenger seats, along with intensive care medical equipment. A flight nurse is normally on-board for each flight. About 20% of the flights involve carrying a patient in critical condition and therefore also require a physician be on-board.

The engineering expertise learned in designing and supporting aircraft for operation in challenging environments helped shape the PC-24, the first Pilatus jet, which was announced at the 2013 European Business Aviation Convention and Exhibition (EBACE).

In keeping with Chairman Schwenk's philosophy, the PC-24 is innovative but clearly carries the Pilatus DNA. It is designed to operate from short, unimproved airstrips, features a large cabin and twinjet performance. Notably, it is also fitted with a large cargo door able to accommodate standard pallets — a feature never before seen on a business jet.

The wing is of advanced design to enable the jet to cover the range of performance requirements from short takeoffs and landings to operating efficiently at 45,000 ft. The PC-24's 2,690-ft. balanced field length enables it to operate from 11,950 paved airports that have this minimum length. By designing this jet to operate from grass, gravel, sand or snow, the number of possible runways expands to over 21,000, according to Pilatus.

The aircraft first flew from Buochs Airport in Stans last May and certification flight-testing is well underway. Certification is expected in 2017, with deliveries to follow shortly thereafter. Among the launch customers is the RFDS, which has ordered four. **BCA**

FOR VIDEO of a Pilatus Turbo Porter operating in Indonesian's remote villages, go to **https://www.youtube.com/watch?v=ik32TsceQHY**

MALHERBE DESIGN - Photo Airborne Films

Safety Data Dump

It's being **collected by the terabyte** from multiple aviation sources — **including the aircraft themselves**

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

More data have been generated, collected and processed by the human race in the last 36 months than during the previous 3,000 years. Further, every day of every month the worldwide flood of information on every conceivable subject increases exponentially.

We are living in the era of "Big Data," and every discipline, including aviation, is involved. In the digital age, enabled by cyber technology and the Internet, ones and zeros dominate.

Every activity in which we engage, every purchase on the Internet, every phone call, text message or email we make or send, leaves digital data trails. Tracking these and processing the information they contain forms databases held in high value, especially by the business community, and thus increasingly, Big Data is evolving as the currency of the digital age.

Aviation has always been at the forefront of data collection, especially during the civil component's formative years when it was obvious that if the nascent airline industry were to grow and prosper, it had to make operational safety its highest priority. And assessing safety — to have a gauge for measuring performance and identifying potentially dangerous trends — requires data.

Early on, manually gathering, formatting and reporting operational and maintenance data was a laborious and time-consuming process, but cybernetics, automation and the digital revolution beginning in the 1960s not only simplified the job but also enabled the reaping of ever larger amounts of information.

By the early 1980s, even the aircraft themselves were recording performance, maintenance and trending data for later downloading into storage devices or laptop computers. Less than a decade later, many were automatically transmitting hundreds of parameters of near-real-time performance data to maintenance departments or trend-monitoring companies while in flight.

(I remember watching at a monitor at United Airlines' San Francisco maintenance base as engine performance numbers streamed in from a Boeing 747-400 cruising over the Western Pacific at FL 410 on a revenue flight between Japan's Narita International Airport (RJAA) and SFO. The data, showing everything that was happening within the four powerplants, were collected electronically, uplinked to a comm satellite in geostationary orbit, then beamed down to the SFO facility. That was 20 years ago.)

At the same time, air navigation service providers (ANSPs) were implementing computer software that automatically recorded gross navigation errors (GNEs) and altitude deviations — often to the chagrin of offending flight crews but nevertheless to the ultimate benefit of the overall safety system. As the technology matured, the data wave turned into a tsunami.

What Does It All Mean?

So, as Russell Lawton, safety director at the Air Charter Safety Foundation

(ACSF), quipped in an email exchange with *BCA,* "What does it all mean?" Indeed, to be useful, data must be organized and analyzed.

All aviation risk-management programs and safety management systems (SMSs), including the International Business Aviation Council's (IBAC) International Standard for Business Aircraft Operations (IS-BAO), depend on accurate flows of data in order to reveal patterns that could presage trouble. It is submitted and collected in two forms: digital and textual. An example of the former would be data downloaded either manually or wirelessly from aircraft, while an example of the latter would be incidents or notices of potential problem areas submitted to the safety-reporting programs.

"What we are doing . . . is looking at the data to verify how we're flying the aircraft," explained Frank Raymond, an aviation safety officer for a major western U.S. business flight department that has participated for five years in an FAA-approved Flight Operational Quality Assurance (FOQA) program which he manages.

In a prior position, Raymond honed his risk-aversion skills at an airline where he oversaw an Aviation Safety Action Program (ASAP), another risk-management scheme detailed further on. Until recently, he also served as chairman of the steering committee for the C-FOQA Centerline user group of 70+ business aviation operators that contract with General Electric Flight Efficiency Services to analyze their flight data. The ensemble collectively operates a total of 140 business aircraft.

C-FOQA Centerline is "a conduit to GE in that regard," Raymond said, "collaborating in terms of projects that would be relevant to the overall group." And the relationship yields one other benefit: "Because we are a member of the C-FOQA group, we are benchmarked against the other operator members. With benchmarking, we can then compare our performance with more than 70 other operators."

While IS-BAO addresses quality and safety management of the entire department, FOQA focuses solely on flight operations, harvesting digital data from aircraft FDRs and flight computers. "We've used IS-BAO to describe how we do business in all parts of our

What ASIAS Has Wrought

The FAA's Aviation Safety Information Analysis and Sharing (ASIAS) program, operated under contract by the MITRE Corp. and launched in 2007 to aggregate and disseminate data from FOQA, ASAP, ATSAP programs and other sources, has so far yielded 19 safety enhancements (SEs) from data contributed by airlines. (No SEs have yet derived from business and general aviation operations, as too few operators are enrolled in the program at this time to reveal problematic trends.) Readers can find descriptions of the 19 SEs in the Commercial Aviation Safety Teams (CAST) section of the SKYbrary website at **http://www.skybrary.aero**

- **SE184: TAWS — Minimum Vectoring Altitude Reevaluation**
- **SE185: TAWS and RNAV Visual or Other Procedures**
- **SE186: TCAS Sensitivity Level Command**
- **SE188: TCAS — ATC Procedures and Airspace Design**
- **SE191: New TCAS/Next TCAS Equipment**
- **SE192: Airplane State Awareness — Low Airspeed Alerting**
- **SE193: Airplane State Awareness — Non-Standard/Non-Revenue Flights**
- **SE194: Airplane State Awareness — Standard Operating Procedures Effectiveness and Adherence**
- **SE195: Airplane State Awareness — Flight Crew Training Verification and Validation**
- **SE196: Airplane State Awareness — Effective Upset Prevention and Recovery Training**
- **SE197: Airplane State Awareness — Policy and Training or Non-Normal Situations**
- **SE198: Airplane State Awareness — Scenario-Based Training for Go-Around Maneuvers**
- **SE199: Airplane State Awareness — Enhanced Crew Resource Management Training**
- **SE200: Airplane State Awareness — Virtual Day-VMC Displays**
- **SE201: Airplane State Awareness — Bank Angle Alerting and Recovery Guidance Systems**
- **SE202: Airplane State Awareness — Bank Angle Protection**
- **SE212: Area Navigation (RNAV) — Equipment and Procedures to Improve Route Entry for RNAV Departures**
- **SE213: Area Navigation (RNAV) — Safe Operating and Design Practices for STARs and RNAV Departures**
- **SE214: Area Navigation (RNAV) — Procedures and Standards to Improve Path Compliance for STARs and RNAV Departures**


JSSI

And the Grandparent of Safety Reporting Systems

Today's FOQA and ASAP voluntary reporting programs owe their origins to the Aviation Safety Reporting System (ASRS) operated on behalf of the FAA by NASA. The ASRS was conceived by the FAA and NTSB in the wake of the TWA Flight 514 CFIT accident in Virginia while on approach to Dulles International Airport in 1974 with the loss of all 92 souls on board. The subsequent NTSB investigation determined that confusion in terminology between the cockpit crew of the Boeing 727 and controllers as to whether the aircraft was in protected airspace (it wasn't) when it was cleared for the approach led the crew to immediately commence a descent in IFR conditions to the final approach fix when the aircraft was approximately 40 sm from the airport, colliding with a mountain.

When it was revealed that the crew of a United Airlines B727 had nearly made the same mistake on the same approach six weeks earlier, the NTSB and the FAA recognized the need for some type of safety reporting system allowing pilots and controllers to report incidents, mistakes or potentially hazardous situations without fear of FAA actions against them. The result was formation of the ASRS and a commission to NASA to run it as an objective third party.

Under the ASRS, reports submitted in a timely manner are anonymous, with filers receiving documentation entitling them to "waivers of immunity from sanction" if the FAA were to initiate an investigation of an event; however, the incident is entered in the filer's permanent record. **BCA**

department but rely on FOQA to monitor the flight operations component," he said. "It feeds into our safety program, which, in turn, is part of the IS-BAO program."

Another of Raymond's responsibilities is "gatekeeper" for his company's FOQA program, protecting the security of data and its connection to flight crewmembers and maintenance staff. This is significant, since the effectiveness and integrity of FOQA and similar safety-reporting programs are based on immunity from FAA action as long as crews and techs are not engaged in patently illegal activity. In order for participants to be forthcoming, a non-punitive atmosphere must prevail.

FOQA was conceived by British Airways as a tool to study stabilized approaches and was subsequently adopted by other airlines and, eventually, the FAA as a completely voluntary data-collection program. As it was non-punitive, it quickly gained in popularity. While generally oriented toward airlines, FOQA can also serve business and general aviation operations, e.g., Raymond's flight department and its counterparts in the GE Flight Efficiency Services fold. To assist U.S.-registered operators in establishing a FOQA program, the FAA issued Advisory Circular 120-82, dated April 12, 2004, for "guidance on one means, but not necessarily the only means," of developing, implementing and operating a program acceptable to the agency.

AC 120-82 states that the intention of FOQA is to increase operational safety by allowing operators and pilots "to share de-identified aggregate information with the FAA" so the aviation authority can monitor operational trends and address "risk issues." The FAA views the program as a "partnership" between employers (the airlines or operators), flight crews and itself "to identify and reduce or eliminate safety risks, as well as minimize deviations from the regulations." Further, the "cornerstone" of the program "is the understanding that aggregate data that is provided to the FAA will be kept confidential" and the identity of reporting pilots or operators will be anonymous "as allowed by law." Thus, under 14 CFR Part 193, submissions to the program will be protected as "voluntarily submitted safety-related data." However, to obtain assurance of protection "from the use by the FAA of FOQA information for enforcement purposes," operators must obtain FAA approval of their programs, hence the 78 pages of guidelines supplied in AC 120-82.

So essentially, FOQA program approval cements an understanding between the operator and the feds that pilots can submit safety concerns to the program without fear of reprisal or punishment. Operators and employees can then be confident that, in this sense at least, their data is "secure." The premise for this protection is that the greater good of being able to identify unsafe trends from the data submitted outweighs punishment, or as Raymond put it, "We are looking for trends in how we fly to ensure that our employees are operating the aircraft within set standards and per their training."

Data used in FOQA programs are the same types stored by digital flight data recorders (FDRs) for accident-investigation purposes but can be downloaded frequently from quick-access recorders. "The FDRs can record thousands of parameters of data," Raymond pointed out. "The pieces we're retrieving aren't that extensive in detail but sufficient to understand what the aircraft were doing, how high and fast they were flying, and so forth.

"Data from our aircraft are downloaded once a month and forwarded to GE for analysis and trending," he continued. "As part of GE's analysis, we get quarterly and annual reports that show what we're doing on a trending basis, and these tell whether we are operating in compliance with our department SOPs, with the manufacturers, and in accordance with how we've been trained. In our operation, we have adopted the Flight Safety Foundation's standard for a stabilized approach and developed our program around the following parameters: correct flight path, aircraft configured for landing, speed within range, appropriate power setting to maintain correct descent rate, and establish an approach 'gate' 1,000 ft. before touchdown."

Tools for Building a Safety Culture

ASAP, mentioned earlier, was launched by the FAA in 1997 in conjunction with participating airlines. Like FOQA, it is a confidential, voluntary reporting program designed so that industry participants are assured security in reporting incidents; i.e., it is non-punitive. A separate program, the Air Traffic Safety Action Program (ATSAP), has been tailored for controllers with the same objectives and protections.

The ACSF's Lawton described ASAP "as a hands-on safety process whereby people come forward and report events they have experienced in exchange for determining root causes and developing corrective action to mitigate hazards, a more formal way of looking at safety because the whole idea is that it is intended to get to the cause and not assign blame. When an issue is identified, we examine how we are currently controlling the risk or whether procedures and training should be revised."

ASAP "owes its origins to the Part 121 world," Lawton said, "where it has subsequently established a proven track record in safety enhancement." However, since its founding in 2007, the ACSF has been approved as a neutral third-party ASAP program manager for Part 135 and 91K operators and now Part 91 flight departments, as well. "Whatever works most effectively getting to the root of the event and is going to make the [reporter] forthcoming is the program's objective. The program can identify trends and patterns, symptoms of larger problems that need to be addressed like, for example, noting that crews are having problems with automation. And it can even report problems back to the OEMs."

Unlike FOQA, which focuses on stabilized approach parameters, ASAP addresses a broader purview of operations, allowing anyone involved in an operation to report incidents or anything that could indicate a potential safety problem. "We now have the capability to do something with this information," Lawton said. "FOQA and ASAP are complementary tools; the former will tell you what happened but not why — you need ASAP for that."

When an ASAP report is received, it is screened against what the FAA terms the "big five" caveats that could disqualify it: The incident occurred due to criminal activity, substance abuse, use of a controlled substance, alcohol abuse or intentional falsification.

If an Event Review Committee (ERC) determines that the report qualifies, it is investigated through a formal process. There are two categories of reports: sole source and non-sole source.

"A sole-source report is one where no one would know what happened if the reporter had not come forward," Lawton said. A non-sole source report is one in which the FAA has knowledge of the incident, e.g., altitude busts, speed deviations, nav errors or things controllers would see and the ATC system would record. (A software tool called Air Traffic Quality Assurance [ATQA] records ATC incidents and identifies pilot-caused events, thus defining a non-sole source report, as ATC already would have a record of the incident.)

An ERC would include representatives of the FAA, the airline or company employing the reporter, and an employee of the operator (not the reporter). After interviews with the reporter (or flight crew), it then develops corrective

action for either the individual or the company involved. "All decisions are reached by consensus," Lawton observed, "a very important point. Everyone has to come to agreement on the corrective action, which is reviewed periodically to ensure implementation and effectiveness. The objective is to get the information needed to identify a problem and develop corrective action to avoid or solve it."

ASAP is an "excellent tool for building a safety culture," Lawton claimed, "because it puts in black and white that you get protection and you are helping to advance safety. Thus people will get more comfortable in sharing what is happening to them. It encourages a dialogue that otherwise might not have occurred. The idea is that this information is used for constructive purposes and not to lay blame."

There are two ways to destroy a safety reporting program, Lawton maintained. "One is to 'burn' the reporter and the other is to do nothing with the information. The way ASAP is set up is that you get a secure database to host the [reported] incidents that allows reviewers to access specific airports or regions to review them. At the ACSF, once a report is investigated and de-identified, it goes into a dedicated server so operators can access the information for learning purposes. Your company always owns its own data, not the FAA, and that's why you get your own secure server."

The majority of Part 121 operators in the U.S. are participating in ASAPs, with more than 90,000 reports submitted last year, of which 90% were sole source. The number one event reported across ASAP is altitude deviations.

It's Not Only Nice to Share, It Also Can Save Lives

As the data roll in and these individual risk-management databases grow, their potential usefulness cannot be achieved unless the information they contain is shared. Enter the FAA's Aviation Safety Information Analysis and Sharing (ASIAS) program, launched in 2007 to aggregate and disseminate data from FOQA, ASAP, ATSAP programs and other sources. Operated under contract to the FAA by the MITRE Corp., ASAIS produces reports and issues alerts on trouble spots and negative trends revealed by the contributing programs.

"ASIAS is a collaboration between the FAA and the aviation industry," said Randy McGuire, department head, aviation safety analysis, at MITRE's McLean, Virginia, laboratory. The lab is one of seven in the U.S. performing research for the federal government in multiple fields including aviation.

"It was started with the intent of collecting and protecting safety data that U.S.-based airlines shared with MITRE as an objective third party," McGuire explained. "A few years ago we began sharing with general aviation operators." Currently, there are 45 airlines and 20 FAR Parts 91, 91K and 135 business aviation operators in the program. ASIAS has also been extended to Part 145 repair stations and Part 141 flight training schools.

> **"They can log in** and view the risks we have identified every two months **and actually see the results,"** McGuire said.

Operators in the program represent one aircraft each to entire fleets numbering in the hundreds of aircraft, with about 850 aircraft represented for general aviation. Additionally, there are training fleets for flight schools and universities (a growing area), and piston operators using their aircraft for business travel and for which they're developing metrics as well.

ASIAS is not a data source, McGuire explained. The program is an aggregation of multiple data sources, including the Aviation Safety Reporting System (ASRS), FOQA, ASAP, ATSAP, and recorded radar and weather data. The data processed are both text-based (the safety reporting programs) and digitally based (like FOQA harvests from digital aircraft reporting systems and FDRs). Text-based data are analyzed with text-mining software that "reads," "translates" and categorizes an event as one of several that safety reporting programs and ASIAS track. "All the data are automatically processed, and we receive them in electronic formats," McGuire said. "So every day the data flow in here. . . ."

As an example of how the aggregation process works, digital data from an aircraft are collected by an operator under FOQA and sent on to MITRE to be added — *i.e.,* aggregated — with data from other operators, de-identified and kept in a secure location. Every two months the archive is pulled and computer metrics based on the "snapshot" are created or updated and the archive is refreshed with new information. Finally, "dashboards," or graphical representations of the pulled data described by month, are created and uploaded to a portal, a secure website, to which each operator in the program has access.

"They can log in and view the risks we have identified every two months and actually see the results," McGuire said. "The airline operators will see benchmarks of their safety rate against the larger group, but at the present time, only them. GA operators see the aggregate of everybody else and can compare that to their own statistics they keep internally. These sites are secure and represent an incentive for operators to participate."

Examining the aggregated data, analysts can decipher trend lines. "So if something is deteriorating, we will see the trend line increase," McGuire said. "One way of making the trend lines decrease is when the [ASAP] General Aviation Joint Steering Committees or the Commercial Aviation Safety Teams [CAST] at the airlines put forward risk mitigations, or suggestions to the operators on how to reduce the risks they're seeing in the data. Once these are implemented, ASIAS then determines whether they are successful using the same process employed to identify the risk in the first place: studying the data, a process that can take several years."

The value of this system, McGuire pointed out, "is when we see something we have not seen before that becomes a new risk to address before it becomes an accident. It enables us to be proactive, to see things that could identify dangerous trends. This might be something we haven't seen before or something we've been tracking that has changed or shown up in new places."

Since ASIAS has opened the program to general aviation input, Jeff Middelman, the program's general aviation lead, said, "we have agreements with operators that do the same type of analysis from a uniquely general aviation or business aviation perspective."

Working with commercial or general aviation operators, "We come up with topics they are interested in tracking," he explained. "To that end, we look for different metrics like FOQA that we compute and update on a regular basis to our stakeholders, and here we can see the trends over time at different airports and for different aircraft."

This is the aggregated form of all operators' data put together that can reveal developing trends. "And of course, all the data are de-identified," Middelman said. "There could be tens of thousands of text-based reports plus the digital data from programs like FOQA. Textual reports are used only when a crewmember reports voluntarily."

The digital data by now represent millions of flights, *e.g.,* 15 million for commercial operations alone covering a three-year period, as the data are stored for 36 months, then deleted. "So you wind up with a 'rolling total,'" Middelman said. And in terms of the textual reports, "Just for the airline component, we are collecting and archiving 150,000 text reports every three years. On the general aviation side, with only 20 operators in the program, the total is smaller: Currently, we have 20,000 FOQA and 13,000 ASAP reports."

How It's Paying Off

So, have trends revealed in the data led to interventions that have made operations in the nation's airspace safer? According to McGuire, based on data from airline operators, there have been 19 safety enhancements implemented by the CAST in the past eight years. "On the general aviation side," he said, "we have not collected enough data to ascertain trends. We are working on that. We need more general aviation operators to join the program to increase the size of the database. We need a lot of operators to get a lot of data over time."

In order to join ASIAS, an operator must be either a FOQA or ASAP data contributor and have a safety program in place. As a general aviation operator, McGuire said, "You can use an SMS provider, registration in IS-BAO or internal programs that do not have be FAA approved. On the other hand, airline programs do have to have an FAA approval. There is no cost to join. You receive access to the portal, study results done previously and invitations to the semiannual FAA InfoShare conferences held around the country at different locations. You can participate in special studies of the trends, where they are occurring. You can request a study. You can help in developing a safety enhancement or mitigation." To get the process started, visit **http://www.asias.aero.**

As an example of how an operator in the program can plumb ASIAS safety data, McGuire cited unstable approaches as a topic. "We can look at unstable approaches at any airport for which we have data. General aviation flies to a lot small airports. Pick one, and the user can log in and go to that airport and determine what the unstable approach rate is. It's possible to see it for each runway, too, so the rate of unstable approaches at the field may be driven by one particular runway." At least two operators participating in ASIAS have to be using an airport for the program to have data on it.

Once in the program, any use of the data has to be approved by the ASIAS executive board to ensure protection. "The program has strict governance in place to protect the data, who can see it, how it is used, to ensure operators are comfortable in providing the data," McGuire said. "The steering committees help oversee how the data is used and how it might be initiated. Industry is always part of that — operators, labor unions, industry groups like the NBAA, and the OEMs, [the last which] often assist with data. It is a totally collaborative process with full transparency. It's all about building trust, which has taken a lot of time. On the general aviation side, we need a lot more operators to get a lot more data. It took years to get the airlines into it."

Observed Frank Raymond, "The airlines are feeding data from thousands of flights into these programs daily. Meanwhile, business aviation may only be submitting a small amount of data, relatively speaking, but every bit helps to raise the bar and give us a bigger data set to look at. So everybody benefits in the end." **BCA**

Air Charter Safety Foundation: Dealing With the Quantifiable

The Air Charter Safety Foundation is a partisan of using data to make aviation safer. ACSF was spawned by the National Air Transportation Association (NATA) in 2007 to enhance safety in business and general aviation charter operations. One of its first accomplishments was to develop a common safety audit standard for the air charter industry.

"When we started ACSF, we wanted to be involved only with things that could be measured," Russ Lawton, the Foundation's safety director, told *BCA.* "We are all about enabling the highest levels of safety in personal and business aviation, so everything we get involved with has to be quantifiable."

ACSF was formed partly because FAR Part 135 operators had been asking NATA to create a single audit standard that could embrace both Parts 135 and 91K operations. "So we compiled the ACSF Industry Audit Standard," Lawton said, "and began qualifying auditors through training conferences. It was intended to be a standard that had demonstrable, measurable results, and since the program was implemented, this has been borne out in annual safety analyses by [Robert E.] Breiling Associates that have shown that operators using the ACSF standard were actually operating at safer levels." **BCA**

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Total Failure

Poor **training, actions, coordination** and **oversight** put Learjet 35 into the Atlantic

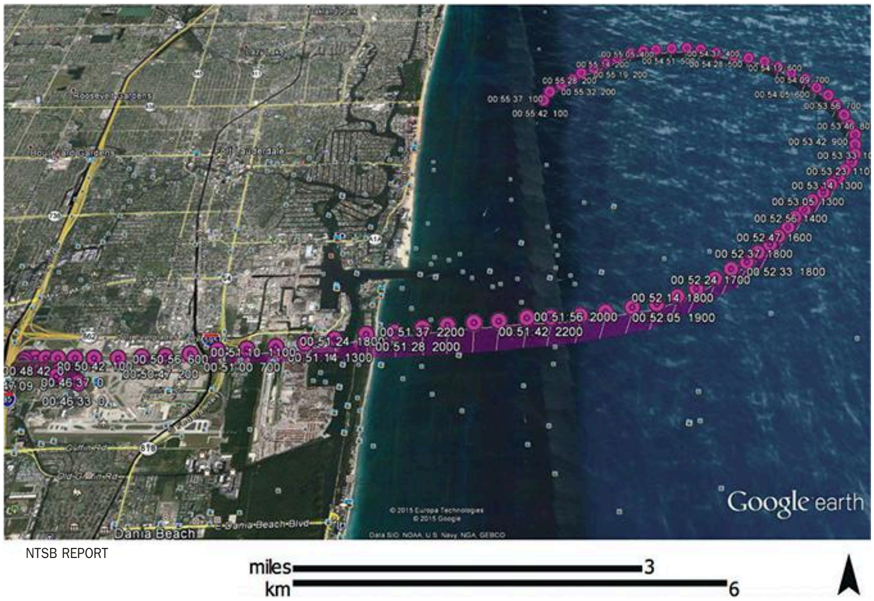
BY **RICHARD N. AARONS** bcasafety@gmail.com

I thought the days of poorly trained captains and seat-warming copilots were long gone in turbine operations — at least those conducted in the U.S. But it would seem there are still operators who are not especially particular about who's in the cockpit, or their level of competency in the face of unexpected situations.

This month we'll take a quick look at the loss of a Learjet 35A (XA-USD) fatal to all four occupants on Nov. 19, 2013, when it crashed into the sea off the Fort Lauderdale, Florida, coast just 3 min. or so after takeoff.

The NTSB determined the probable cause of the accident was "the pilot's failure to maintain control of the airplane following an inflight deployment of the left engine thrust reverser." Further contributing to the accident, it said, "was the flight crew's failure to perform the appropriate emergency procedures, the copilot's lack of qualification and capability to act as a required flight crewmember for the flight, and the inflight deployment of the left engine thrust reverser for reasons that could not be determined through post-accident investigation."

The airplane had just completed an air ambulance flight for Air Evac International from San Jose, Costa Rica, to Fort Lauderdale-Hollywood International Airport (FLL) and was repositioning back to its base in Cozumel, Mexico. Weather at FLL included few clouds at 2,500 ft. and a scattered layer at 6,500 ft. The wind was calm and visibility was 9 mi. The temperature was 23C, the dew point was 22C, and the altimeter setting was 29.93 in. of mercury.



NTSB REPORT

At 1955:15, the copilot reported the airplane was ". . . 200 ft. over the sea." After that, there were no intelligible transmissions received from the airplane, and communications with the airplane were lost.

The Flight

Investigators used FAA ATC voice and radar recordings to determine the Learjet's track and timeline. The airplane departed Runway 10 at FLL at about 1950 and climbed straight ahead. When it reached an altitude of about 2,200 ft. and a groundspeed of 200 kt., the copilot requested radar vectors to return to the runway due to an "engine failure." The controller directed the flight to maintain 4,000 ft. and turn to a heading of 340 deg. The copilot replied, "Not possible" and requested a 180-deg. turn back to the airport. The controller acknowledged, but the airplane continued a gradual turn to the north as it slowed and descended.

Two minutes later, the copilot declared a "Mayday!" and again requested vectors back to FLL. During the next 3 min., the copilot requested vectors to the airport multiple times. While the copilot requested, received and acknowledged increasingly sharper and tighter turns to the southwest from ATC to return to the airport, the airplane continued its slow turn and descent to the north. During the 2 min. following the copilot's declared intention to return to FLL, the airplane descended to 900 ft. and slowed to 140 kt. as it flew northbound, parallel to the shoreline and away from FLL.

At 1955:15, the copilot reported the airplane was ". . . 200 ft. over the sea." After that, there were no intelligible transmissions received from the airplane, and communications with the airplane were lost.

A search began immediately, but there was no evidence of survivors. Some floating wreckage was recovered by the U.S. Coast Guard. It showed impact damage but no evidence of fire. The main wreckage was located on the ocean floor on Dec. 3, 2014.

The wings were separated from the fuselage, and the outboard section of the left wing was missing. The left and right wingtip tanks were detached from the wings. Both ailerons were identified, and one wing flap was found at the retracted position. Both main landing gear were retracted.

On the throttle quadrant, the left power lever was found past the

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NTSB REPORT/BOMBARDIER

(Top photo) No. 1 engine with thrust reverser unlocked; No. 2 engine with thrust reverser stowed.

maximum position and damage to the forward stop was consistent with over-travel. The right lever was found one-half inch from its maximum travel. There was no visible damage to either the idle or cutoff stops.

The thrust reverser control panel and panel chassis were deformed by impact forces. The internal electronic components were corroded and/or coated with dried materials indicative of immersion in salt water. The UNLOCK, DEPLOY and BLEED VALVE annunciator light assembly for both left and right engines appeared intact. The NORMAL/EMERGENCY STOW switch on the thrust reverser control panel was found intact in the control panel and in the NORMAL position.

The engine N2 rpm gauges indicated 96.8% on the left engine and 96.5% on the right. The engine turbine temperature gauges indicated 781C on the left engine and 780C on the right. The engine fan gauges indicated 89.2% on the left engine and 89.8% on the right. It would seem the engines had been operating at near maximum thrust.

Thrust Reverser System

Photographs taken of the submerged wreckage before its recovery from the ocean floor showed that the left engine's thrust reverser and blocker doors were not in the stowed position. Examination of components from both thrust reverser systems (left engine and right engine) after recovery indicated that the components sustained impact- and seawater-immersion damage. This damage precluded testing for electrical, pneumatic and mechanical continuity.

Examination of the left engine's thrust reverser system components found that the upper blocker door was attached to the reverser and was in a partially deployed position. The lower blocker door was found hanging from one of its tension links. The lower blocker door's rod arm was missing a section of its clamping arm, and the pivoting pins were broken. The lower blocker door showed a gap between the door skin and door pan with a bend at the forward edge near the gap. Areas of paint and skin on the left engine nacelle skin and body structure forward and aft of the cascade exhaust showed discoloration and scorching, with some paint blistered or missing. The entire perimeter of the outer fan duct behind which the blocker doors stow (when the thrust reverser was stowed) was missing.

Examination of the right engine's thrust reverser system components found that the upper and lower blocker doors were in the stowed position. There was no visible damage or interference observed between the blocker doors and the surrounding structure. There was no evidence of heat damage on the engine nacelle outer skin or paint.

The Pilots

The wreckage examination (and later bench testing) indicated clearly that the left reverser had deployed in flight. The fact that the airplane ended up in the water suggested that something went very wrong in the cockpit.

Both pilots were employed by Vuela SA de CV, which was an independent company that "leased" the pilots to Aero JL SA de CV. Both companies were owned and operated by the same individuals.

The pilot held a Mexican commercial pilot certificate with ratings for airplane single-engine, airplane multiengine land and instrument airplane, and an ATP and type ratings in Learjets and the Gulfstream GI. The operator told investigators the pilot had accrued 10,091 total hours of flight experience, of which 1,400 hr. were in the 30-series Learjet.

On July 5, 2013, the operator issued the pilot a certificate of training for 8 hr. of crew resource management. On the same day, he was issued another certificate for an additional 8 hr. of instruction on controlled flight into terrain.

The copilot held a commercial pilot certificate issued by Mexico, with ratings for airplane single-engine, airplane multiengine land and instrument airplane. The copilot's total flight experience could not be reconciled. Documents provided by the operator suggested the

copilot had accrued an estimated 1,243 total hours of flight experience, of which 29 hr. were in the Learjet 35.

According to company records and a resume, the copilot began flying Learjets for the Vuela SA/Aero JL organizations on May 1, 2013. At that time, the copilot declared 1,206 total hours of flight experience, of which 82 hr. were "observer" time in Learjet 25s. From the day of employment to the day of the accident, the copilot accrued 37.16 hr. of flight experience in Lear 25/35 airplanes.

A certificate stamped "General Technical Department of Licenses," which was forwarded by the operator to the NTSB, suggested the copilot accrued 175 hr. in the Learjet 35A between July 4, 2013, and Oct. 30, 2013; however, his total documented flight experience increased only 29 hr. over the same time period.

On Aug. 20, 2012, the copilot received a diploma for classroom instruction received for the Learjet 20 series airplanes from a technical training school in Mexico that had neither airplanes nor flight simulators. There was no evidence that the copilot completed any training or practical tests in a Learjet airplane or flight simulator.

On July 5, 2013, the operator issued the copilot a certificate of training for 8 hours of crew resource management. On the same day, he was issued another certificate for an additional 8 hours of instruction on controlled flight into terrain.

Pay records for the pilot and copilot show identical hours, deductions, and pay over several consecutive pay periods. The pilot and copilot had flown together on three occasions before the accident flight. The accident flight was their first flight together in the United States.

The Safety Board said a search of student records by "two prominent Learjet training vendors in the United States" revealed no records of simulator flight training or attendance by either the pilot or copilot. Emergency procedure training for an inflight deployment of a thrust reverser could be performed only in an appropriately equipped flight simulator.

The Director General of Civil Aeronautics (DGAC) for the government of Mexico examined the pilot and flight training records for both pilots and summarized their findings for the NTSB report:

"Both the pilot and copilot records showed inconsistencies on the verifications of training and certifications based on the way official government stamps and certifications were displayed over, and with, the entries. They were copies, and did not represent entries properly certified by the Government of Mexico."

Some of the captain's experience and certifications were based on logbooks never presented. The copilot's records showed the training for the Learjet 20/30 series airplanes provided and conducted exclusively by the operator, Aero JL. Further, there was no "original foreign license and logbook," no "official license certificate" or DGAC file records to support a claim that the copilot had 1,243 total hours of flight experience.

According to the DGAC, the copilot had actually accrued only 206 total hours of flight experience. The copilot was evaluated by the DGAC in the airplane on May 2, 2013, and his performance during the practical test was found to be "unsatisfactory."

Accidents in Brief

Compiled by Jessica A. Salerno

Selected Accidents and Incidents in March 2016. The following NTSB information is preliminary.

▶ **March 27 — About 1135 EDT, a** Robinson Helicopter R44 (N776JM) was destroyed when it crashed near Canadensis, Pennsylvania. The private pilot was fatally injured. The flight departed Doylestown Airport (DYL) Doylestown, Pennsylvania about 1100 EDT, destined for Mountain Bay Airpark (PA49) in Greentown, Pennsylvania, about 60 mi. to the north. It was IFR and no flight plan was filed for the Part 91 personal flight. About the time of the accident, a witness was outside his home about one half mile northwest of the accident site when he heard an aircraft engine overhead. The witness looked upward toward the sound, but the aircraft was obscured by clouds. He estimated the cloud height to be about 200 ft. above the trees in his yard. The witness then heard a loud "boom" sound similar to a car striking a tree, followed by another boom sound a few seconds later. The accident site was subsequently located about 0.5 nm from the witnesses' home. The helicopter crashed in a wooded area about 100 yd. north of an east-west oriented ridgeline, and at an elevation about 20 ft. below the top of the ridge, and about 2,000 ft. above mean sea level. The throttle linkage on the collective pitch control assembly was found in the full open position. The mixture control knob and the control cable end (separated from the control arm) were found in the full rich position. The carburetor heat control linkage and slider valve were found in the on position.

▶ **March 26 — About 1208 EDT, a** Cessna 172N (N6238D) was substantially damaged when it crashed at the Yeager Airport (CRW) Charleston, West Virginia. The flight instructor was fatally injured and the student pilot was seriously injured. It was VFR and no flight plan was filed for the local instructional flight. The airplane was owned by Skylane Aviation LLC. Review of airport security surveillance video revealed the accident airplane lifted off about 1,000 ft. down Runway 5 in a nose high attitude. The airplane then rolled left and reached an inverted attitude before it crashed nose first beside the runway. The airplane came to rest inverted.The debris area was compact and the ground scars were consistent with the airplane impacting nose first, right wing down attitude. Control cable continuity was established to all flight controls. Measurement of the elevator trim jackscrew corresponded to an approximate neutral trim setting. When the engine crankshaft was rotated by hand, valve train continuity was established and thumb compression was attained on all cylinders. The propeller exhibited rotational scoring and one blade tip was missing. According to FAA records, the flight instructor held a commercial pilot certificate with ratings for airplane single-engine land, airplane multi-engine land, and instrument airplane, which was issued on March

The CVR

The transcript of the cockpit voice recorder (CVR) certainly reflected the training situation just outlined.

No checklists were called for, offered or used by either crewmember during normal operations (before or during engine start, taxi, takeoff) or following the announced inflight emergency. There were no challenge-and-response checklist callouts between the pilot and copilot at any time during the flight, no elements of crew coordination and no identification of the emergency.

After the "engine failure" was declared to ATC, neither crewmember asked for or offered the "Engine Failure" checklist, nor was there any attempt to complete an emergency procedure and then ask for a checklist verification of actions taken. The pilot asked the copilot for unspecified "help" because he did not "know what's going on" and he could not identify the emergency or direct the copilot in any way with regard to managing or responding to the emergency. At no time did the copilot identify or verify a specific emergency or malfunction, and he did not provide any guidance or assistance to the pilot.

According to Learjet, in the event of an inflight emergency, the typical convention was for the pilot flying to fly the airplane and take over communications with ATC. The pilot monitoring should then complete the appropriate checklist, while audibly announcing his actions as they are completed. The pilot flying was to verify these actions prior to completion. Although different flight departments may adopt their own procedures, there was no evidence that any crew coordination actions took place on the accident flight.

Specifically, the Safety Board said, "Based on the wreckage evidence and data recovered from the left engine's digital electronic engine control [DEEC], the thrust reverser rocker switch was not placed in the "EMER STOW" position, and the left engine was not shut down.

"The DEEC data showed a reduction in N1 about 100 sec. after takeoff followed by a rise in N1 about 35 sec. later. The data were consistent with the thrust reverser deploying in flight [resulting in the reduction in N1] followed by the inflight separation of the lower blocker door [resulting in the rise in N1 as some direct exhaust flow was restored].

"Further, the DEEC data revealed full engine power application throughout the flight. Although neither flight crewmember recognized that the problem was an inflight deployment of the left thrust reverser, certification flight test data indicated that the airplane would have been controllable as it was configured on the accident flight. If the crew had applied the "engine failure" emergency procedure [the perceived problem that the copilot reported to the air traffic controller], the airplane would have been more easily controlled and could have been successfully landed."

Unwanted TR Deployment

Manufactured in 1979, the accident airplane was powered by two Garrett (Honeywell) TFE731-2 turbofan engines. Its most recent continuous airworthiness inspection was completed Nov. 4, 2013, at 6,842 aircraft hours.

The Lear was equipped with an

3, 2011. She held a flight instructor certificate with ratings for airplane single engine, and instrument airplane. She also held an FAA second-class medical certificate, issued June 11, 2015. At the time of the medical examination, the flight instructor reported 1,694 total hours of flight experience. The student pilot held a student pilot certificate issued on March 9, 2016, and held a third-class medical certificate, issued on the same date. The four-seat, high-wing, tricycle landing gear airplane, serial number 17272656, was manufactured in 1979. It was powered by a Lycoming O-320-H2AD, 160-horsepower engine, equipped with a two-bladed McCauley propeller. Review of maintenance records revealed that the airplane's most recent annual inspection was completed on October 20, 2015. At that time, the airframe had accumulated about 10,995.9 total hours of operation and the engine had accumulated 1540.4 hours since major overhaul. The airplane had been operated about 7 hours since that inspection.
The recorded weather at CRW, at 1218, included winds from 330 deg. at 4 kt., visibility 10 sm and a clear sky.

▶ **March 23 — At 1542 PDT, a North** American AT-6A (N7055D) crashed in the Columbia River near Astoria, Oregon. The airplane was registered to, and operated by, the pilot The private pilot and passenger were killed the accident, and the airplane was destroyed by impact forces. The personal flight departed Pearson Field Airport, Vancouver, Washington, at 1506. It was VFR at the time and location of the accident and no flight plan had been filed. The passenger was seated in the rear of the airplane, and the flight was intended to be for the dispersal of her deceased husband's ashes. A witness, who was the captain of a cargo ship moored in the river channel, about 1 mi. northeast of Astoria, was on the ship's bridge at the time of the accident. He observed the airplane flying about 300 ft. above sea level, approach the ship from the starboard quarter traveling on a north-northeast track. He walked outside to watch as it flew directly overhead and across the port beam. It continued on the same track away from the ship, and a short time later he saw the left wing dip, as the airplane began a left turn. A few seconds later the wings were almost vertical, and the airplane then rapidly transitioned into an aggressive steep vertical dive. The airplane then hit the water in a nose-down attitude, and he saw a red tail section bob back into view, and then sink. The airplane was flying parallel to the water surface leading up to the diversion, and he could hear the engine operating throughout the flight. Another witness, located inside her apartment close to the waterfront in Astoria, was at a north-facing window with a view of the channel. She observed an airplane directly ahead, flying over the water and east towards and over moored ships. She was familiar with the helicopter traffic from the Columbia Bar Pilots, and the airplane immediately seemed unusual because of its low altitude. It was flying at the same level as the ship's stacks relative to her position, at an altitude typically flown by the helicopters. The airplane was flying at a speed she considered to be slower than normal, and it then began a slow and "graceful" turn to what appeared to be the left. She likened the maneuver to the way a large

Aeronca Inc. 45-1000 thrust reverser system. When reverse thrust was commanded from the cockpit during a landing roll, the thrust reversers operated to reverse the direction of the engine exhaust gases to assist with stopping the airplane on the runway. The thrust reversers were designed to deploy only when the squat switches were in the "weight on wheels" mode and the throttles were in the idle position. When activated, the thrust reverser system used 28-volt power for reverser control and engine bleed air to deploy the translating structure. The electrical system in the thrust reverser incorporated an automatically initiated "stow" command if the pneumatic latches became unlocked in flight.

A rocker switch in the cockpit could be positioned to either "NORM" (normal) or "EMER STOW" (emergency). Three indicator lights in the cockpit for each thrust reverser provided the flight crew with thrust reverser status and position information. These lights, "UNLOCK," "DEPLOY" and "BLEED VALVE," illuminated and extinguished during the application and stowing of the thrust reversers. The "UNLOCK" light would remain illuminated any time that a thrust reverser pneumatic latch disengaged or was not in the locked configuration after a thrust reverser was stowed, or if a thrust reverser failed to stow completely.

The AFM Aeronca TR Supplement stated "an inadvertent thrust reverser deployment during takeoff will be indicated by illumination of the affected thrust reverser UNLOCK and/or DEPLOY lights." If this occurred below V1 speed, an aborted takeoff should be performed. If this occurred above V1 speed, the flight crew should maintain directional control, reduce the affected engine thrust lever to idle, place the NORM-EMER STOW switch to EMER STOW and continue the takeoff.

The procedures stated that, "If UNLOCK or DEPLOY lights do not go out, Thrust Lever [affected engine] — CUT-OFF." The procedures stated that the ENGINE SHUTDOWN IN FLIGHT procedure in the basic AFM should be performed.

The AFM Supplement also contained "Abnormal Procedures" for an inadvertent thrust reverser deployment in flight. Those procedures also specify that, if the UNLOCK or DEPLOY lights do not go out, the ENGINE SHUTDOWN IN FLIGHT procedure should be performed, followed by the SINGLE-ENGINE LANDING procedure from the basic AFM.

Safety Board investigators reviewed airplane manufacturer's records and the NTSB accident and incident database and found no previously documented instance of an un-commanded inflight deployment of a thrust reverser on a Learjet 35.

Bottom Line

The airplane required two fully qualified flight crewmembers; however, the copilot was not qualified to act as second-in-command on the airplane, and he provided no meaningful assistance to the pilot in handling the emergency.

Further, although the captain's records indicated considerable experience in similar model airplanes, his performance during the flight was highly deficient. Based on the CVR transcript, the pilot did not adhere to industry best practices involving the execution of checklists during normal operations, was unprepared to identify and handle the emergency, did not refer to the appropriate procedures checklists to properly configure and control the airplane once a problem was detected, and did not direct the copilot to the appropriate checklists.

In short, this was a totally unprofessional operation masked as something well run with well-qualified personnel. And four people and an aircraft were lost as a result of that dangerous illusion. **BCA**

Accidents in Brief

commercial airplane turns, and as it progressed she could eventually see the full wing profile. The turn continued, and before completing 180 deg., the nose of the airplane aggressively dropped, and the airplane transitioned into an almost vertical dive, passing out of view behind a ship. The airplane was flying straight and level up until the diversion. Both witnesses reported that the airplane was not trailing smoke or vapors at any time, and weather included good visibility, with overcast skies well above the airplane's altitude, and rain beginning later in the day. The witnesses guided search and rescue personnel from the Coast Guard and Clatsop County Sheriff's Department to the accident location. No wreckage was observed floating in the water, and weather, fast water currents, and low water visibility hampered the search efforts. Two days later, divers from the Sheriff's Department located the wreckage in 15 ft. of water, in the middle of the channel, about 1.5 mi. northeast of Astoria, and 11 mi. east of the river mouth to the Pacific Ocean. The airplane had fragmented, separating the wings, engine, and tail section from the fuselage, which sustained extensive crush damage.

▶ **March 21 — About 1201 PDT, an** Airborne XT912 weight shift control (WSC) special light sport aircraft (N670EM) was destroyed when it hit a fence and a roadway shortly after takeoff from Northrop/Hawthorne Municipal Airport (HHR), Hawthorne, California. The student pilot was killed in the accident. The aircraft was owned and operated by Pacific Blue Air of Venice, California, and was based at HHR. It was VFR for the instructional flight and no flight plan was filed. According to witnesses, the aircraft initiated its takeoff roll from HHR Runway 25, at a point prior to the displaced threshold. Just after liftoff, the aircraft began to bank and turn right, and continued to do so until its flight track was approximately perpendicular to the runway heading. The aircraft initially climbed, but then descended, and struck a fence and then a four-lane road about 220 ft. north of the runway centerline, and about 1,400 ft. from the start of the takeoff roll. Witness estimates of the maximum altitude ranged between 40 ft. and 200 ft., and maximum bank angle estimates ranged between 45 deg. and 90 deg. All witnesses reported that the engine rpm increased during the flight, and that the engine continued to run at least until impact. The aircraft came to rest at the north edge of the road, and a fire began immediately. **BCA**


Crafted in Switzerland
PC-12 NG
PILATUS

Departure Obstacles

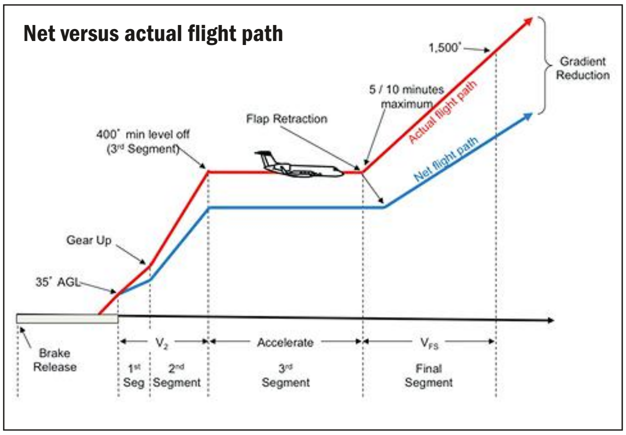
Strategies for **avoiding things** that can **snag and grab**

COURTESY HTTP://WWW.TOM CUCCIO.COM

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

I was in Aspen, Colorado, about 15 years ago, sitting in the FBO with at least 10 other crews all doing the same thing: looking at the overcast. The obstacle departure procedure for the Aspen-Pitkin County/Sardy Field Airport (KASE) simply says, “use SARDD DEPARTURE.” That departure procedure requires the weather be at least 400-1 and mandates a climb of at least 460 ft./nm all the way up to 14,000 ft.

“If we can’t see the obstacles,” I explained to our CEO and lead passenger, “we have to out-climb them. We are too heavy to do that so we have to wait until the weather improves.”



Net versus actual flight path

Just then we heard the roar of another corporate jet rolling down the runway. Everyone rushed to the windows as the airplane disappeared into the low overcast. Was that crew acting recklessly or were we crews in the FBO missing something important?

There are at least three strategies for dealing with airport departure obstacles, each valid in its own way but each with limitations that must be understood to maximize safety margins. And therein lies the problem: The rules are spread across at least seven FARs, two documents from the International Civil Aviation Organization (ICAO), a U.S. Advisory Circular and the U.S. Standard for Terminal Instrument Procedures (TERPS), also known as FAA Order 8260.3B. But once you understand the competing regulatory issues, you can dispassionately sift through the strategies and pick one that works for you. That process begins with looking at how your airplane’s performance gets reported in your Airplane Flight Manual (AFM).

Takeoff Climb Performance

The takeoff performance data in your AFM may not be designed as you might think.

First off, the takeoff path of the airplane must assume the loss of the critical engine. The U.S. rules for transport category aircraft are covered by 14 CFR 25, Section 25.111. Internationally, these rules are covered by ICAO Annex 8, Part IIIA, Paragraph 2.2.3.

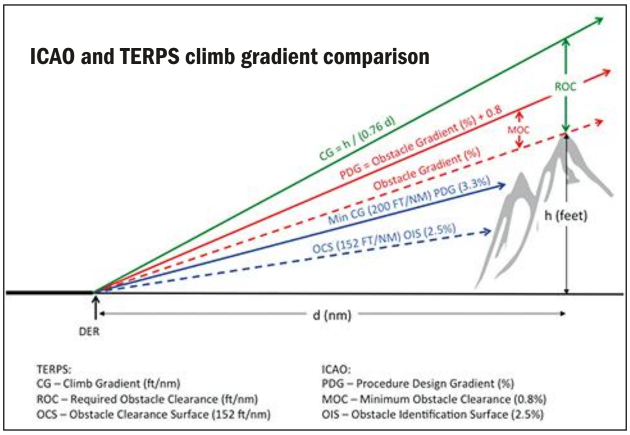
Secondly, the “net” takeoff flight path reflected by AFM performance data represents the actual takeoff flight path reduced at each point by a gradient of climb equal to 0.8% for two-engine airplanes, 0.9% for three-engine airplanes and 1.0% for four-engine airplanes.

These reductions are found in 14 CFR 25.115. ICAO Annex 6 requires a net takeoff path be used. In either case, these numbers reflect a margin of safety. A margin of 0.8% for a two-engine aircraft doesn’t sound like much and it isn’t: just 0.008 x 6,076 = 48.6 ft./nm. There is, however, another margin to consider.

Procedures Based on All Engines Operating

Unlike aircraft takeoff performance data, obstacle departure procedures are designed assuming all engines operating (AEO). The U.S. rules are given in TERPS, Volume 1, Paragraph 201: "Criteria are predicated on normal aircraft operations for considering obstacle clearance requirements." ICAO has a similar provision in Document 8168, Volume II.

Both ICAO and TERPS specify a minimum climb gradient for all departure procedures. ICAO calls this the minimum procedure design gradient (PDG) and says it can never be less than 3.3%. TERPS calls this the minimum climb gradient (CG) and says it can never be less than 200 ft./nm. These values are about the same, since 200 ÷ 6,076 = 0.033, which is simply another way of writing 3.3%.



ICAO and TERPS also specify a surface below the aircraft's path that identifies a zone where obstacles cannot penetrate without having to change the climb gradient. (There is an exception for low, close-in obstacles but more on that later.) The ICAO obstacle identification surface (OIS) starts at the departure end of runway (DER) and inclines upward by 2.5%. The TERPS obstacle clearance surface (OCS) also starts at the DER and inclines upward by 152 ft./nm. The values are about the same, since (152 ÷ 6,076 = 0.025, which is 2.5%.

If you take the minimum climb gradient and subtract the obstacle surface you get the safety margin between the two. Under ICAO, the minimum obstacle clearance (MOC) is 3.3 - 2.5 = 0.8%. Mathematically, MOC = 0.008 x d, where d is the distance from the DER expressed in feet. Note that this value does not change with the climb gradient. MOC is 0.008 x 6,076 ft./nm = 48.6 ft./nm, no matter how steep is your climb gradient.

Under TERPS, the required obstacle clearance (ROC) is 24% of the climb gradient. Mathematically, ROC = 0.24 x CG. For the minimum climb gradient of 200 ft./nm, you have an ROC of 0.24 x 200 = 48 ft./nm. But as you steepen your climb, you also increase your ROC.

If an obstacle, other than a low, close-in obstacle (more on that later), penetrates the OIS/OCS, the procedure's climb gradient must be raised to preserve the MOC or ROC. Under ICAO, the 0.8% MOC is added to the gradient created by the obstacle. If, for example, a line from the DER to the obstacle is 5%, the procedure design gradient is raised to 5.8%.

Under TERPS, the climb gradient is adjusted to the following formula: CG = h ÷ (0.76 x d), where h is the height of the obstacle in feet and d is the distance from the DER in nautical miles.

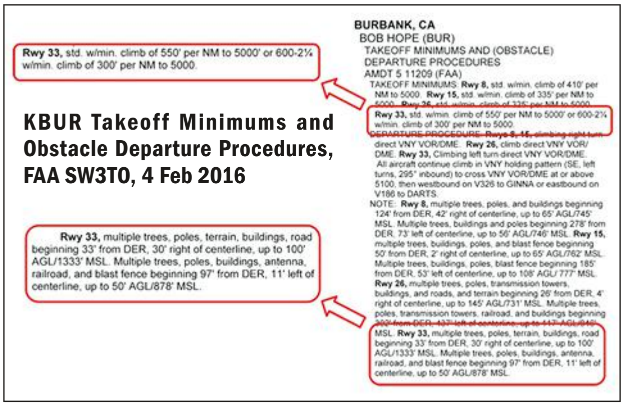
Let's say, for example, we have an obstacle that is 1,500 ft. above and 5 nm (30,380 ft.) away from the DER. The obstacle has a gradient of 1,500 ÷ 30,380 = 0.0494, or 4.94%. The ICAO MOC is always 0.8%, so our PDG is 4.94 + 0.8 = 5.74%. Our height above the obstacle would be (0.0574 x 30,380) - 1,500) = 244 ft. Under TERPS, the climb gradient is h ÷ (0.76 x d), or 1,500 ÷ (0.76 x 5) = 395 ft./nm. (That's 6.5%, much higher than the ICAO PDG.) So our ROC = 0.24 x 395 = 95 ft./nm. At 5 nm, our height above the obstacle will be 5 x 95 = 475 ft., almost double the ICAO margin.

Low, Close-In Obstacles

While ICAO and TERPS cast a very wide net when considering most departure obstacles, both seem to ignore obstacles known by the seemingly innocuous term "low, close-in obstacles."

TERPS and ICAO do not adjust climb gradients, takeoff minimums or procedures for any obstacles that are not higher than 200 ft. within the first nautical mile from the DER. TERPS, Volume 4, Paragraph 1.3.1 requires only that "the location and height of any obstacles that cause such climb gradients" be annotated. The same "catch" exists in ICAO Document 8168, Volume II, Paragraph 2.

In either case, a note is published to help us identify and plan to avoid these obstacles, but these are rarely written with enough specifics to help the pilot.



KBUR Takeoff Minimums and Obstacle Departure Procedures, FAA SW3TO, 4 Feb 2016

Rwy 33, std. w/min. climb of 550' per NM to 5000' or 600-2¼ w/min. climb of 300' per NM to 5000.

Rwy 33, multiple trees, poles, terrain, buildings, road beginning 33' from DER, 30' right of centerline, up to 100' AGL/1333' MSL. Multiple trees, poles, buildings, antenna, railroad, and blast fence beginning 97' from DER, 11' left of centerline, up to 50' AGL/878' MSL.

BURBANK, CA

BOB HOPE (BUR)

TAKEOFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES

AMDT 5 11209 (FAA)

TAKEOFF MINIMUMS: **Rwy 8,** std. w/min. climb of 410' per NM to 5000. **Rwy 15,** std. w/min. climb of 335' per NM to 5000. **Rwy 26,** std. w/min. climb of 325' per NM to 5000. **Rwy 33,** std. w/min. climb of 550' per NM to 5000' or 600-2¼ w/min. climb of 300' per NM to 5000.

DEPARTURE PROCEDURE: **Rwys 8, 15,** climbing right turn direct VNY VOR/DME. **Rwy 26,** climb direct VNY VOR/DME. **Rwy 33,** Climbing left turn direct VNY VOR/DME. All aircraft continue climb in VNY holding pattern (SE, left turns, 295° inbound) to cross VNY VOR/DME at or above 5100, then westbound on V326 to GINNA or eastbound on V186 to DARTS.

NOTE: **Rwy 8,** multiple trees, poles, and buildings beginning 124' from DER, 42' right of centerline, up to 65' AGL/745' MSL. Multiple trees, buildings and poles beginning 278' from DER, 73' left of centerline, up to 56' AGL/746' MSL. **Rwy 15,** multiple trees, buildings, poles, and blast fence beginning 50' from DER, 2' right of centerline, up to 65' AGL/762' MSL. Multiple trees, buildings, poles, blast fence beginning 185' from DER, 53' left of centerline, up to 108' AGL/ 777' MSL. **Rwy 26,** multiple trees, poles, transmission towers, buildings, and roads, and terrain beginning 26' from DER, 4' right of centerline, up to 145' AGL/731' MSL. Multiple trees, poles, transmission towers, railroad, and buildings beginning 302' from DER, 437' left of centerline, up to 117' AGL/846' MSL. **Rwy 33,** multiple trees, poles, terrain, buildings, road beginning 33' from DER, 30' right of centerline, up to 100' AGL/1333' MSL. Multiple trees, poles, buildings, antenna, railroad, and blast fence beginning 97' from DER, 11' left of centerline, up to 50' AGL/878' MSL.

Consider, for example, the note associated with Runway 33 at Bob Hope Airport, Burbank, California (KBUR). There are "multiple trees, poles, terrain, buildings, road beginning 33 ft. from DER, 30 ft. right of centerline, up to 100 ft. AGL." For anyone who has used that runway, finding a 100-ft. AGL target 33 ft. from DER would seem an easy task, except that it doesn't exist. The poorly worded sentence provides the pilot with very little useful information.

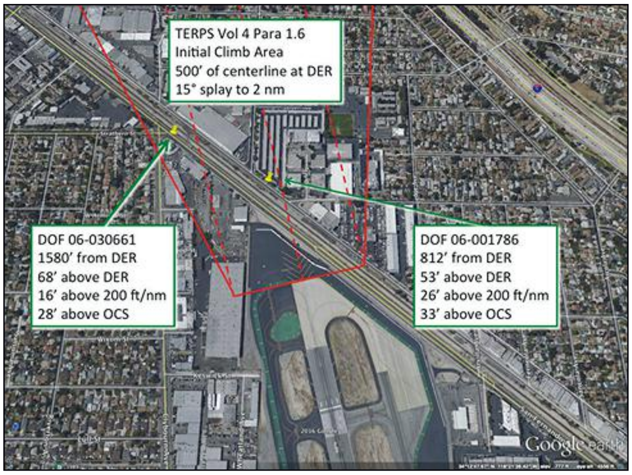
The FAA offers a digital obstacle file for the U.S. at **http://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dof/**, but these are very large, cumbersome, and take a good computer to really digest. If you wanted to try, you would see that the file covering KBUR is 790 pages long and includes these two gems:

06-030661 O US CA BURBANK 34 12 56.17N 118 21 50.28W POLE 1 00050 00846 R 2 C U A 2013106

06-001786 O US CA BURBANK 34 12 52.00N 118 21 41.00W POLE 1 00048 00831 L 1 A U C 2014152

So, if you were able to find these two obstacles out of the thousands given, and if you plotted them, you would see exactly the location of two of your low, close-in obstacles. The most critical appears to be 53 ft. above and 812 ft. from the DER, almost on centerline.

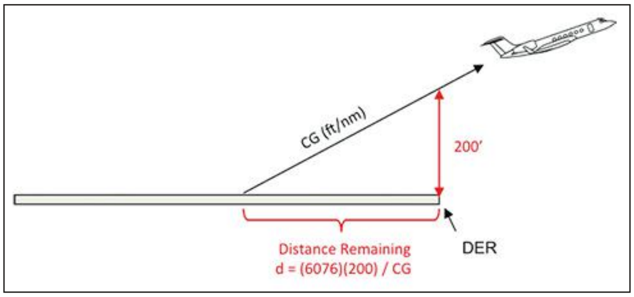
Is this a problem? Let's say it is raining, the weather is above standard and you are permitted to leave with the minimum climb gradient of 300 ft./nm to 5,000 ft. That comes to 300 ÷ 6,076 = 0.0494, or 4.94%. If the maximum weight for this climb gradient requires a ground run following an engine failure that equals the runway available, you can expect to cross the DER at 15 ft. (for aircraft that have wet runway performance data). A 4.94% gradient across a distance of 812 ft. results in a climb of 0.0494 x 812 = 40 ft. If you cross the DER at 15 ft., that means you are at 40 + 15 = 55 ft. when you cross the pole marked as DOF 06-001786, which is 53 ft. above the DER. You have a clearance of only 2 ft. A call to the airport manager might be useful, but without a very good database of terrain and obstacles, the only way to guarantee low, close-in obstacle clearance is to cross the DER at or above 200 ft.



GOOGLE EARTH IMAGE

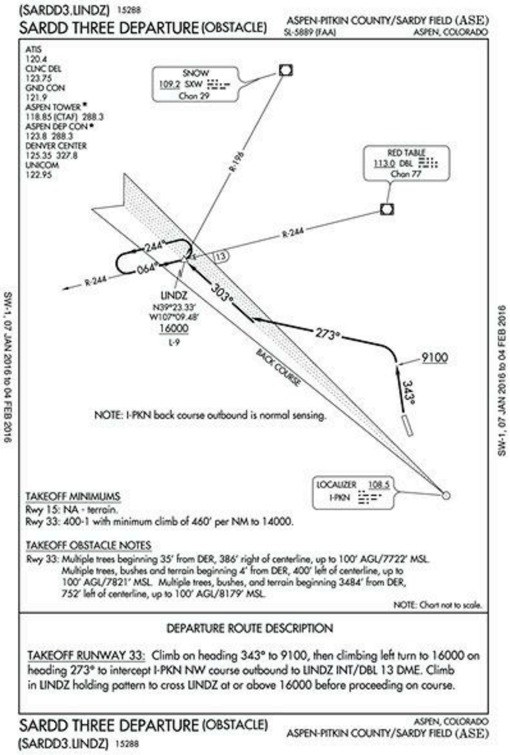
Two low, close-in obstacles at KBUR

If, for example, your planned weight at Burbank produces an engine-out climb gradient of 600 ft./nm, you will need to have at least (6,076 x 200) ÷ 600 = 2,025 ft. beyond your planned takeoff run to guarantee that you will clear any low, close-in obstacles.



Low, close-in obstacle avoidance, the "Brute Force" method.

Of course giving up such a large chunk of runway can be unnecessarily prohibitive if the low, close-in obstacles aren't really that close. A sound strategy for dealing with departure obstacles must consider all obstacles, even those TERPS and ICAO choose to ignore with nothing more than a nebulous note. Unfortunately, most strategies are blind to the issue.



(SARDD3.LINDZ) 15288
SARDD THREE DEPARTURE (OBSTACLE)
ASPEN-PITKIN COUNTY/SARDY FIELD (ASE)
SL-5889 (FAA)
ASPEN, COLORADO

NOTE: I-PKN back course outbound is normal sensing.

TAKEOFF MINIMUMS
Rwy 15: NA - terrain.
Rwy 33: 400-1 with minimum climb of 460' per NM to 14000.

TAKEOFF OBSTACLE NOTES
Rwy 33: Multiple trees beginning 35' from DER, 386' right of centerline, up to 100' AGL/7722' MSL. Multiple trees, bushes and terrain beginning 4' from DER, 400' left of centerline, up to 100' AGL/7821' MSL. Multiple trees, bushes, and terrain beginning 3484' from DER, 752' left of centerline, up to 100' AGL/8179' MSL.

NOTE: Chart not to scale.

DEPARTURE ROUTE DESCRIPTION

TAKEOFF RUNWAY 33: Climb on heading 343° to 9100, then climbing left turn to 16000 on heading 273° to intercept I-PKN NW course outbound to LINDZ INT/DBL 13 DME. Climb in LINDZ holding pattern to cross LINDZ at or above 16000 before proceeding on course.

SARDD THREE DEPARTURE (OBSTACLE)
(SARDD3.LINDZ) 15288
ASPEN, COLORADO
ASPEN-PITKIN COUNTY/SARDY FIELD (ASE)

Aspen-Pitkin County/Sardy Field SARDD THREE Departure, FAA SL-5889

Strategy: OEI Performance for AEO Procedures

Not too many years ago most pilots would tell you that the only way to legally and safely depart a mountainous airport was to use your aircraft's one engine inoperative (OEI) performance charts to meet the AEO departure procedure's gradient.

In the Gulfstream G450, for example, the AFM restricts us to only 47,000 lb. gross weight when leaving Aspen on the SARDD THREE Departure at 20C and 7,000 ft. pressure altitude — that's just barely enough fuel to fly for an hour and without any kind of safe fuel reserve. Armed with that information, the pilot would be forced to wait out the weather.

This strategy grounds the aircraft for obstacles that are miles away laterally and perhaps gives too generous a vertical margin as well. While they are maximizing their distant obstacle clearance, the published obstacle departure procedures do not consider low, close-in obstacles when establishing weather minimums or minimum climb gradients.

Strategy: Reduce Vertical Margins

Another technique is to keep the net takeoff path safety margin (between 0.8% and 1.0%, depending on number of engines) and remove the TERPS 24% ROC or the ICAO 0.8% MOC.

In the Aspen example, the required climb gradient is 460 ft./nm. You can remove the ROC by multiplying the CG by 0.76 (1 - 0.24), which means you only need to climb at 460 x 0.76 = 350 ft./nm. An ICAO departure will also be given in ft./nm but should also have the value given as a percentage. If not, divide the ft./nm by 6,076 ft. to get a percentage. An ICAO departure with a 460 ft./nm example becomes 460 ÷ 6,076 = 7.6%. To

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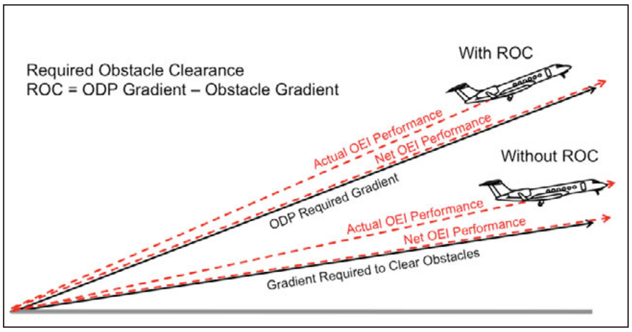
remove the MOC, subtract 0.8. Your new climb gradient target is 7.6 - 0.8 = 6.8%.

Using this strategy can be problematic because there is math involved and the principles can be confusing. Commercially available programs can automate the process, but these too, in my opinion, can be confusing. When entering the obstacle departure procedure gradient in one such program, you are asked to note if the procedure is designed under ICAO or TERPS. If you select ICAO, the program subtracts the 0.8% MOC from what it calls the "gross gradient" to produce a "net gradient." Likewise, if you select TERPS, the program multiplies the "gross gradient" by 0.76 (1 - 0.24) to produce a "net gradient." Selecting TERPS in our Aspen example yields a takeoff gross weight of 55,720 lb., an increase of over 8,000 lb.

Pilots may be misled into thinking they are only giving up their FAR Part 25 net takeoff path and still have the more generous TERPS ROC. This isn't the case. TERPS and ICAO Document 8168 do not use the terms "gross gradient" and "net gradient" to describe ROC and MOC. Using this program your climb gradient ends up being equal to the obstacle height plus only the net takeoff flight path factor. (For a two-engine airplane, that comes to only 48.6 ft. for every nautical mile traveled.)



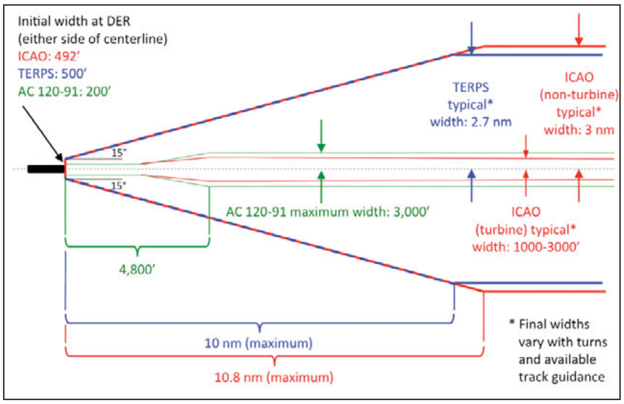
The impact of removing required obstacle clearance from performance computations

Let's say we are dealing with an obstacle right at the maximum allowed without having to increase the climb gradient, which comes to 152 ft./nm. So, we could conceivably have an obstacle at 5 mi. that is 5 x 152 = 760 ft. higher than the DER. Loading the airplane to achieve the required climb gradient of 200 ft./nm means we will be at 5 x 200) = 1,000 ft. plus the net flight path difference of 5 x 0.008 x 6,076 = 243 ft. We would clear the obstacle by 1,000 + 243 - 760 = 483 ft. If we elect to load our aircraft with more fuel and passengers so as to achieve only the 152 ft./nm climb gradient, our margin is cut in half.

This strategy also leaves untouched low, close-in obstacles and ignores one more factor in the departure obstacle avoidance problem. We often think of obstacles vertically: We have to out-climb what is directly beneath us. But we must also consider the lateral dimension.

Strategy: Airport Obstacle Analysis

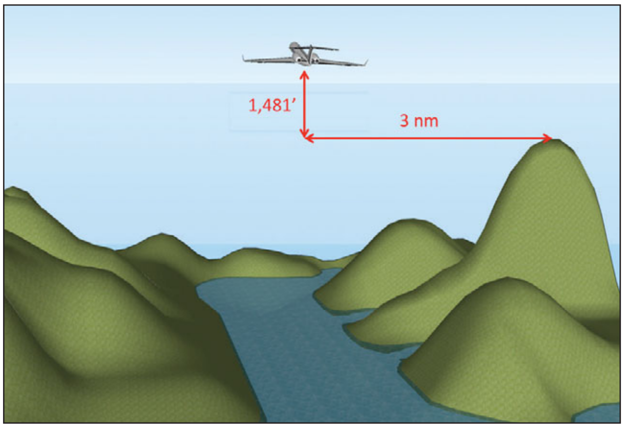
Obstacle departure procedures are designed with very wide lateral tolerances under both ICAO and TERPS. Those minimum climb gradients could be unnecessarily high because they are considering obstacles miles away from course centerline. Perhaps this was necessary back when an aircraft climbing into a cloud deck was lucky to be within a mile of course centerline. What about today? If you have an airplane with an instantaneous readout of "position uncertainty" you very seldom see your airplane more than 0.05 nm off course. That's just 300 ft.! While departure procedures continue to be built off these wide lateral areas, we as pilots are allowed to narrow our gaze if we have a plan.



ICAO and TERPS lateral obstacle consideration area comparison

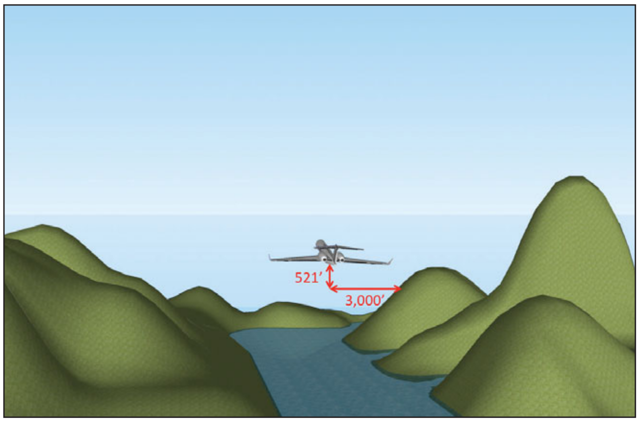
TERPS procedure construction can be very complicated; the lateral margins vary with distance from the departure end of the runway. The lateral margin starts at 200 ft. either side of runway centerline and quickly expands by thousands of feet to as much as 3 mi. ICAO procedure construction mimics TERPS in many ways and becomes almost as wide. Unless the procedure says otherwise, the climb gradient on these procedures could be based on obstacles that are miles away.

ICAO Annex 6 narrows the lateral margin that must be considered by large (more than 5,700 kg, about 12,500 lb.) turbine aircraft. The margin can be as tight as 1,000 ft. but will be no more than 3,000 ft., depending on course guidance, turns and distance from the runway. U.S. Advisory Circular 120-91 provides a method of applying an obstacle clearance area that is narrower than the TERPS area and is almost as narrow as the tightest ICAO margin. If an aircraft can maintain course within 3,000 ft., the required climb gradient can drop significantly, and that can allow much higher payloads.



Example vertical/lateral clearances under TERPS at 10 nm

Let's say you are departing in a two-engine aircraft from an airport that leads into a valley with what looks to be a challenging obstacle departure procedure. The SID says you need to climb at 400 ft./nm to an altitude that is 4,000 ft. above the departure end of the runway. Looking at the chart it appears the greatest problem will be around 10 nm after takeoff about 3 nm to the right. The departure takes you right down the middle of the valley, so if you lose an engine on takeoff how high above the obstacle will you really be?



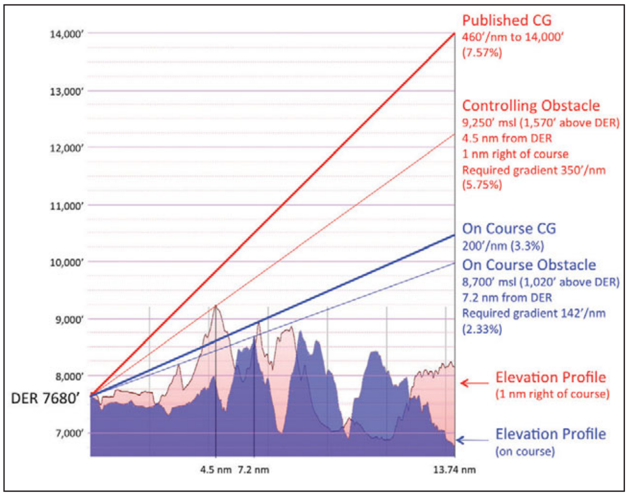
Example vertical/lateral clearances under TERPS at 10 nm

The procedure required obstacle clearance is ROC = 0.24, CG = 0.24 x 400 = 96 ft./nm, which means at 10 nm it will be 960 ft. A two-engine aircraft will also have the net flight path margin of 0.008 x 10 x 6,076 = 486 ft. While TERPS assumes the departure begins at DER on the runway, your aircraft manuals are usually predicated on 35 ft., which means you will cross almost 3 nm abeam the obstacle at an altitude 960 + 486 + 35 = 1,481 ft. higher than the obstacle.

Now let's say we narrow our lateral boundaries to the maximum provided in AC 120-91, just 3,000 ft. from either wingtip. We can increase our payload since we no longer have to out-climb the more distant obstacles and will give up the TERPS 24% ROC.

That means we will cross 3,000 ft. abeam another obstacle at an altitude 486 + 35 = 521 ft. higher than the obstacle.

Using terrain-mapping software, such as Google Earth, we can draw the Aspen SARDD obstacle departure procedure course line from the DER all the way to the completion of the procedure. We can also diagram the borders of the obstacle clearance area and discover the most challenging obstacles are about a mile right of course.

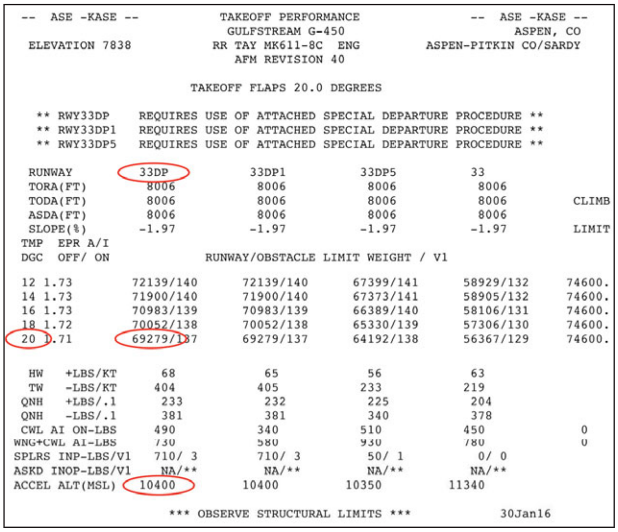


Comparing "on course" versus "1 nm right" SARDD departure obstacles, using Google Earth elevation profile feature

The published climb gradient is 460 ft./nm, which comes to 460 ÷ 6,076) = 7.57%. The DER is 7,680 ft. We will reach 14,000 ft. in (14,000 – 7,680) ÷ 460 = 13.74 nm. A theoretical controlling obstacle height can be derived from the TERPS formula: CG = h ÷ (0.76 x d). Solving for the height of the obstacle we see that h = 0.76 x d x CG = 0.76 x 13.74 x 460) = 4,804 ft. Our obstacle gradient appears to be 4,804 ÷ (13.74 x 6,076) = 5.75%.

Google Earth allows us to trace the departure procedure and produce a terrain elevation profile for an on-course departure (shown in blue) and for one that deviates to the right inside the TERPS obstacle clearance area until it is 1 nm to the right (shown in red). Right of course we see an obstacle at 9,250 ft. MSL, 4.5 nm from the DER. This obstacle will be 9,250 – 7,680 = 1,570 ft. above the DER. We can compute its gradient: 1,570 ÷ (4.5 x 6,076) = 5.74%, pretty close to our theoretical gradient.

We can repeat this process for what appears to be the most challenging obstacle if the airplane were to remain precisely on course, a peak of 8,700 ft. found 7.2 nm from DER. The peak is 8,700 – 7,680 = 1,020 ft. above DER. The gradient of this obstacle is: 1,020 ÷ (7.2 x 6,076) = 2.33%. This is less than the TERPS 152 ft./nm OCS, since 0.0233 x 6,076 = 142 ft./nm. If you could remain on course you would only need the minimum 200 ft./nm climb gradient.



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 --  ASE -KASE --          TAKEOFF PERFORMANCE                  --  ASE -KASE --
                            GULFSTREAM G-450                           ASPEN, CO
  ELEVATION 7838           RR TAY MK611-8C  ENG              ASPEN-PITKIN CO/SARDY
                             AFM REVISION 40

                         TAKEOFF FLAPS 20.0 DEGREES

   ** RWY33DP    REQUIRES USE OF ATTACHED SPECIAL DEPARTURE PROCEDURE **
   ** RWY33DP1   REQUIRES USE OF ATTACHED SPECIAL DEPARTURE PROCEDURE **
   ** RWY33DP5   REQUIRES USE OF ATTACHED SPECIAL DEPARTURE PROCEDURE **

  RUNWAY          33DP           33DP1          33DP5          33
  TORA(FT)        8006           8006           8006           8006
  TODA(FT)        8006           8006           8006           8006          CLIMB
  ASDA(FT)        8006           8006           8006           8006
  SLOPE(%)       -1.97          -1.97          -1.97          -1.97          LIMIT
 TMP  EPR A/I
 DGC  OFF/ ON                RUNWAY/OBSTACLE LIMIT WEIGHT / V1

 12 1.73         72139/140      72139/140      67399/141      58929/132      74600.
 14 1.73         71900/140      71900/140      67373/141      58905/132      74600.
 16 1.73         70983/139      70983/139      66389/140      58106/131      74600.
 18 1.72         70052/138      70052/138      65330/139      57306/130      74600.
 20 1.71         69279/137      69279/137      64192/138      56367/129      74600.

  HW   +LBS/KT     68             65             56             63
  TW   -LBS/KT    404            405            233            219
 QNH   +LBS/.1     233            232            225            204
 QNH   -LBS/.1     381            381            340            378
 CWL AI ON-LBS    490            340            510            450             0
WNG+CWL AI-LBS    730            580            930            780             0
SPLRS INP-LBS/V1  710/ 3         710/ 3          50/ 1           0/ 0
ASKD INOP-LBS/V1   NA/**          NA/**          NA/**          NA/**
ACCEL ALT(MSL)   10400          10400          10350          11340

                    *** OBSERVE STRUCTURAL LIMITS ***               30Jan16
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Extract of aircraft performance group example output, Gulfstream G450, Aspen

Of course this kind of analysis is impractical without the benefit of extensive terrain databases and sophisticated software. Many major airlines have been using these systems for years. One such system is available from Aircraft Performance Group) (APG, **http://www.flyapg.com**) available with a subscription and in many commercial flight-planning services.

Plugging our Aspen example into the software yields a significant increase in gross weight, nearly an extra 20,000 lb., which would be enough to make the East Coast. The program has the added benefit of factoring in low, close-in obstacles. But this software must also be used with care.

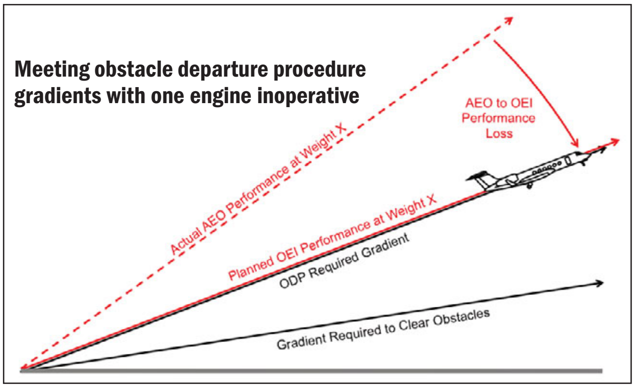
The software sometimes uses unpublished procedures that require additional steps in the event of an engine failure. You would have to file one procedure with the intent of using it under normal conditions. In the event of an engine failure, you may have to reprogram flight management systems or other avionics while letting ATC know you are deviating from the filed procedure. This is certainly possible but not something with which you should burden yourself while dealing with an engine failure in mountainous terrain.

The example "33DP" procedure, however, precisely mimics the SARDD THREE procedure. In fact, it is more precise, offering bank angles, a turn based on position and not altitude, and a specific time to begin flap retraction and acceleration. We can, as a result, have confidence that we can load our G450 to 69,279 lb. and: (1) be able to stay clear of all obstacles in the event of an engine failure if we stay within 3,000 ft. of our filed and planned course, (2) not have to worry about changing departure procedures in the event of an engine failure, (3) have enough fuel to make it to our destination on the east coast and (4) avoid all low, close-in obstacles.

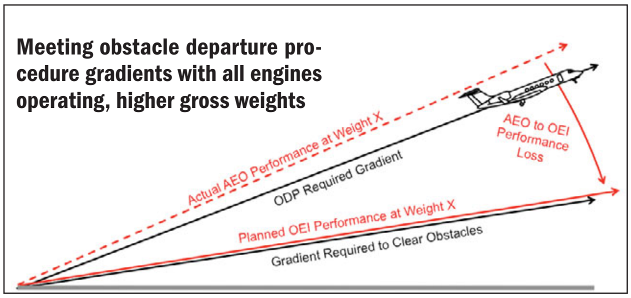
There still remains one loose end that the regulations do not address and that most proponents of increasing departure weights fail to recognize. If you increase your weight above the point where OEI performance will meet the AEO climb gradient you know you are OK if you lose an engine because you have (1) ensured you clear all obstacles by required vertical and lateral margins, and (2) you do not have to meet the departure procedure climb gradient because you have a failed engine. But what if you don't lose the engine? If your AFM does not have AEO takeoff climb path data, how can you be sure you will meet or exceed the procedure's minimum climb gradient? The FAA is silent on this subject other than to say it is something you need to consider.

Meeting AEO Climb Gradients at Higher Weights

Let's say, as with the Aspen example, you have an ODP climb gradient of 7.6% and elect to reduce that by the TERPS 24% ROC, lowering your OEI climb gradient to (1 - 0.24) x 7.6 = 5.8%. You know you will clear the obstacles because the climb gradient minus the ROC is based on that. Now if you don't lose an engine can you still meet the AEO climb gradient? What follows is my personal theory.



Meeting obstacle departure procedure gradients with one engine inoperative

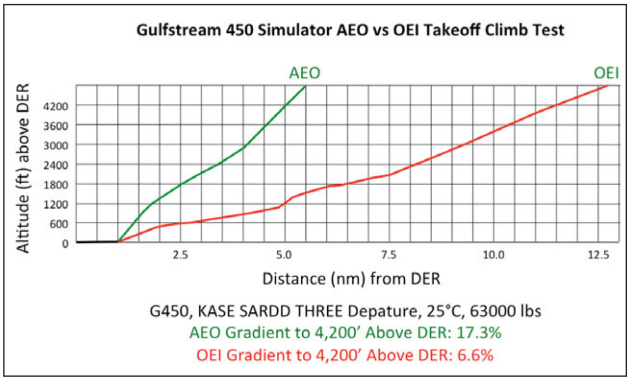


Meeting obstacle departure procedure gradients with all engines operating, higher gross weights

If you are flying a two-engine aircraft you are getting half your climb gradient from each engine. If you lose an engine, your climb gradient decreases by at least 50% because you will also have the parasite drag from the windmilling or seized engine.

It follows, then, that your all-engine climb gradient will be at least double your one-engine climb gradient. Since you've reduced your target climb gradient by a maximum of 24% and will have double the climb gradient available, you should be OK.

Since the loss of an engine in a three-engine aircraft results in 33% thrust loss and in a four-engine aircraft results in a 25% thrust loss, each aircraft should be OK since the maximum gradient reduction is 24%. In the case of our Gulfstream with a 5.8% OEI climb gradient, we can guess our AEO climb gradient will be at least 11.6%, much higher than the 7.6% obstacle departure procedure requirement.



G450 simulator climb tests, AEO versus OEI

I've tested this theory in a few aircraft simulators and it appears to be valid. In the case of a G450 loaded to near APG weights, the AEO takeoff climb performance was 2.5 times greater than with OEI. Armed with this data, I believe my aircraft will meet the required climb gradient with all engines operating, even after I've increased the gross weight to underperform the climb gradient with an engine failed by the TERPS ROC margin. You can test your aircraft by having the simulator operator freeze the gross weight and run an altitude-versus-distance track on two tries, one flying AEO and another with an engine failed at V1.

Rationalizing Your Margin of Safety

Picking a departure obstacle avoidance strategy is not as straightforward as one might think. Simply choosing to load the aircraft up so the AEO climb gradients are met with OEI does assure distant obstacle clearance and departure procedure compliance, but it does not assure all low, close-in obstacles are avoided. Electing to increase takeoff gross weight erodes the aircraft's vertical margin of safety, but in many cases the combined margins are unnecessarily wide. Using departure obstacle analysis software provides pilots with the ability to narrow the lateral margins so as to discount obstacles that are miles off course with the additional assurance that low, close-in obstacles will be avoided too.

But in every case where the vertical margin is decreased, pilots must understand how much of a margin is left over before they can decide if they are safe "enough." Let's return to our Aspen example to bring theory into practice.

▶ **Strategy One:** Our G450 was grounded in Aspen with a maximum takeoff weight of 47,000 lb. We could have flown for an hour and expected to top every obstacle within a few miles by a vertical margin that included the 24% ROC in TERPS as well as the 0.8% net takeoff path. This strategy fails to address low, close-in obstacles.

▶ **Strategy Two:** We could have increased our takeoff weight to 55,720 lb. by removing the TERPS 24% ROC. We still have the 0.8% net takeoff path vertical margin, but this isn't much when looking down on those jagged cliffs north of Aspen. If we found ourselves just 1 nm right of course, we would pass the mountain at 4.5 nm by just 218 ft. This strategy also fails to consider low, close-in obstacles.

▶ **Strategy Three.** Using computerized terrain and obstacle analysis software, we can increase our takeoff weight to over 69,000 lb., enough to fly to the east coast. We are assured of clearing all low, close-in obstacles, as well as those that are more distant. We must fly much tighter lateral tolerances and will end up with the same reduced vertical margins as found with the second strategy.

Modern aircraft have a way to address the tighter lateral tolerances. Navigating to within 3,000 ft. of course line is pretty easy if you ensure your GPS is operating with a good receiver autonomous integrity monitoring (RAIM) check and you are able to set your course deviation indicator to give you ample warning of a deviation. All of this electronic wizardry will be for naught, however, if you fail to "step on the good engine" and eliminate all adverse yaw with rudder.

The vertical performance is more problematic. In our Aspen example we are cutting our vertical margin over the most demanding obstacle from 500 to only 218 ft. How much of that margin will remain if you encounter a 10-kt. tailwind a few hundred feet in the air? What about a temperature inversion? Finally, if the rudder isn't perfect, any adverse yaw will erode that vertical margin further. Even in ideal conditions, crossing that shear mountaintop with only 218 ft. is sure to set off the enhanced ground proximity warning system.

Picking a Strategy

It has been said that the safest way to fly is to never leave the ground. Of course that also has an adverse effect on one's paycheck. We are constantly required to weigh "the safest way" with "safe enough." In our Aspen example, there is a tradeoff between how much fuel and how many passengers you can carry versus the vertical clearance you can hope for in the event of an engine failure. I can't pick a strategy for you since you may not be flying the same type of aircraft and your risk tolerances are surely different than mine. But I can offer my strategy as a possible template.

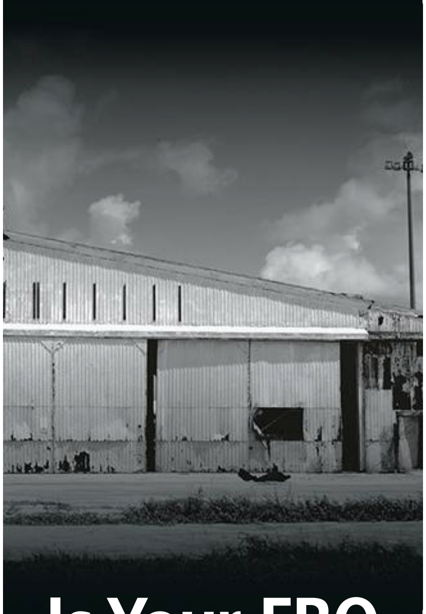
Whenever I go to an unfamiliar airport I run an airport obstacle analysis using APG software. If the charts say I can load up to maximum weight on published procedures, I know I can rely on my airplane's built-in performance computer and know I will beat all obstacles while meeting AEO climb gradients. Of course I need to do this for every departure because obstacles (manmade and natural) are constantly changing.

If the software says I am obstacle limited, I will consider the gross weight specified for published procedures only, and even then only as an absolute maximum. The winds and temperature at altitude have to cooperate for this plan to work.

I then brief the crew that we are about to take off with reduced vertical and lateral clearances and we will need to do a GPS RAIM check. Then I'll brief the other pilot on what I expect from each of us in the event of an engine failure.

I have been using airport obstacle analysis software for 10 years and I could further say I have been doing so without incident. But I haven't lost an engine in all that time. I do practice in the simulator a lot and my favorite place to practice is Aspen when loaded to APG weights. You need to see that cliff at 4.5 nm getting closer with the EGPWS going crazy to really understand how narrow that 0.8 net takeoff path percent margin really is. My aircraft has synthetic vision and a flight path vector that assures me through it all that I am not going to hit that mountain. It is still unnerving, nonetheless.

Back to Aspen. Five years after our original scenario I was back in Aspen with a new airplane and a new company. Our dispatchers were as despondent as the rest of the crews in the FBO. I loaded up our Gulfstream V to the weight we needed to make the East Coast, which split the difference between the strategy one weight and the maximum strategy three weight found in the APG software application. We departed on time and I am sure there were a few crews stuck on the ground wondering, "are those guys operating recklessly or are we missing something important?" **BCA**



Pilatus PC-12 NG

Faster and farther, more **capable** and more **comfortable**

PILATUS

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

There's no mistaking a 2016 Pilatus PC-12 NG from earlier versions of the aircraft. The third iteration of this 22-year old model sports a five-blade Hartzell prop with scimitar shaped blades made of black carbon fiber. Because of the new prop's computer-refined blade airfoil and thin chord section, it's more efficient at converting torque into thrust in all phases of flight than the aluminum Hartzell four-blade prop it replaces. It's also 7-lb. lighter, so it has less rotating inertia.

Harder to spot are the half dozen plus drag reduction improvements that, in combination with the new prop, enable the aircraft to cruise up to 5-kt. faster, take off on slightly shorter runways and climb to cruise altitude 10% quicker. The drag reduction is all about the details. Look closely on preflight inspection and you'll notice that the oil cooler cover has been reconfigured, the cowl exhaust vent has a flush surface, all antennas are aligned with the local airflow patterns, gap seals have been fitted to the flaps, the flap track fairings are more streamlined and there's a flush mount operating handle on the main entry door, among myriad other detail refinements.

Inside the aircraft, there are several quality and comfort improvements. Starting at s.n. 1576, there's a new air stair door with illuminated steps and a back-lit Pilatus logo. Cabin furnishings are on a par with best-in-class turboprop business aircraft costing up to twice the price.

The interior layout, created by Pilatus in partnership with BMWGroup Designworks, makes the most of the available cabin size. Large wells in the cabin side panels increased seated hip room. The side rails are positioned at the ideal height to function as outboard armrests for the chairs. The work tables fold out flush with the side rails to increase usable area. Headrests and aisle-side arm rests on the chairs retract to make it easier to move about the cabin.

Serial number 1589, the aircraft we flew for this report, is fitted with the optional Executive 6 + 2 cabin seating package. It includes a center four-seat club section with four, fully articulating chairs, plus two forward facing chairs with full extension leg rests in the aft cabin. When extra seating is needed, two occasional use seats may be installed in the rear of the cabin.

The cabinetry is top notch and finished with high gloss wood veneers. It's supplied either by F. List GmbH in Thomasberg, Austria or Precision Pattern in Wichita, Kansas. There are both USB and AC power outlets in the cabin. The IFE system offers audio-video on demand entertainment by means of a 100 terabyte hard drive and WiFi. Passengers can use their own tablets, PDAs or laptops as display devices.

As with all previous versions of the aircraft, the 2016 model has a 190-cu.-ft. cabin, a fully flat floor and a 4.3 ft. high by 4.4 ft. wide, swing up, aft cargo door. That feature makes it easy remove the aft seats and to load up to 1,000 lb. of large items. Cargo net tie-down fittings at frame 27 assure the passengers in the club section and cargo in the aft section

▶ ASK FRED

Send your questions about this article to: fred.george@penton.com

remain safely separated. The 16 cubic foot aft interior baggage compartment, behind frame 34, holds another 400 lb. of gear behind a separate cargo net.

As soon as the engine is started, pilots and passengers will notice a distinct difference in interior sound levels. The new prop turns at the same speed as the old four-blade version, but the extra blade causes it to emit 25% higher frequency sound that's more effectively sopped up by the interior acoustical insulation. That means noise levels drop by 2 to 3 dBA throughout the cockpit and FAR Part 36 noise levels drop by 2.3 dBA. Vibration levels aboard PC-12 always have been low, but the five-blade prop appears to make them even lower.

PILATUS

Apex's FMS has an impressive feature set. The system has runways, airways/jetways and a full complement of ARINC 424 procedures in its waypoint database, plus it can store an ample number of pilot-defined waypoints.

Rugged Swiss Design

As with all Pilatus designs, PC-12's airframe primarily is fabricated from high-strength aluminum alloys using conventional semi-monocoque construction. The nose cowl is a carbon fiber/nomex honeycomb composite sandwich, covered with a copper mesh for electrical bonding and lightning protection. Composites also are used for various fairings, landing gear doors and wing tips / winglets, plus the dorsal fin extension forward of the vertical stabilizer and ventral fin on the tail cone.

Each wing has an integral wet wing fuel tank with an overwing refueling port and a usable capacity of about 1,347 lb. An anti-icing additive must be mixed into the fuel.

The fuel system has left and right collector sumps, each having a DC-powered boost pump used for engine start, cross-feed and as a back-up to the main jet pumps. Fuel balancing is automatic, but it can be pilot controlled in case of a malfunction. Jet pumps also are used to transfer fuel from low points in the tanks to the sumps.

The left and right windshields are glass layers with stretched acrylic sandwiched in between the plies. All other windows are stretched acrylic. The main air stair entry door is 2.0-ft. wide by 4.5 ft tall. There is a 2.1 ft. high by 1.5 ft. wide emergency exit plug door over the right wing.

Aluminum is used for all the primary control surfaces, all of which are manually actuated, with inputs from the control wheel and rudder pedals transmitted to the control surfaces by push-pull rods and cables. There is an aileron/rudder spring interconnect to help prevent adverse yaw or roll. A 3-axis electric trim system actuates tabs on the rudder and ailerons, plus a screw jack moves the trimmable horizontal stabilizer. The ailerons have geared servo tabs that reduce roll control effort by two-thirds, endowing the aircraft with excellent pitch / roll control force harmony. The elevator has a stall barrier stick shaker and pusher system to help prevent excessively high angles of attack (AOA). The aircraft's Fowler flaps are electrically actuated.

The landing gear, having low-pressure tires, is built for rough field operations. The trailing link main gear have 14 inches of travel. A 28-volt electrically powered, 2,800 psi hydraulic pack supplies hydraulic power for gear extension and retraction. The gear are held in the retracted position by hydraulic pressure and in the extended position by mechanical locks. Back up hydraulic power for extension is provided by a hand pump.

Mechanical links through the rudder pedals provide +/- 12° of steering. Differential braking can pivot the nosewheel up to 60°.

Starting in March 2008, PC-12 received six major systems improvements, including one of the only dual-redundant, split-buss electrical systems to be fitted to a single-engine turboprop aircraft. Indeed, the electrical system layout resembles that of Eclipse 500 or Embraer Phenom 100. Each side of the split-buss system has its own 42 AH lead-acid battery and 300 amp generator bolted directly to the engine accessory gear box. Standard equipment also includes an emergency power system with a third battery. NiCad batteries are optional for operators who need more robust cold-weather cranking power. New for 2016 is an inflight heating package for the NiCads.

The split-buss system is designed for easy operation, with each side carrying designated loads. There are automatic buss tie and automatic load shedding functions that reduce pilot workload when neither generator is on line. The primary side powers essential equipment and the secondary side supplies non-essential gear. For pre-departure clearance delivery chores prior to engine start, a stand-by buss provides power to radios, FMS and the MFD map.

The split-buss's primary side battery powers all avionics prior to and during the initial part of the engine start cycle, thereby protecting it from current surges and eliminating the need to turn off avionics gear before both generators are on line. At 10% rpm, the primary side battery automatically ties into secondary side to assist in cranking the engine. With both generators on line after start, the electrical system reverts the normal split-buss configuration. Both generators must be on line to power the standard auxiliary electric heaters or optional vapor-cycle system (VCS) air conditioner.

If external power is available, it can be used to power equipment on all busses, including the electric heaters or VCS air conditioner. External power also is the only way to provide power all four Primus Apex screens prior to engine start because of the system's automatic load shedding design.

Ice protection is provided by deicer boots on the wing and horizontal stabilizer leading edges, exhaust heat ducted through the engine inlet lips and a particle separator that can be deployed in the engine air intake duct. Electric heaters provide anti-ice protection for the windshields, probes and static ports.

Aircraft built after March 2008 also feature a dual-channel, electronically controlled pressurization system with an FMS-derived landing field elevation look-up function. Once the crew plugs a flight plan into the FMS, the destination airport elevation automatically is sent to the pressurization system controller. If the destination airport is not in the FMS database, the crew can program in landing field elevation. That's a useful function if your destination is a grass strip next to your favorite trout stream or hunting lodge.

No other pressurization system inputs are required from the crew. Cabin altitude is 8,000 ft. at FL 262 and 10,000 ft. at FL 300, the aircraft's maximum certified operating altitude.

The airplane has ample heating capacity, as dual under-floor electrical aux heaters are standard equipment. The standard aircraft has an air-cycle machine (ACM) that provides air-conditioning, once the engine is running. But the bleed air supplied to the ACM by the Pratt & Whitney Canada PT-6A engine is too meager to provide much cooling in warm climates. Serial number 1589 has the optional VCS air conditioner that provides much needed additional cooling capacity in warm weather when both generators are on line. It also can be used to cool the cabin prior to engine start if 28-volt external power is available.

A four-screen Primus Apex avionics now is standard. An L-3 integrated standby instrument system replaces the Thales emergency gyro.

Flying Impressions

Configured as demonstrator for Pilatus Business Aircraft, s.n. 1589 is chock full of optional equipment, including vapor cycle air-conditioning, pulsing recognition lights, premium avionics package including ADS-B out, second FMS, along with the executive 6 + 2 cabin configuration, dual USB charging ports in the cockpit and WiFi IFE with 100 GB file server, among other options.

For our flight, single-pilot BOW was 6,828 lb., 46-lb. heavier than Pilatus' spec weight for the aircraft. In spite of the lighter weight carbon fiber prop, the NG models are heavier than the original aircraft because of a higher level of standard equipment, including emergency power system and under-floor heaters. Even so, the aircraft has a 963-lb. full tanks payload. Each additional passenger costs about 120 nm of range. For flight planning purposes, the aircraft has a 260 KTAS block speed and 1,600+ nm NBAA IFR (100-nm alternate) max range at that speed.


PILATUS

The Pilatus cabinetry is top notch and finished with high gloss wood veneers. It's supplied either by F. List GmbH in Thomasberg, Austria or Precision Pattern in Wichita, Kansas.

With Chief Pilot Jed Johnson in the right seat, two passengers and cargo, zero fuel weight was 7,613 lb. Fueled with 1,800 lb., ramp weight was 9,413 lb. Johnson used the Pilatus PC-12 digital AFM app on his iPad to compute takeoff data. Based on San Diego – Montgomery Field's 423-ft. field elevation and near standard-day conditions, the app predicted a 2,147 ft. takeoff distance over a 50 ft. obstacle using flaps 15 deg. Rotation speed was 78 KIAS and V50, analogous to VX, was 96 KIAS. Had we used flaps 30 deg., takeoff distance would have been reduced by 250 ft. That was unnecessary, considering Runway 28R is 4,600 ft. long. The purpose of our demo flight was to evaluate the performance and acoustical differences of the new Hartzell carbon composite prop and to sample the capabilities of Primus Apex Build 10.

Temperature compensation (T-COMP) for Baro VNAV approaches tops the list of Build 10 software updates, providing a capability long offered by other high-end Honeywell avionics packages. T-COMP provides the adjustment needed to correct pressure altitude for ISA temperature deviation to determine true altitude. As true altitude varies approximate 4 ft. per 1,000 ft. for each 1C of deviation from ISA, T-COMP is a critical function when flying baro VNAV approaches in extremely cold weather.

The flight plan log display has been updated to show the names of SIDs, STARs and airways. Estimated en route times to each waypoint also now are displayed. Vertical direct-to functionality has been enhanced and weather radar display inconsistencies have been cleaned up.

A "gateway" tab has been added to the flight plan page of the flight management window on the MFD, enabling pilots to select saved flight plans more easily and WiFi flight plan uploading from a tablet or PDA has been enhanced.

We started by switching on the standby battery buss, powering up the lower MFD, FMS, GPS and comm 2 radio. The standby mode enabled Johnson to call for clearance while conserving primary side battery power.

Immediately, we were reminded that Primus Apex, as configured for PC-12 NG, largely is based on Primus Epic as tailored for Dassault EASy. So, if you're comfortable with the EASy user interface and color conventions, you'll be at home in the PC-12 NG cockpit.

Apex, similar to EASy, depends extensively upon a cursor control device (CCD) or the joystick and arrow keys the multifunction display keyboard, to slew the cursor from field to field on each page. This involves a steep learning curve, in *BCA*'s opinion. Apex also has an on-screen graphic-user-interface waypoint entry system. The cursor can be moved to any location on the map and both published and user-defined waypoints can be entered. Build 10 allows pilot-defined waypoints to be displayed on the map, even if they're not part of the flight plan. Map resolution has been greatly improved over the original Apex installation in PC-12, so it's easier to use the point-and-click entry method to define VFR waypoints. Honeywell has upgraded the MFD with cartographical and topographical features, but the overall design of the system is intended for IFR, not VFR, operations.

Prior to start, it's also difficult to calculate aircraft weight because, while you can manually enter weights for the aircraft, pax and cargo, a fuel quantity indication is not immediately available. After engine start, you can sync the fuel quantity indication on the weight calculation page. But the weight build-up page only computes weight — not center of gravity.


PILATUS

As with all previous versions of the aircraft, the 2016 model has a 190-cu.-ft. cabin, a fully flat floor and a 4.3 ft. high by 4.4 ft. wide, swing up, aft cargo door. That feature makes it easy remove the aft seats and to load up to 1,000 lb. of large items. Cargo net tie-down fittings at frame 27 assure the passengers in the club section and cargo in the aft section remain safely separated. The 16-cu.-ft. aft interior baggage compartment, behind frame 34, holds another 400 lb. of gear behind a separate cargo net.

While the FMS doesn't have AFM tabular airport performance data, Pilatus has a performance planning app that runs on tablets or PDA computers that calculates runway length and V speeds.

Apex's FMS has an impressive feature set. The system has runways, airways/jetways and a full complement of ARINC 424 procedures in its waypoint database, plus it can store an ample number of pilot-defined waypoints. It can compute estimated time of arrival to each waypoint in a flight plan based upon projected cruise performance and winds aloft at each waypoint, similar to the functionality of Honeywell's top-of-the-line NZ-2000 FMS. Or, the pilot can use the aircraft's current ground speed and fuel flow while in flight.

Apex also has the ability to store an active and alternative flight plan, so it's easy to pre-plan and store a route to an alternate destination should the primary destination airport be fogged in.

Published crossing altitudes now are shown for each waypoint on a published procedure programmed into the FMS and they also can be manually programmed waypoint by waypoint into the flight plan. VNAV functions now include vertical glidepath, LPV and en route VNAV, plus a vertical direct-to function. Build 10 also provides advisory VNAV to other waypoints.

Apex has several other features that make it relatively intuitive to use, including adherence to the quiet, dark cockpit design philosophy. Display colors are used appropriately, with sparing restraint to avoid screen clutter and distraction. There is mostly industry-standard color consistency from function to function on most screens, with the exceptions of magenta always being used for active course guidance and non-standard colors for the radio management window. There is no color distinction between short-range and long-range navigation guidance.

Similar to the colors used on legacy Primus II radio management units, cyan instead of white is used for standby frequency fields and white instead of green is used for active frequency fields. We prefer the industry-standard white-for-standby, green-for-active color convention originally planned for the Apex radio displays, but not used in production Apex systems. The white and green color convention for radio tuning also is used by Gulfstream and Rockwell Collins.

Our flight plan called for climbing to FL 210 and flying east of Mission Bay on V-66 and J-2. We planned to reverse course over Imperial and fly over to Borrego Valley Airport for airwork and approaches.

Taxiing out of the chocks, it was necessary to use differential braking to steer clear of parked aircraft on CrownAir's ramp. Once clear, nosewheel steering through the rudder pedals sufficed to keep us on centerline. We noted that the new prop provides more than ample thrust at idle, so it's necessary to use a little reverse thrust [beta range] to control taxi speed without riding the brakes. Standard procedures call for extending the ice-protection particle separator in the engine air inlet to minimize the possibility of foreign object ingestion.

We used the automatic torque limiter on takeoff to ease pilot workload, but Johnson cautioned that the pilot still must monitor engine torque and temp to avoid exceeding limits. Even with 1,200 shp on tap, we needed only slight right rudder pedal pressure to keep the aircraft on centerline. Control forces on liftoff were quite pleasant, especially with the 2/3 reduction in roll control effort made possible by the addition of aileron servo tabs in Series 10 aircraft, the model that immediately preceded the PC-12 NG.

Notably, PC-12 NG's -67P engine has a 60C hotter maximum continuous ITT limit than the -67B in earlier models, so it can be run at 1,200 shp in climb rather than being limited to 1,000 shp. And 1,200 shp is available up to 18,000 ft.

The 20% boost in MCT horsepower makes it much easier to climb out of mountain valleys and over ridgelines in warm weather. It also gets passengers above most of the cumulus bumps 20% faster. Time to climb to FL 300 is 27 minutes in PC-12 NG versus 34 min. in the older model.


PILATUS

We settled into a 1,700 fpm climb. When Apex's yaw damper is engaged, rudder trim is automatic, also reducing pilot workload. After a series of intermediate level offs, we reached FL 210 about 18 minutes after takeoff.

At a weight of 9,200 lb. and at ISA+5C, the aircraft settled into a 271 KTAS cruise speed with a fuel flow of 464

PILATUS

PC 12 competitors lack its rough-field capability, spacious 6 to 8 seat cabin and a full width lavatory (above), among other capabilities.

lb./hr. That was 5 kt. slower than book speed.

And for good reason. The wind was howling from west to east over the Laguna Mountains at 50+ knots and it was stronger at FL 210. We were fighting a mountain wave sinkhole just to stay level in cruise. By the time we reached Imperial we were on the upswing of the wave, but it was time to turn back toward Borrego Valley airport for pattern work.

Keeping in mind the strong mountain wave, we began our descent toward Borrego Valley. That was not a good idea as it turned out. By the time, we descended through 8,000 ft., we knew we had entered an invisible, wind-powered meteorological washing machine on the leeward side of the Lagunas. Large clouds of sand and dust were blowing up from the desert floor. Rotor clouds were forming on the leeward side of the Lagunas.

Time to punt. We climbed up to 16,500 ft. to find smoother air, radioed L.A. Center to pick-up our IFR clearance back to Montgomery Field and called it a day. Johnson activated the standby flight plan from Julian to Mission Bay via V-460. We loaded the ILS 28R approach into the flight plan, automatically selecting Runway 28R as the landing runway. We found the CCD track ball somewhat more difficult to use for such graphic user interface tasks than conventional controls on the MFD. Johnson, though, commented that it takes a few hours to adjust and adapt to Apex, similar to the learning curve with EASy.

After L. A. Center had handed us off to SOCAL, we were instructed to proceed directly to NESTY, one of the intermediate waypoints on the ILS 28R approach. Again, Apex's direct-to function is not intuitive, in our opinion. Several steps are necessary to select and activate either the lateral or vertical direct-to guidance modes.

But once the box was programmed, it was easy to fly the ILS because of the flight path marker, acceleration chevron and "dynamic speed bug," or filtered AOA symbol, on the PF. These symbols provide HUD-like guidance on the head-down display, making it possible to fly the aircraft with greater precision and smoothness.

At a landing weight of 8,500 lb. and using full flaps 40 deg., VAPP (VREF) was 80 KIAS and computed landing distance was 1,950 ft. without using reverse thrust. Using beta range shortened landing distance by nearly 200 ft.

We actually used the dynamic speed bug, normalized AOA, to fly the approach. The bug is considerably more stable than the raw AOA formerly displayed on the Apex PFD. VREF landing speeds range from 73 to 87 KIAS, depending upon aircraft weight, enabling the aircraft to use 2,200 to 3,150 ft. runways regardless of surface.

Long-travel, trailing-link landing gear make for gentle touchdowns in the PC-12 NG. With the wheels on the runway, we used a little reverse thrust to slow to brake speed. Robust use of reverse thrust and wheel brakes can shorten landing rolls to 800 to 1,000 ft. And the AFM performance charts indicate that you can fly out of virtually any airport at which you can land, assuming equal takeoff and landing weights.

The following day, we flew out to Santa Catalina for pattern work, plus photography and video. Unfortunately, we encountered local officials from the Santa Catalina Island Conservancy who informed us we would need to fill out forms, pay commercial photography fees, wait at least three days for processing and comply with multiple procedures.

Again, we aborted the mission after one landing and returned to Montgomery Field.

Our overall impressions? The 2016 PC-12 NG is quieter, smoother and more capable than earlier models. It's capable of flying 240 KIAS on arrival for synching up with jetliners arriving at major airports. It's also able to slow down to 80 KIAS on approach to fit in with traffic at small general aviation airports. The cabin is comfortable, commodious and the IFE will keep each passenger occupied on the longest missions. Honeywell keeps updating Primus Apex, but there's still room for improvement to make the system simpler and the GUI more discoverable.

In a Class of Its Own

Single engine turboprops have certainly come of age. Look at this year's *Purchase Planning Handbook* and you'll see 10 SET models, six of which are high-performance, pressurized business aircraft that compete favorably with twin-turboprops on shorter-range missions. Textron Aviation also plans to introduce a 280 KTAS cruise, 1,500-nm range SET business aircraft, adding heft to this segment.

To date, though, PC-12 has no direct competitors in the segment. TBM900/930 are the closest, having comparable range, much better climb performance, up to a 45 KTAS speed advantage and better fuel efficiency. But they lack the PC-12's rough-field capability, capacious 6 to 8 seat cabin, full width lavatory and 2,220+ lb. payload, along with the largest cargo door in class.

The PC-12 is the largest, heaviest and most expensive model in the single-engine turboprop class. But it continues to sell strongly. Pilatus will deliver its 1,400th PC-12 in 2016 — more than twice the number of the closest competitor.

With single-engine turboprop commercial operations in North America becoming more popular and with EASA moving toward permitting single-engine turboprop charter operations, demand for 8+ passenger aircraft in this class is increasing. In addition, now that engine reliability is better than one inflight shutdown per 100,000 flying hours, more corporate flight departments are eying PC-12 as a reliable, cost-effective alternative to twin-turboprops for trips up to 600 nm.

And now that General Electric is developing its new 2,000+ thermodynamic horsepower GE93 turboprop, another variant seems possible.

The PC-12, as a result, is likely to remain in a class of its own for years to come. **BCA**

International Ops Alerts

Brazil Olympics, impending ICAO emissions standard, Euro ramp inspections, **and more**

Locations of the Rio de Janeiro Summer Olympic Games

NBAA IOC REPORT

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

The Rio de Janeiro Summer Olympic Games — dubbed "Rio 2016" — are scheduled to begin Aug. 5 and extend through Aug. 21. The 2016 Paralympics will run from Sept. 7 to Sept. 18 in the same locale.

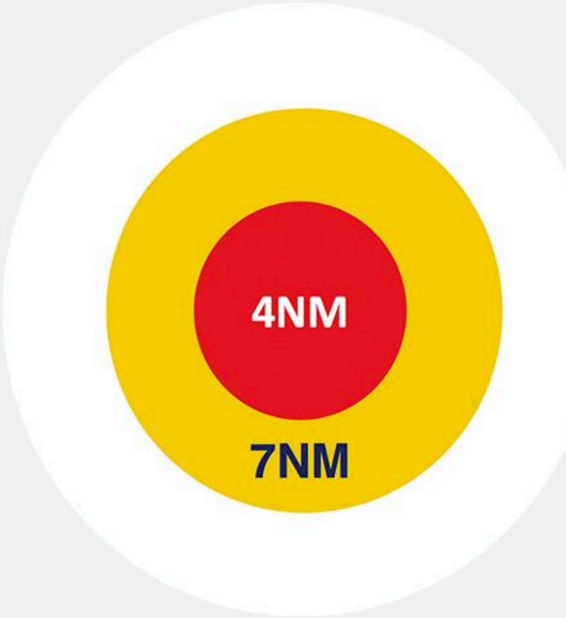
This presupposes, of course, that lagging construction at some venues will be completed in time, the beleaguered Brazilian economy won't collapse, and the huge host country's political turmoil involving the possible impeachment of President Dilma Rousseff for corruption, among other issues, will calm before or throughout the events. Regardless, business aviation operators planning to attend the Games should be making plans, reserving slots and accommodations, and getting their documentation — a burdensome requirement for visiting Brazil — in order now. It also behooves operators and charter providers to be acquainted with the extensive temporary flight restrictions that will be implemented in Rio and the five other cities where the various competitions will be held. Coordination with operators' handling and flight planning agencies should have already begun as you read this.

Athletes and teams representing more than 200 countries are slated to compete in the Games and more than 100,000 Brazilian citizens will be involved in staging the competitions.

Several million spectators are expected to flood into the country, most arriving via airline at Rio de Janeiro Galeão International Airport (SBGL), where US$1.6 billion has been invested in improvements to accommodate them. Additionally, an estimated 1,000 business aircraft are predicted to visit Brazil for the Games, some whose operators are willing to shell out big money for parking and handling services at Galeão. Others plan to touch down there only to disembark passengers and clear customs, then reposition to other less-expensive airports.

The six venues for the 2016 Games are, of course, Rio, where the opening and closing ceremonies will be held; plus Belo Horizonte; Brazil's capital, Brasília; Salvador; the nation's largest city, São Paulo; and the Amazonian city of Manaus. Now, Brazil's Department of

Airspace Restrictions — Exclusion Areas



Reserved Area (White): Area existing in all cities involved, ATC specific rules apply.

Who can fly on the white area:
Aircraft respecting:
- Flight plan rules
- Having a transponder
- Maintaining communication by radio with the ATC

Restricted Area (Yellow): Within the yellow area, ATC specific rules, Airspace Defense authorization and specific security measures.

Who can fly on the yellow area:
- Governmental authorities and military
- Medevac flights
- VIPs classified by presidential "chief of staff"
- Olympic, Paralympic committees and Federations, and official filming

Prohibited Area (Red): Within the red area, permitted exclusively under Airspace Defense authorization.

Who can fly on the red area:
- Governmental authorities; military medevac flights on duty
- Police aircraft on duty
- Official filming

* Up to FL 145 (Except for Rio FL 195)

BRAZILIAN DEPARTMENT OF AIRSPACE CONTROL

Airspace Control (a division of the country's military) has devised a system of airspace restrictions, or "exclusion areas," over these cities defined by three concentric circles: white, yellow and, directly over the Olympic venue, red, all of them in effect only during the period of the relevant event.

In the outermost circle (white), up to FL 145 (FL 195 over only Rio), only aircraft equipped with transponders, maintaining radio comm with ATC and "respecting flight plan rules" can operate while the zone is in effect. Moving closer to the venue, things get more restrictive: In the yellow zone, the same altitude caps hold but the space is restricted to "governmental authorities," military aircraft, VIPs "classified by presidential chief of staff," Olympic and Paralympic committee members and federations, and aircraft approved to engage in filming. Additionally, before entering a yellow zone, an aircraft must undergo a security inspection "carried out by the accredited service provider hired by the air operator . . . when it is inoperative for longer than 6 hr. or when there is a suspicion of unauthorized access to aircraft." Further, "aircraft access control" must be kept under surveillance at all times.

The red zones, not surprisingly, are designated "prohibited" and entry during Olympic events is allowed solely under "airspace defense authorization." Thus, only transportation of government authorities and military operations, medevac and police flights, and official aerial filming will be allowed.

As already mentioned, the exclusion zones will go into effect only during the duration of the events they overlay; at other times normal procedures prevail.

All of this is detailed in the Brazil Department of Airspace Control publication AIC18-15, Dec. 15, 2015.

As of this spring, DAC authorities had yet to announce whether operators would be able to fly directly to Rio Galeão or be required to land at a port of entry (POE) elsewhere, clear customs, then fly on to SBGL during a period when the airspace there was open. Given the expected congestion at both Rio Galeão and the city's domestic airport, Santos Dumont (SBRJ), many visiting operators may want to "drop and go" anyway, depositing passengers at Rio and then repositioning to outlying airports outside of the Olympic exclusion areas. Both fields also exercise slot controls that — as one would expect — will be tightened for the period of the Games.

Two days before and after the opening and closing ceremonies, 15% of slots at SBGL will be allocated to general aviation, dropping to 10% during the Games. The other 85% and 90%, respectively, go to airlines and VIP, including head of state, aircraft.

And while the "normal" lead time for approving slot applications through the coordination agency CGNA is five days, during the Olympic period, it is a minimum of 30 days in advance. Additionally, flight plan submission will be extended from the normal 45 min. prior to ETD to at least 90 min. before ETD.

Expensive Real Estate

At Rio Galeão, general aviation parking is being managed by Lider Aviation of São Paulo and occurs on Taxiway M, the same as used during the 2014 World Cup. According to Cynthia de Oliveira, Lider's operations director, the taxiway can accommodate up to 165 business jets, "depending on the mix of aircraft types." The parking scheme is optimized to facilitate movements and is promised not to be like the cargo ramp arrangement used by another handling contractor at Rio during the World Cup, where airplanes were crammed into a confined space with limited ingress/egress. Thus, to move an aircraft from the back of the ramp, numerous planes had to be repositioned requiring lots of marshals, tugs, etc., with associated fees.

In any case, cargo ramp or taxiway, ground handling at a world event like the Olympics is expensive "because we have to bring people — supervisors, managers and coordinators — from other airports to make it work, and this adds to cost of handling," Oliveira explained. "The situation is further complicated in Brazil because the aircraft handlers' shifts are limited by law to 6 hr., hence the need to have more people on hand."

The rules governing parking and pricing have yet to be formulated, Oliveira said, "and this will influence whether an operator will drop and go or stay there [assuming there is space available]. Repositioning is always an option." The company has identified five relatively nearby airports for the purpose. "We learned from the World Cup," she said.

During the World Cup at Rio, Lider claimed 80% of the operations in ground handling. "In all of Brazil, we had 70% of the movements, the only company with presence in all 12 of the host cities," she continued. "So we've learned a few things about how to do this."

The five recommended airports for repositioning, all less than 215 nm from Rio, are: Sao Pãulo Guarulhos (SBGR), São Paulo Congonhas (SBSP), Viracopos/Campinas (SBKP), Belo Horizonte (SBBH) and Tancredo Neves/Confins (SBCF). Between 215 and 1,000 nm, add Brazil's capital airport, Brasília (SBBR), Salvador (SBSV), Porto Alegre (SBPA) and, further up the coast, Recife (SBRF). Understand, however, that except for Porto Alegre and Recife (the latter, 1,000 nm distant), all the others will have slot requirements either permanently in place (read: São Paulo) or temporarily imposed for the duration of the Olympic period.

Obviously, if your principals have indicated that they want to fly to the Olympics, your planning should already be completed or at least well underway. The best strategy to avoid problems and surprises is to work closely with a reliable flight planning and handling agency that knows the proclivities of Brazilian entry requirements.

For those unfamiliar with Brazilian operations, the country's byzantine directives governing foreign operators can be daunting:

▶ Permits and notifications: overflight, single landing or multiple landings, the last requiring the "AVANAC certificate," which must be secured prior to filing flight plans to Brazil or entry will be refused.

▶ Temporary Admission Entry Term: a customs document awarded on arrival at a POE to register the aircraft into Brazil's customs system, which along with the AVANAC, must be surrendered when the aircraft leaves the country.

▶ Mandatory documents: airworthiness certificate, aircraft registration, insurance policy with Brazil rider, and for commercial operators, Air Operating Certificate (AOC) and Operations Specification (Ops Spec).

▶ Cockpit crew licenses and medical certificates. Note that all pilots must carry First Class Medicals — even first officers holding Commercial Certificates.

▶ Visas: required for passengers and cabin attendants only. However, the Brazilian government has waived the visa requirement for U.S., Canadian, Australian and Japanese citizens entering the country between June 12 and Sept. 18, 2016. While not required for pilots arriving with the aircraft, relief crews entering the country via airline must have them.

Note that the Brazilians are unwavering in their requirements for visiting operators, and those who arrive without proper documentation will be denied entry into the country. The lack of a signature on a document, a wrong medical certificate or one that will expire too soon for Brazilian authorities to accept, failure of your handler to register your aircraft tail number with Brazilian customs — any of a myriad small details that could send you and your passengers back home on arrival.

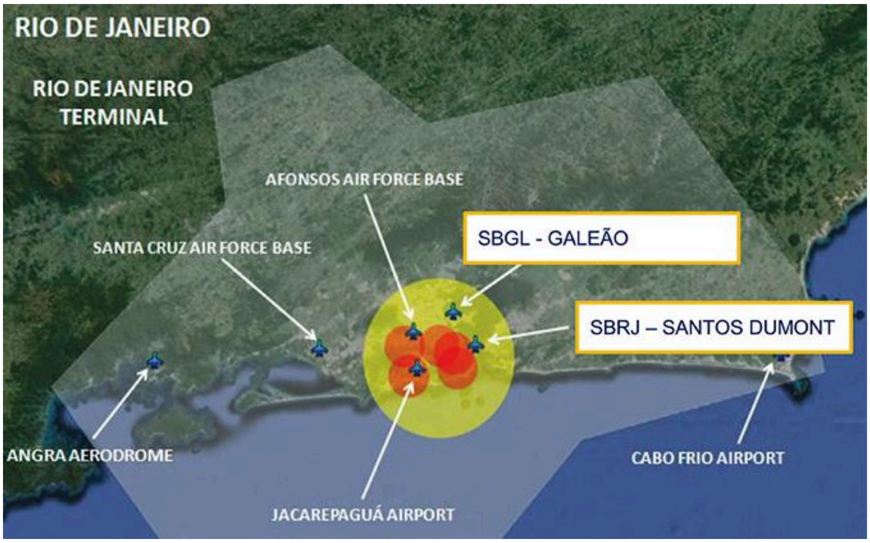
For a more detailed discussion of Brazilian aviation and customs requirements, see "Operating in Brazil" (*BCA*, January 2009). Also, Lider Aviation has published a pamphlet titled "Rio De Janeiro 2016, Come and Be Part of This Show," which contains airport

Rio International Airport Galeao (SBGL). Due to activation of restriction zones, operation will be very limited.

NBAA IOC REPORT

information and other data on negotiating the Olympics' aviation obstacle course. It as well as updates on Rio 2016 news and procedures can be obtained at Lider's website: **http://rio2016.lideraviacao.com.br/en**.

Finally, Oliveira adds this advice to Olympics-bound operators: "Please consider Galeão Airport as a short-term stop. For movements throughout Brazil during the Games, consider planning operations only within the white areas [of the exclusion zones]. When considering Rio, plan to fly during times when exclusion zones are not activated. Come to Brazil — it will be a challenge, but we are a friendly country."



BRAZIL'S DEPARTMENT OF AIRSPACE CONTROL (2)

No Joy in Bali

Business aviation operators headed to Indonesia should be aware that in October 2015 the nation's Ministry of Transport implemented a regulation banning domestic operations by foreign operators within the archipelago. PM 66 applies to both "Non Commercial and Commercial International Unscheduled Air Transport using Foreign Civil Aircraft to and from the Territory of the Republic of Indonesia."

While the regulation doesn't ban foreign operators from entering the country, foreign-registered aircraft are now required to fly only to a POE, disembark passengers and remain there until passengers reboard and then depart the country. Passengers desiring to travel within Indonesia must do so on domestic airlines or aboard local charter services.

The International Business Aviation Council (IBAC) registered its opposition to the new policy in a Nov. 30, 2015, letter to Transportation Minister Ignatius Jonan, pointing out that on a visit to Washington, D.C., Indonesian President Joko Widodo had "emphasized the importance of policies that encourage foreign investment in Indonesia."

The letter from IBAC Secretary General Kurt Edwards pointed out that PM 66 had established "burdensome processes" for operators of foreign-registered aircraft visiting Indonesia and restricted movement within the country that inhibited business activities of both visitors and domestic business aircraft operators. The letter was accompanied by a comprehensive IBAC-generated white paper explaining the advantages of business aviation as a proven productivity tool.

IBAC's appeal was refuted in a terse letter dated Jan. 13, 2016, from the Indonesian director of civil aviation. In it, he stated that PM 66 would not be altered to accommodate operation of foreign-registered aircraft within the country and that if operators wanted "to conduct business by visiting two points within Indonesian territory you can use Indonesian carrier [sic.]."

But there may be more to the new regulation restricting movement within Indonesia's borders than what appears to be an ill-conceived anti-cabotage policy.

"Looking behind the curtains," an informed source who requested anonymity told BCA, "the Indonesian government is after wealthy Indonesians who have bought airplanes and based them out of the country, having their flight crews reposition them to Indonesia when they want to use them." Thus, these operators have not "imported" the airplanes and paid required duties, which can be significant. "So indications are that they are after people gaming the system," the source concluded.

Toward a World Standard for Aviation Emissions Trading

The International Civil Aviation Organization (ICAO) continues to plod toward a global standard for CO_2 and NOx emissions trading that will rationalize the EU's controversial Emissions Trading Scheme (ETS) — if the Europeans agree to accept it.

As we reported in "Euro ETS Reconsidered" (*BCA*, April 2013), the ETS was born out of an interim environmental initiative designed to pressure ICAO into developing a world standard for mitigating aviation's contribution to greenhouse gases. The problem was that the EU went too far in conceiving the ETS.

Particularly harsh on business aviation, the principal insult of the carbon-trading program was its "extraterritorial" provision, calling for visiting operators — airlines as well as general aviation — to be accountable for their CO_2 emissions not just in EU member country airspace but all the way from their points of origin and return as well. The program required operators to purchase carbon credits at the end of each year of operation to offset their aggregate CO_2 emissions in metric tons for the previous 12 months, with the provision of some free allowances. (Burning one ton of jet fuel releases 3.12 tons of CO_2 into the atmosphere.)

When the ETS was announced at the beginning of the decade, it was met with worldwide opposition that nearly fomented a tit-for-tat trade war, with many countries questioning the legality of the measures. "It was the whole world against the EU," Guy Visele, a consultant to the European Business Aviation Association, told BCA. In response, the EU environmental authorities declared a moratorium on the extra-territorial provision and confined emissions reporting and purchasing of carbon offsets to its 28 member states. The program continues on that basis today, with operators accessing EU airspace — either domestic or visiting international — obligated to monitor and calculate their CO_2 emissions, purchase carbon credits and surrender them to the EU during the following year.

Annual emissions exemptions have been assigned to both private and

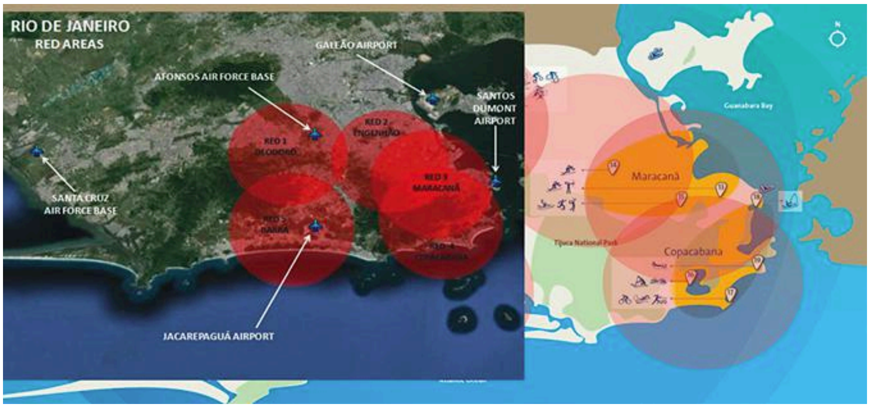


Photo to the left shows more airspace restrictions for Rio de Janeiro. Above illustration shows prohibited areas in red.

commercial operators, 1,000 metric tons for the former and 25,000 tons for the latter, beyond which carbon offsets have to be purchased. For 2015 emissions, the reporting deadline for applicable operators to surrender their carbon credits was April 30, 2016. The EU has put teeth into the reporting requirement by levying heavy fines, having issued 1 million euros in sanctions to non-complying operators for the 2012 reporting period alone. And for operators making only a few trips a year into EU airspace, Eurocontrol has established the Small Emitter Support Facility that removes the verification requirement and provides a simple formula for calculating emissions, greatly reducing the workload for reporting.

In response to the massive pushback to the ETS's extra-territorial provision, the ICAO at the 2013 iteration of its triennial Assembly committed to develop a draft global carbon-trading scheme that would incorporate market-based measures (MBMs) for presentation to the following Assembly, which convenes this October in Montreal. "That was only three years to start from scratch to develop a system," Visele observed. It is hoped that a majority of ICAO's 191 member states will ratify the global scheme for implementation by 2020. After years of debating the issue, the current "official" position of the EU Commission is that if ICAO succeeds in bringing in a workable global MBM, it would adopt it as an EU regulation in place of the current ETS.

The stakes are high. "If we don't develop a global system, then individual states can impose their own, and we will have a proliferation of schemes that will be unmanageable for small operators," Visele explained. "We have to be pragmatic and realistic, as climate change impact is being taken more seriously by more countries, and the U.N. has committed to reduce climate change."

While the Kyoto Protocols, dating from the 1997 U.N. Framework Convention on Climate Change, set goals for the reduction of CO_2 and NOx levels in the atmosphere among treaty signatories, aviation and maritime activity were initially exempted as sources. Subsequently, under pressure from international environmental organizations (the "Greens"), the U.N. mandated ICAO and the International Maritime Organization (both U.N. agencies) to come up with mitigation strategies. "But aviation was slow to respond," Visele said. Hence, the EU's ETS, intended to not only reduce emissions over Europe but also pressure ICAO to do something on an international basis.

Last year, the ICAO Council produced draft policy proposals for a global MBM scheme, and in February 2016, the ICAO Committee for Aviation and Environmental Protection (CAEP), tasked with the technical work for any carbon-mitigation strategy, unveiled a new CO_2 standard. Combined, these achievements will serve as what Visele terms a "strawman," or template, to frame the environmental discussions at the forthcoming Assembly.

To ensure all states have the latest information on the draft international ETS proposal, five Global Aviation Dialogue (GLAD) meetings, one for each ICAO geographical region, were convened, the last at the end of March in Indonesia. "In October, they will vote on the draft proposal," Visele said. "However, it is important to remember that, in terms of reducing emissions, there is a split in opinion between developed and developing states."

So how will this affect international business aviation operators? Visele put it this way: "The way EU ETS exists now, it takes into consideration that if ICAO comes up with something global, it will be amended accordingly. If not, the previous version will be applied to international flights into and out of EU states — that is the political willingness." What that means is that, depending on the ICAO "final deliverable," as Visele described it, "the EU will then accept some European regulatory initiatives to either align EU ETS with the new global MBM, or if no ICAO agreement is reached, reinstate the 'full ETS.'"

European Ramp Inspections

If you operate in Europe, there's an increasing chance your flying machine could become the subject of a Ramp Inspection Program (RIP) condition check, formerly known as the Safety Assessment of Foreign Aircraft (SAFA).

Whatever they're calling it, it's almost as comprehensive as a mandated airframe inspection, and the aviation authorities of EU states are racking up more of them than ever, with 11,167 in 2012 alone. Leading the pack was France, which invented the original SAFA inspection 20 years ago, scoring 2,442, up from 75 in 1996. The most ever conducted in the EU was 11,703 in 2010.

Leading causes for busts, with category items often cited, include:

▶ Defects in condition of aircraft: known defects not reported or assessed; defects deferred with a wrong MEL or CDL reference; and improperly reported maintenance items.

▶ General condition of aircraft: operational flight deck markings and/or placards incorrect or missing; interior equipment and/or other objects not correctly secured or stowed.

▶ Flight preparation: flight plan, NOTAMs and fuel plan irregularities.

▶ Weight and balance: incorrect mass and/or balance calculations; no mass and balance calculations performed; completed mass and balance sheet not on board.

According to a U.S. operator whose aircraft was selected for inspection recently, a less popular but common item for failure is "messy cockpit." So put away your charts and dispose of the used latte cups after the aircraft is secured in the assigned parking area. **BCA**

Purchase Planning Handbook

2016 Avionics

The competition for **aftermarket flight Deck** makeovers is white hot. **Go.**

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

Rockwell Collins Pro Line Fusion on Embraer's Legacy 500 flight deck going into London City Airport

In a flat market for new aircraft, the best place for avionics makers is to focus their resources on the aftermarket, and indeed that's what we're seeing — witness the panel upgrade competition between Sandel, Garmin, Universal, Avidyne and others. Prices for some avionics, such as transponders and thunderstorm detectors, have tumbled or risen only marginally, while cockpit voice recorders (CVRs) and flight data recorders (FDRs) are up dramatically. Meanwhile, other original equipment manufacturers (OEMs) are teaming to cross-certify their products, particularly in Automatic Dependent Surveillance — Broadcast (ADS-B) display and Terrain Awareness and Warning System (TAWS) capabilities, as worldwide use of ADS-B continues to spread.

As detailed in "Global ADS-B" (*BCA,* December 2015, page 22), if your plans include flights through Southeast Asian or Australasian airspace, you'll find yourself deep in ADS-B country. Across these regions, countries are engaged in building ADS-B infrastructure, many leapfrogging expensive and maintenance-intensive surveillance radar technologies. In Southeast Asia for example, a band of ADS-B airspace extends across the continent, covering Taiwan, Hong Kong, Southern China, Vietnam, Cambodia, Myanmar (aka Burma) and Singapore. To fly through it, operators must be ADS-B-equipped or be content to mush along at FL 280 and below.

Similar requirements apply in Indonesia, China, India and Australia (where the system is in routine use for traffic above FL 290 and will be extended to all Australian airspace for IFR operations in 2017, as will that of New Zealand). Similar ADS-B efforts are underway in other continents as well. For full state-by-state details see Appendix J of the International Civil

Aviation Organization's "Report of the Nineteenth Meeting of the Communications, Navigation and Surveillance (CNS SG/19) of APANPIRG at Bangkok, 20-24 July 2015," which can be downloaded from **http://bit.ly/1OC3OD8**

Here, in a nutshell, are the most salient business aviation avionics developments from the OEMs since our last update.

Aspen Avionics

Aspen Avionics displays, coupled with L-3 Aviation Products' NGT-9000 or NGT-2500 systems, can provide operators with more affordable, and feature-rich ADS-B options. Aspen reports receiving FAA certification for its ADS-B integrated interface with Aspen's Evolution primary and multifunction displays with L-3's Lynx NGT-9000 and NGT-2500 systems. The interface includes the display of ADS-B weather and traffic data from either the NGT-9000 transponder model or the NGT-2500 remote UAT box, onto Aspen displays. Additionally, Lynx NextGen Active Traffic from the NGT-9000+ model will display active ADS-B Traffic Advisory System (ATAS) traffic onto Aspen displays.

The Lynx NGT-9000 model is a Mode S extended squitter (ES) transponder with an integrated touchscreen display and an embedded GPS/WAAS that ports ADS-B traffic and weather data to the Aspen Evolution displays through an RS-232 interface. While the Lynx NGT-9000 presents these data on its own touchscreen display, pilots now have several options to arrange data on the larger Aspen primary flight or multifunction displays, allowing them to view more information where they need it. L-3's NGT-2500 is also a single-box ticket to ADS-B compliance that works with existing Mode S ES transponders and is an ADS-B Out/In system that features display options for aircraft situation display/MFD/PFDs as well as Wi-Fi capabilities for iPad apps. With an embedded GPS/WAAS source, pairing with a separate position source is not required.

Meanwhile, a creative application of Aspen's Connected Pilot CG100 Connected Gateway system enables pilots and crew to communicate wirelessly through any Wi-Fi-capable computer, tablet or smartphone in flight. Using a proprietary version of the CG-100, New Zealand-based Flightcell International can enable pilots and passengers of both fixed- and rotary-wing aircraft to receive and send data communications. The CG-100 can be used as a wireless router and, when combined with Flightcell's DZMx satellite communication system, they provide Wi-Fi Internet connectivity across both broadband cellular and narrowband satellite networks.

Flightcell's DZMx satellite and cellular communication system provides broadband data and voice services through GSM, 3G and 4G networks, with the Iridium satellite network providing narrowband capability when outside cellular coverage. When combined with the CG-100, a DO-160 certified Wi-Fi router, the DZMx will provide pilots and crew access to data from any Wi-Fi-capable device, including computers, smartphones and tablets.

Avidyne

Lincoln, Massachusetts-based Avidyne Avionics is offering a new lower-priced IFD440 FMS/GPS/NAV/COM, starting at $12,399, including mounting tray and installation kit. The new entry-level IFD440 pricing option allows customers to add wireless (Wi-Fi and Bluetooth) for $1,300 and forward-looking terrain avoidance (FLTA/RTC) for an additional $1,300 should they choose. These capabilities are enabled as add-ons through separate activations. Previously, all IFD440s included wireless and FLTA/RTC at $14,995 plus $650 for a tray and install kit.

The company's IFD540 will continue to be offered with Wi-Fi/Bluetooth and FLTA/RTC included as standard functions for $16,999, and a 16-watt transmitter as an option. By including the tray and kit into the retail price, customers net a price savings of $650 MSRP.

The company also has received FAA certification of Release 10.1.1 software for its IFD440 and IFD540 systems. R10.1.1 adds a number of performance improvements and product enhancements, including activation of the integrated Bluetooth and Wi-Fi capabilities. The software is a field-loadable upgrade.

Avidyne's MK10 Bluetooth wireless keyboard will be the first device to take advantage of wireless capability. The company previously announced a Software Developer Kit (SDK) that allows third-party software developers to create applications for smartphones and portable tablet devices using the wireless data streams coming out of the IFD540 and IFD440. With throughput rates of up to 3 Mbps, Bluetooth provides terrific point-to-point connectivity for specific devices and app-based tasks, while Wi-Fi provides a higher-bandwidth connection of up to 65 Mbps for more robust purposes including laptops and browser-based connectivity.

Esterline CMC Electronics

Esterline CMC Electronics (CMC) is now supporting DAC International, a distributor for Esterline CMC's CMA-6800 LCD, to develop an FAR Part 25 Approved Model List (AML) FAA STC to allow for the display upgrade on the Cessna Citation III/V/VII, Hawker 800 and Dassault Falcon 900. Initial ground and flight testing have been completed.

This is a form, fit and functional replacement for Honeywell ED-800 CRT displays and additional I/O and processor growth provisions for future mandates. DAC International is working on additional STCs, including one for the Sikorsky S-76 helicopter.

FreeFlight Systems

Citing added functionality and increased flexibility for ADS-B avionics, Waco, Texas-based FreeFlight Systems' line of RANGR ADS-B systems will interface with Garmin's GNS 430W/530W GPS navigators. This compatibility is being promoted as increasing equipage flexibility as well as providing cost savings for those aircraft currently equipped with 430W/530W navigators.

FreeFlight's Blue Box transceiver system, the FDL-978-XVR, is available for purchase without an internal GPS, allowing aircraft owners to use their existing GPS source for ADS-B compliance. The company reports this integration was key in reducing costs, as an additional GPS source and antenna are not required. Customers will have the ability to display ADS-B traffic to their 430W/530W navigator for increased situational awareness.

When paired with a GNS 430W/530W navigator, the FDL-978-XVR provides full ADS-B capability and ADS-B compliance, with the added benefit of subscription-free weather and traffic information.

The FDL-978-XVR without an internal GPS is priced at $3,495, which includes antennas, installation kits and Wi-Fi module to display weather and traffic to a compatible tablet device. FreeFlight's line of RANGR ADS-B systems integrates with several compatible tablet devices and inflight apps.

The company's ADS-B products are part of the ForeFlight Connect program app, and it says they are the first certified solutions to integrate with ForeFlight.

In addition, the company has obtained an ADS-B AML STC for FAR Part 27 rotorcraft. FreeFlight Systems touts being the first company to receive an STC for a rule-compliant 978 MHz ADS-B system for both Part 27 and Part 29 rotorcraft. The AML STC allows for the installation of RANGR ADS-B avionics into a wide variety of rotorcraft, including most Airbus, Bell and Robinson helicopter models.

Garmin G3000 in the Hondajet

Garmin International

Garmin International has achieved several milestones toward the certification of its G5000 for the Beechjet 400A and Hawker 400XP aircraft. Installation and system architecture details have been completed, which typically augurs the avionics suite's entry to the final stages of certification. HIRF and lightning testing, as well as RVSM testing required for group approval, contribute to the many milestones that have been achieved as the development program continues to progress. Additionally, autopilot feature development has been finalized and verification testing is nearly complete, further signifying the G5000 Integrated Flight Deck (IFD) is nearing certification.

Garmin G5000 in the Beechjet 40

The Beechjet 400A/Hawker 400XP modernization program features three high-resolution 12-in. flight displays, which are situated alongside dual touchscreen display controllers that serve as the primary crew interface for the system. Landscape flight displays offer multi-pane capability, allowing multiple pages and a variety of information to be displayed at the same time. Charts can be viewed across all three displays, including FliteCharts terminal approach procedures or optional Garmin ChartView powered by Jeppesen, as well as geo-referenced Garmin SafeTaxi airport diagrams. Pilots can simultaneously display maps, charts, checklists, TAWS and TCAS information, flight plans, weather and more. Additionally, the flight deck is estimated to provide a 150-lb. weight savings compared to the current system, allowing operators the option to carry an additional passenger with the same fuel load.

The G5000 features PBN/RNP 0.3 with Localizer Performance with Vertical Guidance/APV approach capability. Pilots are provided an elevated level of situational awareness with optional synthetic vision technology (SVT), which presents a 3-D depiction of virtual terrain, obstacles, traffic and the runway environment so the image on the display replicates what the pilot would see outside the cockpit on a clear day. SVT works seamlessly with TAWS alert coloring and voice alerts to warn pilots of potential ground hazards by displaying obstacles and terrain that may pose a threat to the aircraft. The G5000 offers TAWS-B alerting as standard with optional TAWS-A, providing alerts such as excessive closure rate and large glideslope deviations.

The G5000 upgrade includes fully integrated FAA and EASA rule-compliant ADS-B Out capability. Additionally, Garmin Connext services are optionally available and include access to worldwide weather, voice calling and text messaging within the G5000.

As standard equipment with the G5000 upgrade, the GWX 70 weather radar offers full-color storm cell tracking capabilities and turbulence detection and other features.

Meanwhile, Garmin's new GTX 345 and GTX 335 all-in-one ADS-B transponders that include extended squitter ADS-B Out, offer a wealth of options for built-in WAAS, as well as dual-link ADS-B In. The GTX 345/335 integrate with a wide variety of current and legacy Garmin displays, including select G1000 integrated flight decks. Regardless of the existing avionics configuration, the GTX 345 displays ADS-B traffic, subscription-free weather, GPS position data and backup attitude information on the popular Garmin Pilot and ForeFlight Mobile apps via Bluetooth and Connext wireless technology. Remote options are also available for compatibility with the GTN 650/750 series and G1000-equipped aircraft. GTX 345/335 transponder prices start at $2,995.

Garmin GTX panel on the Beech Baron

The GTX 345 and GTX 335 incorporate the popular 1.65-in. (4.2 centimeters) tall panel-mount transponder form factor and a sunlight-readable digital display and other features. An option for an integrated WAAS/GPS position source provides aircraft owners and operators with an all-in-one solution that meets ADS-B Out requirements. The GTX 345 pairs with compatible displays to add subscription-free Flight Information Service-Broadcast (FIS-B) weather and ADS-B In traffic, incorporating exclusive features such as TargetTrend and TerminalTraffic. Beyond the display, the GTX 345 may be integrated into the aircraft's audio panel to provide ATC-like audible alerts to help pilots keep their eyes outside the cockpit looking for traffic. Additionally, an optional altitude encoder is available and mounts on the tray of the transponder for easy installation and service, precluding the need for a static check.

Meanwhile, installation of Garmin's GNC 255 NAV/COM and GTR 225 COM series offers an economical solution to meet the requirements of 8.33-kHz channel spacing required under the Single European Sky (SES) initiative by Dec. 31, 2017. This certification reduces installation time and the cost associated with the installation of the GTR/GNC radios in a wide variety of helicopter types in Europe.

The stand-alone GTR 225 COM and GNC 255 NAV/COM offer handy features that make it easy to find frequencies for a given airport or NAVAID. When manually tuning a frequency, the reverse lookup function displays the airport identifier or NAVAID, allowing pilots to easily locate the frequency of the nearest airport, air route traffic control center (ARTCC), flight service station and more. The GTR and GNC also include a COM monitor feature, which provides pilots with the option of listening to a secondary frequency without leaving the active frequency assigned by ATC.

Garmin says that unique to the GTR and GNC series, the 20 most recently used frequencies are automatically stored within the NAV/COM radios. Quick and easy access to commonly used frequencies is possible as both the GTR and GNC provide the option to manually store 15 additional frequencies associated with the pilot's home airport or other frequently visited airports. The GNC NAV/COM series offers all of the same COM features provided by the GTR, adding VOR/ILS and glideslope capabilities.

As a result of new policy issued by the FAA, helicopter owners and operators now have the ability to install HTAWS more easily. With thousands of HTAWS-ready avionics fielded, including the GTN 650/750 and GNS 430W/530W series navigators, this critical safety tool and soon to be required technology is easier to incorporate into new and existing installations.

This new path provides owners and operators a clear understanding of the steps required for the approval, resulting in more control over schedule, less downtime and overall lower cost. The FAA recently OK'd qualified HTAWS avionics to be field approved without requiring Aircraft Certification Office (ACO) participation in most cases. Both the GNS 430W/530W series as well as the GTN 650/750 series of touchscreen navigators meet these new standards for expedited approval. This streamlined approach also allows local FSDOs the authority to approve the required Flight Manual Supplements for HTAWS, which further reduces the time required to complete these installations. This new policy will help expedite the installation of HTAWS required of all Helicopter Emergency Medical Service (HEMS) operators by April 24, 2017, as well as other operators.

Honeywell EASy III on the Dassault Falcon 5X

Garmin's HTAWS system provides visual and aural FLTA alerts that are fully contained in the GTN 650/750 and GNS 430W/530W. Offering Reduced Protection (RP) mode, the system works to minimize nuisance alerts during low-altitude helicopter operations, while continuing to provide protection from terrain and obstacles. In addition to terrain and obstacle alerting, it features voice callouts, which audibly announce height above terrain when descending below 500 ft. in 100-ft. intervals.

With the addition of the GRA 55 radar altimeter, soon required equipment for all Part 135 operators, audible HTAWS callouts are provided to 50 ft. When combined with HTAWS, Garmin WireAware wire-strike avoidance technology provides alerts to help make seemingly invisible power lines easier to identify within the GTN 650/750. Garmin GTN and GNS WAAS HTAWS solutions are completely self-contained so integration with external equipment is not required, providing helicopter operators with situational awareness in a single avionics solution.

Helicopter owners and operators with existing GNS WAAS and GTN installations can add HTAWS with a simple software update and the addition of a few annunciators. This policy change gives many helicopter operators an easier path to install Garmin's HTAWS capabilities with schedule certainty, minimal downtime and a lower cost approval process.

Honeywell Aerospace

To meet the growing need for current airport and runway data, Honeywell's aerospace database services has redesigned its aerospace software and database services (ASDS) website (**https://ads.honeywell.com**) to provide enhanced access to essential information, along with some new features. In addition, customers will soon be able to obtain terrain updates twice as often — six times per year — for what the company says is a modest incremental cost.

Upon first visiting the website, customers are asked to share key information about their fleet and operations, which Honeywell says helps it streamline downloads and saves the user time sorting through unneeded data.

Honeywell's new enhanced ground proximity warning system (EGPWS) terrain database subscription service offers six up-to-date downloads a year, timed to pair with the customer's navigation database subscription.

By increasing update cycles from three to six per year, customers can get fresher, more accurate data so changes, whether anticipated or unanticipated, can be implemented sooner, keeping fleets "smarter" and safer.

Customers will find heads-up notifications of new or modified runways, changes in runway awareness advisory system (RAAS), SmartRunway/SmartLanding, runway overrun prevention system (ROPS) status, temporary airport modifications and more — all with the ability to customize the new information to the operator's specific destination or alternative airports.

Meanwhile, Embraer premiered the first E-Jet E2 with Honeywell's Primus Epic integrated flight deck. The Primus Epic 2 system on the second generation of E-Jets is an evolution of the existing cockpit on the current generation of E-Jets, which is designed to ensure a smooth transition for pilots.

The five 8-by-10-in. displays will be replaced by four 13-by-10-in. landscape displays with advanced graphics capabilities. The SmartView synthetic vision system (SVS) improves the flight crew's situational awareness by providing a large, 3-D color synthetic image of the outside world to enhance safety and efficiency. Honeywell's Next Generation Flight Management System provides enhanced flight planning, navigation and aircraft performance capabilities. Since Honeywell's Primus Epic avionics are software based, Embraer should be able to integrate future communication, navigation and air traffic management functionalities.


Innovative Solutions & Support FG retrofit on the Pilatus PC-12

Innovative Solutions & Support

The new Future Generation (FG) Flight Deck by Innovative Solutions & Support (IS&S) will feature its PT6 autothrottle for retrofit in the Pilatus PC-12. The FG Flight Deck features primary flight and multifunction displays (PFD/MFD) and an integrated standby unit, as well as the integrated FMS and EFB system. The avionics suite will include dual flight management systems, autothrottles, synthetic vision and FLIR enhanced vision. Additional configuration options include an ADAHRS upgrade and a full-time oil quantity sensor.

The FG avionics suite integrates PFD/MFD and aircraft situation display information including charts, maps, airspace depiction with low and high vector routes, satellite weather, engine instruments, IGuard engine monitoring and electronic checklists. It also features dual satellite-based augmentation system (SBAS) GPS receivers in support of the FMS with localizer performance with vertical guidance (LPV) approach capability. The end result is an integrated avionics suite providing notable situational awareness.

The Exton, Pennsylvania, manufacturer's TSO-C198-compliant PT6 autothrottle allows a pilot to control the power setting of the aircraft's engines by setting a desired flight characteristic rather than manually controlling fuel flow. The autothrottle controls toward the optimum flight patterns to reduce pilot workload.

The system provides a Maximum Continuous Thrust, Speed Hold and Speed Protection Mode. When engaged by the pilot, the autothrottle system manipulates the throttles automatically to achieve and hold the manually selected airspeed. It also has a torque/temperature mode and AOA mode. Protection modes will automatically activate, regardless of autopilot engagement state, in an attempt to keep airspeed, torque and temperature from exceeding predefined targets.

The integrated FMS features include coupled WAAS/LPV approaches, full RNP compliance to DO-236B with 0.3-nm precision, Required Time of Arrival fully coupled flight profile performance-based VNAV, autothrottle controls and dual FMS with synthetic DME capability. The integrated EFB features include airport diagrams and approaches, moving maps with flight plan overlay, airspaces, airways, runway and intersection depictions, navaids, satellite weather and checklists, among other features.

L-3 Aviation Products

The ESI-500 standby system, a 3-in. display, has now received TSO authorization as well as an AML STC covering a wide variety of aircraft. The L-3 Aviation Products unit is designed for Class I, II and III Part 23 aircraft and Part 27 helicopters. It incorporates features such as synthetic vision, obstacles, terrain alerting and navigation. The first displays were shipped to customers in December 2015.

The new unit features a hi-res color display for the presentation of altitude, attitude, airspeed, aircraft track, vertical speed, airspeed awareness cues and slip/skid information. An internal lithium-ion battery provides power in the event of a power failure in the panel. The scalable ESI-500 has numerous additional display options, including vertical speed and heading. The unit can be configured per aircraft performance specifications to include an airspeed awareness band highlighting VNE and VMO cues.

Meanwhile, the Grand Rapids, Michigan, manufacturer's Lynx NGT-9000 has been TSO'd for the additional capabilities of a Class B embedded eTAWS option and an ADS-B Traffic Advisory System (ATAS) aural alerting option. L-3's Lynx NGT-9000 is an ADS-B touchscreen transponder that is also capable of displaying traffic and weather data.

The newly added features are software upgrades to the existing Lynx NGT-9000 operating system. The eTAWS option adds an additional screen to the display, highlighting terrain surrounding the aircraft to provide pilots with a Class B TAWS capability where mandated, while the ATAS option provides an aural alert for intruder ADS-B traffic to help pilots visually acquire potential traffic threats.

The Lynx's Class B eTAWS option brings terrain alerting through both graphic and aural warnings. The color-coded terrain screen provides a surveillance range of 24 nm and can alert the pilot when Controlled Flight Into Terrain

Rockwell Collins Pro Line Fusion panel for the King Air

(CFIT) is imminent. The Lynx unit will automatically switch to the eTAWS screen when a terrain warning is issued and will alert the pilot of the terrain situation through the audio panel.

The Lynx eTAWS page also shows land-based obstacles and provides alerts for negative climb rates and other ground proximity warnings. And the Lynx ATAS option also announces the range, bearing and relative altitude of intruder aircraft through the cockpit audio system.

Rockwell Collins

The Pro Line Fusion integrated avionics system has been selected for 20 aircraft to-date, including business jets, transport and military aircraft, and even tiltrotor flight decks. It's even been flight tested as an unmanned aerial system (UAS) ground station. Rockwell Collins has been promoting the system for rotary-wing applications around the globe as well.

Featuring advanced graphical interfaces, intuitive icons and easily configurable multifunction display windows, the suite's layout can be arranged to match specific operational scenarios and offers a variety of technologies to reduce pilot workload and enhance situational awareness.

Mission-specific helicopter profiles include offshore platform approaches, hovering in place, extended search and rescue patterns, and other critical mission capabilities.

Meanwhile, in August 2015, the Cedar Rapids, Iowa, manufacturer acquired International Communications Group Inc. (ICG), a satellite-based global voice and data communication provider for the aviation industry based in Newport News, Virginia.

The acquisition broadens Rockwell Collins' portfolio of information-enabled avionics by adding ICG's latest generation of Iridium satcom terminals and smart routers to its existing flight deck and cabin connectivity offerings.

Sandel

Designed specifically for the King Air family, beginning with the King Air 200, Sandel's new, all-glass Avilon integrated avionics suite is poised to reconfigure a lot of flight decks. And the Vista, California-based manufacturer has teamed with Stevens Aviation in Greenville, South Carolina, to make that happen.

Sandel's $175,000 flyaway cost for the Avilon system is significantly less than that of competing systems. Avilon comes as a prewired assembly that includes four large LCDs, two smaller data entry touchscreens, radios, flight management computers, dual AHRS, audio panel, an ADS-B-compliant Mode S transponder and flight director/autopilot (minus the autopilot servos, which are retained).

Sandel's retrofit panel for the King Air 200

The company says the panel installs in a single installation step, replacing the LRUs, instruments and their wiring harnesses all at once, making it possible to update an aircraft in as little as five days.

Universal Avionics Systems Corp.

Teamwork pays off. The FAA's award of an ADS-B Out AML STC to CMD Flight Solutions could provide aircraft operators with an expanded certification path. The solution includes the installation of Universal Avionics' SBAS-Flight Management System and Rockwell Collins TDR-94(D) Mode S transponder. This comes at an opportune time to allow operators to take advantage of Universal's and Rockwell's ADS-B Out Incentive Package Program. But those interested will have to hurry — the incentive program is valid for new orders placed by June 1, 2016.

The companies recently joined forces to develop an affordable, integrated ADS-B Out option, allowing operators to add the Rockwell TDR-94(D) to their Universal SBAS-FMS installation. In addition to meeting the ADS-B Out mandate, these operators are also able to provision for controller-pilot data link communications (CPDLC) and LPV, unlike other standalone ADS-B Out solutions. Just remember that June 1 deadline.

The CMD AML STC ST03424CH is available to the Universal Avionics Authorized Dealer Network and includes many popular models of business aircraft. To view the complete list of aircraft in CMD's AML STC, visit: **http://www.cmdflightsolutions.com/approval.php**

Universal and Rockwell Collins ADS-B Out solution

Universal's upgrade package for the CASA CN-235

The Part 23 STC covering the same equipment pairing is expected this summer, and foreign CAA validations/acceptances are being evaluated, along with the European Aviation Safety Agency and Transport Canada.

So the opportunities to put a 21st century panel or ADS-B capability on your flight line are at hand. **BCA**

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 Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KY 196A**	760	16 nominal	1/3.2	$5,312	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	$5,374	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	$7.246	Active/standby frequency; stored channels; LED 28 VDC.
	C37c C38c	LED; nvm	28 VDC	6.3 x 1.35 x 10.8		
	BendixKing KX 155-39	760 com; 200 nav	10 nominal	1/5.0	$4,639	Nav/Com/ISO A/A 14 V 760 freq.
	C37b C38b	LCD; non-volatile	28 VDC	6.25 x 2.05 x x10.16		
	BendixKing KX 155-39	760 com; 200 nav	10 nominal	1/5.0	$4,901	Nav/Com/ISO A/A 28 V 760 freq.
	C37b C38b	LCD; non-volatile	14 VDC	6.25 x 2.05 x x10.16		
	BendixKing KX 155-42	760 com; 200 nav	10 nominal	1/5.0	$5,344	Nav/Com/ISO A/A 14 V 760 freq.
	C37b C38b	LCD; non-volatile	14 VDC	6.25 x 2.05 x x10.16		
	BendixKing 155-43	760 com; 200 nav	10 nominal	1/5.0	$5,532	Nav/Com/ISO A/A 14 V 760 freq.
	C37b C38b	LCD; non-volatile	28 VDC	6.25 x 2.05 x x10.16		
	BendixKing 155A-01	760 com; 200 nav	10 nominal	1/5.0	$4,658	Nav/Com/ISO 25 kHz 28 V (no G/S)
	C37c C38c	LCD; non-volatile	28 VDC	6.25 x 2.05 x x10.16		
	BendixKing KX 155A-03	760 com; 200 nav	10 nominal	1/5.0	$5,596	Nav/Com/ISO 25 kHz 28 V GS
	C37c C38c	LCD; non-volatile	28 VDC	6.25 x 2.05 x x10.16		

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 Avionics** 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**BendixKing KX 155A-97**	760 com; 200 nav	10 nominal	1/5.65	$7,733	Nav/Com, 25 kHz 28V GS
	C37c C38c	LCD; non-volitile	28 VDC	6.25 x 2.05 x 10.16		
	BendixKing KX 165-21	760 com; 200 nav	10 nominal	1/5.65	$6,399	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 165-25	760 com; 200 nav	10 nominal	1/5.65	$6,680	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 165-01	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	$6,212	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.	$2,645	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/NA	2/4.3	$21,483	Includes KFS 598A control with digital display of active/standby frequencies, flip-flop 118.0-151.975 MHz.
	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	

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	
Cobham Electronics (formerly Wulfsberg) 6400 Wilkinson Dr. Prescott, AZ 86301 (928) 708-1550 (928) 541-7627 **www.cobham.com**	**CVC-152**	color LCD	N/A	1/0.75	$4,347*	Gray or black panel. **BCA* estimate.
	control display	—		2.50 x 3.15 x 4.29	5 VDC, 5 VAC or 28 VDC	
	CCN-955	see remarks	N/A	1/0.75	$7,643*	Optional multi-function display; color LCD displays nav and comm data. **BCA* estimate.
				2.50 x 3.15 x 4.29	5 VDC, 5 VAC, 28 VDC	
	CVC-151 FliteLine	118-136 MHz 118-11.975 MHz	20	1/3.3	$14,461*	ARINC 429 bus interface; 8.33 or 25 kHz spacing; FM immunity; auto-tune capability. FMS and radio management interface capability VDL Mode 2 & 3 provisions; color LCD shows nav and comm data. **BCA* estimate.
	C169	color LCD		4.10 x 2.40 x 13.33	18 - 33 VDC	

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.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	—	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.
				—	28 VDC <50 Watts - optional 115 VAC 400 Hz primary power	
Garmin International 1200 E. 151st St. Olathe, KS 66062 (800) 800-1020 (913) 397-8200 Fax: (913) 397-8282 **www.garmin.com**	**GI 102**	—	14/28V	1/1.4	$2,449	
	TSO C36e, C40c	—		3.25 x 3.25 x 4.75	—	High-quality course deviation indicator (CDI) with VOR/LOC/GPS needle.
	GI 106A	—	14/28V	1/1.4	$3,199	High-quality course deviation indicator (CDI) with VOR/LOC/GPS/ 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 BendixKing Avionics 9201 San Mateo Blvd. NE Albuquerque, NM 87113 (855) 250-7027 **www.bendixking.com**	**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	$13,407	3-ATI primary navigation display; sunlight readable LED backlit display with 180-deg. viewing angle and over 10,000-hr. 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. Compatible with the WX-500 Stormscope. Optional interfaces for traffic, $980; WSI data link weather, $980; high-vibration version, $16,829. NVIS compatible version, $20,800.
	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-deg. viewing angle and over 10,000-hr. 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 data link 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 Avionics 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	$9,023	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	
Cobham Eelctronics 6400 Wilkinson Dr. Prescott, AZ 86301 (928) 708-1550 (928) 541-7627 **www.cobham.com**	**DFS-43A TSO C-41C**		ARINC 429, analog	1/5.64 4.1 x 4.0 x 13.33	18-33 VDC $4,890*	Arinc 429 bus, AFCS interface; steering guidance to/from NDB. Self-diagnostics and auto-calibration.
		190-1860 kHz 2181-2183 kHz				
	AT-434A Antenna			0.60 3.15 x 2.50 x 4.29	5 VDC, 5 VAC or 28 VDC $6,020*	LCD color display; power; gray or black panel **BCA* estimate.

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 KN 53**	200 nav 40 channel glideslope	nav glideslope localizer	1/2.5	$6,286	Simultaneous display of both active and standby frequencies; push-botton frequency flip-flop; solid-state design for reliability; TSO'd.
	C40a, C36c, C34c	—	—	—	28 VDC	
	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	
Cobham Electronics 6400 Wilkinson Dr. Prescott, AZ 86301 (928) 708-1550 (928) 541-7627 **www.cobham.com**	**CVN-251**	108.0-117.95 MHz	ARINC 429 SIN/COS	1/3.31 4.0 x 2.4 x 13.33	$23,200*	ARINC 429 interface; 160 VOR channels; 40 LOC channels; includes glideslope/marker beacon receivers. FM immunity standard. **BCA* estimate.
	C40c, C36e, C34c, C35d	LCD		1/0.75 2.5 x 3.15 x 4.29	18-33 VDC	
	CVC-152 Control Display	108.0-117.95 MHz	ARINC 429 SIN/COS	1/3.31 4.0 x 2.4 x 13.33	$4,890*	Combines comm and nav tuning; gray or black panel. **BCA* estimate.
	—	LCD		1/0.75 2.5 x 3.15 x 4.29	5 VDC, 5 VAC or 28 VDC	
	CCN-955	108.0-117.95 MHz	ARINC 429 SIN/COS	1/3.31 4.0 x 2.4 x 13.33	$9,540*	Combines comm and nav tuning. **BCA* estimate.
	—	LCD		1/0.75 2.5 x 3.15 x 4.29	5 VDC, 5 VAC or 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	
Cobham Electronics 6400 Wilkinson Dr. Prescott, AZ 86301 (928) 708-1550 (928) 541-7627 **www.cobham.com**	**CDM-451 FliteLine**	LCD	3 ARINC 429 2 ARINC 568 1 40-bit serial	1/3.6	$24,500*	Three-channel scanning. ARINC 429 interface; nav frequency display in DME hold mode; six-wire analog continuous self-test. SD-442B display, $7,630. Available with NVG option. **BCA* estimate.
	C66c		325	3.87 x 3.27 x 13.33	18-33 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	Outputs	Size or Form Factor	Power Required	
	TSO				
Avidyne 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 **www.avidyne.com**	**IFD 540**	VHF Com; VOR-LOC-ILS; GPS SBAS-WAAS	1/8.5	$16,995	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 10-watt VHF com (16- watt option available)	
	IFD 440	VHF com; VOR-LOC-ILS; GPS; SBAS-WAAS	1/6.6	$12,399	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).
	GPS receiver with WASS (SBAS) capability, VOR/ILS/LOC receiver, VHF com				
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	—	2.66 x 6.3 x 11.0	11-33 VDC 10W VHF Com (16W option)	

LONG-RANGE NAV/COMS

Manufacturer	Model	Inputs	Units/Weight (lb.)	Price	Remarks
	System Type	Outputs	Size or Form Factor	Power Required	
	TSO				
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	$11,399	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				
	C34e, C36e, C40c, C110a, C113, C118, C146c, C147, C151b, C157, C165, C169a	—	2.66 x 6.3 x 11.0	11-33 VDC	
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	$20,000	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 Part 25 requirements, operation from 55C to +70C
	GPS receiver with SBAS and LPV				
	C145b Beta-3 C146b Delta-4	ARINC 429	9.5 x 8.5 x 2.5	28 VDC	
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	$4,495	10W or 16W com and 200 channel nav with VOR/Localizer and Guideslope receiver
	VOR/ILS/LOC receiver, VHF com				
	C34e, C36e Class A, C40c, C128a, C169a Class 3, 4 5, 6, C, E, H1, H2	ARINC 429, RS-232	6.25 x 1.65 x 10.4	9 -33V; 10W com (16W optional)	
	GTN 750	HSDB, ARINC 429, ARINC 453/708, RS-232, RS-422	1/9.3	$16,900	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				
	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 Class A, C151c Class A, B, C157a Class 1, 2, C165, C169a Class c E, 3, 4, 5, 6, C194, C195a Class B1, B3, B5	HSDB, ARINC 429, RS-232, RS-422	6.25 x 6.00 x 11.25	11-33 VDC	
	GTN 650	HSDB, ARNC 429, ARINC 453/708, RS-232, RS-422	1/7.0	$11,400	Full integrated system combines GPS, COM and NAV functions with MFD capabilties.
	VOR/ILS/LOC receiver, VHF com				
	C34e, C36e Class A, C40c, C74d Class A, C110a, C112c, C113 Class I, II, III, C118, C128a, C146c Class 3, C147 Class A, C151c Class a, B, C157a Class 1, 2, C165, C169a Class C, E, 3, 4, 5 6, C194, C195a ClassB1, B3, B5	HSDB, ARINC 429	6.25 x 2.65 x 11.25	11-33V	
	GSR 56	RS-232	1/2.51	$9,995	The GSR 56 gives access to on-demand global weather information and text/voice communication through the Iridium stellite network.
	Iridium weathre datalink, text/voice communications	RS-232	2.08 x 6.96 x 12.96	14 - 28V	
	C139				

LONG-RANGE NAV/COMS

Manufacturer	Model	Inputs	Units/Weight (lb.)	Price	Remarks
	System Type	Outputs	Size or Form Factor	Power Required	
	TSO				
Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 (800) 601-3099 Fax: (602) 365-3343 **www.honeywell.com**	**Laseref IV**	ARINC 419/429	2/16.9	$265,361*	All digital; 4 MCU, ARINC 704. **BCA* estimate.
	Laser Gyro IRS	ARINC 429/ASCB	4.9 x 7.6 x 13.1	28 VDC or 115 VAC	
	C4c, C5e, C6d				
	Laseref VI Micro IRS	ARINC 429	2/3.2	$355,992*	Laseref VI Inertial Reference Unit with updated microprocessor, on-aircraft data load capability; HIGH Step II software for 100% available RNP. **BCA* estimate.
	Laser Gyro IRS	ARINC 429	6.5 x 6.4 6.4	28 VDC	
	C4c, C5e, C6d, C129a				
	AH-1000 Attitude Header Reference Unit	ARINC 429 and discrete I/O	2/3.2	$33, 334*	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.
	MEMS AHRS	ARINC 429	2.5 x 5.0 x7.8	28 VDC	
	C3e, C4c, C5f, C6e (ETSO C3d, C4c, C5e, C6e)				
	KTR 2280	ARINC 429 Interface	—	—	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.
	Multi-Mode Digital Radio		—	27.5 VDC	
	C37d, C38d, C40c, C36e, C34e, C41d				
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.	$38,022	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.
			15.98 x 2.33 x 7.75	28 VDC	
	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.	$48,714	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.
			15.98 x 2.33 x 7.75	28 VC	
	GPS-4000S	ARINC 429 (complies with ARINC 743A)	N/A	$32,576*	**BCA* estimate.
	GPS receiver w SBAS (WAAS) capability	ARINC 429	2 MCU	28 VDC	
	C145A Class Beta-3				

TRANSPONDERS

Manufacturer	Model	Modes	Units/Weight (lb.)	Price	Remarks
	TSO	Power Output (W)	Size or Form Factor	Power Required	
ACSS, an L-3 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-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	$3,995	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 stopwatch 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	$4,495	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	A, C, S	1/4.2	$3,495	IFR-certified panel-mounted Mode C transponder.
	C112d Level 2ens, Class 1	250	6.25 x 1.65 x 11.25	11-33 VDC	
	GTX 330 ES	A, C, S, ES	1/4.2	$3,995	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 330D	A, C, S	1/4.2	$7,996	IFR-certified panel-mounted Mode S transponder with Diversity (dual antenna).
	C112d, Level 2dens Class 1	250	6.25 x 1.65 x 11.25	11-33 VDC	
	GTX 330ES	A, C, S, ES	1/4.2	$8,636	IFR-certified panel-mounted Mode S transponder with ADS-B compliant ES capability and Diversity.
	C112d Level 2dens Class 1, C166b Class B1	250	6.25 x 1.65 x 11.25	11-23 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 33**	A, C, S, ES	1/3.1	$4,195	IFR-certified remoted-mounted Mode S transponder for GTN series.
	C112d Level 2ens Class 1, C166b B1S	250	6.92 x 1.78 x 11.05	11-23 VDC	
	GTX 33 ES	A, C, S, ES	1/3.1	$5,450	IFR-certified remote-mounted transponder for GTN series with ADS-B compliant ES capability.
	C112d Level 2ens Class 1, C166b B1S	250	6.92 x 1.78 x 11.05	11-23 VDC	
	GTX 33D	A, C, S	1/3.4	$8,395	IFR remote mounted transponder.
	C112d Level 2dens Class 1	250	6.92 x 1.78 x 11.05	11-33 VDC	
	GTX 33D ES	A, C, S, ES	1/3.4	$9,145	IFR-certified remote-mounted transponder for GTN series with ADS-B compliant ES capability and Diversity (dual antenna).
	C112d Level 2dens Class 1, C166b B1	250	6.92 x 1.78 x 11.05	11-33 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	
	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	$2,999	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	2/9.7	$33,068	Mode S transponder; European Elementary and Enhanced Surveillance compliant. Compatible with TCAS II Change 6.04 and Change 7.0 systems. DO-260A ADS-B trasmit compliant. Includes CTL-92E flight ID capable control panel.
	C112; Class 3	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 x 9.93 (18 in.)	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.) 8.78 x 10.06 x 9.93 (18 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 typical system.
	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 surviellance missions; displayed menus and AC 90-80A specified clear zones. Allows full dual-mode operation for pilot and copilot. Price reflects typical system.
	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			Pulse Width	Stabl. Sig.					
	Circuits	Power Output (Peak KW)		Looks/Min.	Ant. Tilt	Colors	Indicator Size	RT. Size	Power	
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									
	See remarks	40W Peak				4			28 VDC or 115 VAC 400 Hz (depending on part number)	
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	12/8	60°	±15° tilt	ARINC 708A	N/A	1/15.1	$180,976	*Price *BCA* estimate.
	C63c			3.44-55usec	—					
	—	38-75 W		—	—	4	—	12 in.	80 W avg.	
	RTS-4114	5-320 nm	14/6.7	60°	±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.	

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	4.6 lb./ 4.56 x 4.09 x 11.07	N/A	Pilot Activated Self Test (PAST) input available to verify system operation. Two separate inputs provided to inhibit self-test operation and may be used to prevent self-test when aircraft flight control system is engaged. Valid output signifies system status and separate logic output indicates when unit is tracking return signal.
	RT300 C-87, RTCA DO-160A	N/A				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	
L-3 Aviation Products 5353 52nd St. SE Grand Rapids, MI 45912 (616) 949-6600 Fax: (616) 285-4224 **www.L3com.com/ aviationproducts**	**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 thunderstorm 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	Autopilot	Power	Weight	Price	Remarks
		Attitude Sensors	Flight Director		AP Only	AP Only	
					IFCS	IFCS	
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.
Cobham (S-TEC) One S-TEC Way Municipal Airport Mineral Wells, TX 76067 (817)215-7600 **www.s-tec.com**	**IntelliFlight DFCS**	digital ADAHARS	Magic EFIS N/A	14 or 28 VDC	14.5 N/A	See remarks	Dual-side EFIS and 2100 DFCS autopilot, $146,700.*Single-side EFIS and 2100 DFCS autopilot, $119,800*. **BCA* estimate.
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	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.
		GRS 77, GRS 7800					
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	

INTEGRATED FLIGHT CONTROL SYSTEMS

Manufacturer	Model	Air Data	Autopilot	Power	Weight	Price	Remarks
		Attitude Sensors	Flight Director		AP Only	AP Only	
					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 L-3 & 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	$8,495	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	$9,990	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 530 (W) series; GNS 500 (W) series, GTN 600/700 series; G600, G900X G950, G1000, 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		2.66 x 6.25 x 14.78	$9,995	Affordable TAS traffic surveilance system able to track up to 45 targets up to a 22 nm interrogration range.
	C147 Class A ETSO C147 Class A C166b		1/8.92		
	GTS 825	GNS 400 (W) series, 500 (W) series, GTN 600/700 series	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, GNS 500 (W) series, GTN 600/700 series, GNS 480, GMX 200, G500, G600, G900X, G950, G1000(H), G2000, G3000, G5000(H)	3.42 x 6.25 x 14.78	$$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 C166b ETSO 166b		1/11.3		
	GTS 8000	GNS 400 (W) series, GNS 500 (W) series, GTN 600/700 series, GNS 480, GMX 200, G500, G600, G900X, G950, G1000(H), 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 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	$2,849	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				
L-3 Aviation Products 5353 52nd St. S.W. Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3com.com/ aviationproducts**	**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.)		
L-3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3com.com/ aviataionproducts**	**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 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**	**Business Aviation** **LW-CVR (429)** 980-6044-002	solid-state 120 min.	7.45 x 5.92 x 4.0 <7.0 with AR for factor mounting adapter	$38,207* 28 VDC	A fully compliant recorder developed for business aviation. **BCA* estimate.
	Air Tranport **HFR5-CVR** 980-6032-003	solid-state 120 min.	½ ATR Short 8.6	Not provided 28 VDC 115 AC	A fully compliant recorder developed air business aviation.
	Business Aviation **LW-FDR (717)** 980-4131-002	solid-state 25 hr. @ 512 wps	7.45 x 5,92 x 4.0 <7.0 with AR form foactor mounting adapter	$62,374* 28 VDC	A fully compliant recorder developed air business aviation. **BCA* estimate.
	Air Transport **HFR5-FDR** ½ ATR Long only	solid-state 25 hr. @ 1,024 wps	½ ATR Long or Short 10.0	$46,228* 115 VAC 28 VDC	A fully compliant recorder developed air business aviation. **BCA* estimate.
	Business Aviation **LWCVR/FDR** 980-6050-042 (429 input) 980-6050-072 (717 imput)	solid-state 120 min. CVR 25 hr. @512 wps FDR	7.45 x 5. 92 x 4.0 <7.0 with AR form factor mounting adapter	$60,904* 28 VDC	A fully compliant recorder developed air business aviation. **BCA* estimate.
	— **CVR AR 120 CVR** 980-6023-002 ED 56A, C123a	solid state, digital 120-min. CVR	8.8 9.5 x 5.88 x 5.75	Not provided 28 VDC	Non-ARINC size with underwater locator beacon; control panel and mounting tray not required. ARINC 557 and ARINC 757.
	— **AR FDR** 980-4710-00X ED 55, C124e	solid-state, digital 25 hr. @ 64, 128, 256 wps	8.8 9.5 x 5.88 x 5.75	Not provided 28 VDC	Non-ARINC FDR, ARINC 717, 429. Mounting tray not required.

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	$31,935* 28 VDC	Non-ARINC size with underwater locator beacon; control panel and mounting tray not required. ARINC 557 and ARINC 757. **BCA* estimate.
	CVR **SSCVR 980-6022-011** ED 56A, C123	solid-state, digital 120 min.	½ ATR Short 11.5	$48,208* 28 VDC 115 AC	Solid-state CVR with underwater locator beacon. ARINC 557 and ARINC 757. **BCA* estimate.
	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	$57,438* 28 VDC	Combination CVR/FDR; ARINC Form Factor. Mounting tray not required. Data download through front access PCMCIA. **BCA* estimate.
L-3 Aviation Recorders 100 Cattlemen Rd. Sarasota, FL 34232 (941) 371-0811 **www.L-3ar.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 Model TSO	Recording Medium Duration	Size Weight (lb.)	Price Power Required	Remarks
L-3 Aviation Recorders 100 Cattlemen Rd. Sarasota, FL 34232 (941) 371-0811 **www.L-3ar.com**	**CVDR/SRVIVR** — C123b, C124b EUROCAE Ed-112	solid-state 2 hr. CVR 25 hr. FDR	6.55 x 5.55 x 3.25 6.75	$40,675 28 VDC	Same as FA5000
	Lightweight Data Recorder **LDR** C197, EUROCAE ED-155	solid-state 2 hr. CVR 25 hr. FDR 2-hr. video	8.0 x 3.9 x 4.9 5.0	$21,370 28 VDC	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.
	Micro Quick Access Recorder — —	Minimum 2 GB compact flash memory —	2.7 x 2.2 x 1.8 6 oz.	$8,513 115 VAC 400 Hz or 28 VDC	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.
Universal Avionics Systems Corp. 3260 E. Universal Way Tucson, AZ 85756 (520) 295-2300 Fax: (520) 295-2395 **www.uasc.com**	**Combi CVR/FDR** **CVFDR-145** C123b, C124b, C177, C123a, C124a, EUROCAE ED-112	solid-state flash memory 120-min. voice & ambient audio +25 hr. (min.) Flight data +120 minute data link messaging	6.0 x 4.9 x 8.0 7.0	$19,500 28 VDC	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.
	Combi CVR/FDR w/ embedded Redorded Independedt Power Supply (RIPS) **CVFDR-145R** C123b, C124b, C155, C177, C123a, C124a, EUROCAE ED-112	solid-state flash memory 120-min. voice & ambient audio +25 hr. (min.) Flight data +120 minute data link messaging	6.0 x 4.9 x 8.0 8.68	$27,500 28 VDC	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.
	CVR **CVR-120A** C123b, C177, C123a, EUROCAE ED-112	solid-state flash memory 120-min. voice & ambient audio	6.0 x 4.9 x 8.0 7.9	$16,500 28 VDC	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.

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

Manufacturer	Type Model TSO	Recording Medium Duration	Size Weight (lb.)	Price Power Required	Remarks
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				
	C123b, C155, C177, C123a, EUROCAE ED-112	120 min. voice & ambient audio	8.68	28 VDC	
	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				
	C124b, C124a, EUROCAE ED-112	25 hr. (min) Flight data + 120 min. data link messaging	7.9	28 VDC	

HEAD-UP DISPLAYS

Manufacturer	Model	Inputs & Outputs	Units/Weight (lb.) Size or Form Factor	Price Power Required	Remarks
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*	Develped for the Boeing B737, Bombardier CRJ and Q400. Cat III landing 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	Develped 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	Developed for Embraer jets, Dassault Falcon 7X.
			3 LRUs		
	HGS-6000	ARINC 429, various discretes, enhanced vision, synthetic vision	40.0 - 46.0	Price not provided	Developed for Gulfstreams, Bombardier CSeries, Global and Challenger aircraft.
			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	$5,995*	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. **BCA* estimate.
	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	$9,995*	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. EFD PRO HPFD for helicopters, $14,995. **BCA* estimate.
	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	$10,700	Economical full-feature glass panels 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.	$8,825	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.	$5,245	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.	$14,995	Special vibration mount meets DO-160F helicopter vibration standards; airspeed and altitude tapes, with altitude alerter; built-in GPS steering; full electronic HIS 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	
Genesys Aerosystems (Chelton Flight Systems) One S-Tec Way Municipal Airport Mineral Wells, TX 76067 (817) 215-7600 **www.genesys-aerosystems .com**	**EFIS**	LCD	ARINC 429, Stormscope WX-500, TCAS, TCAD, ARINC, RMI, ADF, FMS, OAT, VS, GS deviation, landing gear, DH, GPS, RS-232	display, annunciators and aural warnings	—	$70,000* one screen including sensors	TAWS moving map display, WSI wx, terrain with waterways, TCAS I/II, lightning, Jeppesen NavData, FAA NACO obstructions availlable by subscription. DO-178B 6.0 software TSOed. **BCA estimate.*
	C113, C110a, C151b, C92c	6.4-in. diag.			5.5 x 6.25 x 4.5	11-33 VDC	
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 Avionics 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	see remarks	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		8.5	List Price Starting at $10,995	Combines GPS navigation, nav/com, terrain mapping, charting and safety sensor displays, XM data link wx, radar-based wx, traffic, and terrain. Features wide area augmentation system (WAAS) and localizer performance with vertical guidance (LPV), enhanced ground proximity warning system (EGPWS), TAWS and TCAS. Features split-screen displays.* Display information: Stormscope WX-500 (RS-422 interface) Weather Radar BendixKing: ART 2000, 2100; RDS-81/82 Traffic BendixKing: TPU66A, 67A; TPA81A*, KTA810,910; KMH820, 920; KT 74 (TIS) Avidyne: TCAD 9900BX Goodrich: TRC899, 487 Terrain Honeywell: MK V*, VI, VII, VIII*, XXI, XXII EGPWS BendixKing: KGP-560; KMH-820,920 XM Weather Aspen EWR 50 Air data*/ Heading Interface Shadin: Fuel Flow Air Data Computer Aeronetics: 9100 Bendix/King: KCS 55A Collins: PN101; MCS65; MC102, 103 Sperry: C14.
		see remarks			screen diagonal/ display size: 5.7” active matrix LCD		
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	
L-3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3com.com/ aviationproducts**	**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	
L-3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3com.com/ aviationproducts**	**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 display 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	$61,800*	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	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.) Class 2**	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	ARINC 429 (2) Discretes (2) Video GPS position	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	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 ma, weather, XM and other capabilities. New 3-D Vision technology shows a virtual 3-D behind-the-aircrft 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 Sesrvice (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					

ELECTRONIC FLIGHT BAGS

Manufacturer	Model	Display	Inputs	Outputs	Units/Weight (lb)	Price	Remarks
	Class	Display Size			Size	Power Required	
NavAero 9-15 W. Hubbard St. 5th Floor Chicago, IL 60610 (866) 628-2376 Fax: (312) 423-9966 **www.navaero.com**	t-BagC22 EFB	color TFT LCD resistive touch screen	CPU: 1 USB slot Connectors: 61 pin sealed cradle connector, tPad interface, 3 USB, 1 RS-232 1 LAN	CPU: 1 USB slot Connectors: 61 pin sealed cradle connector, tPad interface, 3 USB, 1 RS-232 1 LAN	1/NA	$3,495* with 8.4-in. display $3,995* with 10.4-in. display	*Installation kit extra. Class 2 EFB can be used to store, retrieve, display and use a wide variety of required documents and procedures such as operations specifications, performance data, operations manuals, MELs, control documents and video surveillance. CPU: 1 GHz processor, 40GB hard drive, 512MB memory, Windows XP Professional OS. Removable CPU module computer system contains CPU, power supply and emergency battery backup nickel cadmium power pack. **B&CA* estimate.
	Class 2	8.4 in. or 10.4 in.			93.8 x 113.8 x 23.8 excluding connectors and mounting hardware	13.8-30 VDC 60 W maximum	

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	When used with a HUD as part of a certified EVS, infrared sensor provides situational awareness to pilot for night and low-visibility situations.
	—				NA	
	CMA-2600i 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	1/LRU 21.0	Infrared sensor provides situation awareness to pilots for night and low-visibility situations.
	—				—	
	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 —	Infrared sensor provides situation awareness to pilots for night and low-visibility situations.
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	
L-3 Aviation Products 5353 52nd St. SW Grand Rapids, MI 49512 (616) 949-6600 Fax: (616) 285-4224 **www.L3com.com/ aviationproducts**	**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.
	—				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.	Recently introduced.
	—				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.	Recently introduced.
	—				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.	Multiple STCs for light general aviation 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 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
Avidyne 55 Old Bedford Rd. Lincoln, MA 01773 (781) 402-7400 (800) AVIDYNE Fax: (781) 402-7599 **www.avidyne.com**	**FMS900W** C146 WAAS RNP 0.3, -5, -10 BRNAV	see remarks LCD (optional)	— WAAS, VOR, IRS	multi-waypoint, advisory 23	No Yes No	4 optional; 2 std.	none none	NA 4.6 x 6.25 x 11.0 20 - 40 VDC	$70,000. Integrated into Avidyne Entegra Release 9 Flight Deck. Price includes FMS900W, dual IDF5000 displays, dual VHF nav/com, dual WAAS GPS sensors and ACD215 control panel.
Esterline CMC Electronics 600 Dr. Frederik Philips Blvd. Montreal, Quebec Canada H4M 2S9 (514) 748-3184 Fax: (514) 748-3100 **www.cmcelectronics.ca**	**CMA-9000** C129, C146 RNP 0.3, -10, BRNAV, PRNAV	full alpha keyboard AMLCD, color	24/8 GPS, WAAS, VOR, DME, INS, IRS, TACAN	fully coupled performance VNAV All ARINC 424 leg types supported, including RF	No Yes No	ARINC 429/ ARINC 575	429 DME std.; 429 VOR std.	8.0 6.75 x 5.75 x 7.15 —	Price varies by installation. Coupled, performance optimized and advisory VNAV for climb, cruise, descent, approach. Performance table based. FANS-1 capable LPV Approach capable. Optional NVG display.

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	
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 GPS RS-232	3.65	$7,245. Price includes receiver, data card, installation kit (with antena), installation manual and pilot guide, Unit also available with NVG capability.
	—	LED	GPS, WAAS	4	No			3.0 x 5.75 x 7.68	
	BRNAV				None			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 GPS RS-232	3.65	$11,500. Price includes receiver, datacard, installation kit (with antena), installation manual and pilot guide. Sole means oceanic approval; interfaces with EGPWS.
	—	LED	GPS, WAAS	4	No			3.0 x 5.75 x 7.68	
	BRNAV				None			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	color LCD	GPS, WAAS, DME, INC, Loran C	23	Yes			6.375 x 5.75 x 6.33	
	RNP 0.3, -10, BRNAV				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	color LCD	GPS, WAAS, DME, INC, Loran C	23	Yes			6.375 x 5.75 x 6.33	
	RNP 0.3, -10 BRNAV				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	color LCD	VOR< GPS, WAAS, DME, INS, Loran C	23	Yes			6.375 x 5.75 x 6.33	
	RNP 0.3, -10 BRNAV				see remarks			20- 40 VDC	

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	
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**	Full alpha keyboard	8/5	23	opt.	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	$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.
	C129 GPS, C146B Gamma	color LCD	GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	multi-waypoint	opt.			4.5 x 5.75 x 6.33; remote computer: 2 MCU, 7.7 lb.	
	RNP 0.3, -5, -10				std.			20- 40 VDC	
	UNS-1LEw	full alpha keyboard	8/5	23	opt.	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	$69,000. 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.
	C129 GPS, C146B Gamma	color LCD	GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	multi-waypoint	opt.			6.38 x 5.75 x 8.96	
					std.			20- 40 VDC	
	UNS-1Espw	full alpha keyboard	8/5	23	opt.	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	$68,000. 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.
	C129 GPS, C146B	color LCD	GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	multi-waypoint	opt.			6.38 x 5.75 x 7.62	
	RNP 0.3, 5, 10				std.			20- 40 VDC	
	UNS-1Fw	full alpha keyboard	8/5	23	opt.	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	$81,500. 3-D coupled approach mode; PC program for remote/ oceanic ops.; Uni-Link text compatible; WAAS/SBAS capable.
	C129 GPS, C146B Gamma	color LCD	GPS, WAAS, Optional: VOR, DME, INS, IRS, Loran, TACAN	multi-waypoint	opt.			6.38 x 7.5 x 3.5; remote computer: 2.0 lb.	
	RNP 0.3, 5, 10				std.			20- 40 VDC	

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 $64,000; Piper Matrix starting at $72,800. 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.
Cobham Commercial Systems Integrated Systems One S-TEC Way Municipal Airport Mineral Well, TX 76067 (817) 215-7600 **www.cobham.com**	**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**	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	10- or 12-in. flat-panel LCDs interchangeable for use as either a PFD or MFD. Optional 15 in. screen available	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 business 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; Mode S transponder with TIS; Class B TAWS; Digital weather radar; System also available for King Air 200 and C90.
	G1000H (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, air data	Varies by installation	See remarks	N/A	Prices varies by installation. An all-glass avionics suite designed for OEM installation on a wide range of rotorcraft. 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 Helicopter Synthetic Vision Technology (HSVT) with Pathways navigation; solid-state AHRS; DADC; dual radio modules with WAAS certified GPS, VHF Nav with ILS and VHF Com; EICAS; Modes with extended squitter; HTWAS; satellite weather radar; units hardned for vibration.

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 two 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; Mode S with TIS; 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 3 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; Mode S transponder with TIS; Class B TAWS; XM Wx and/or digital weather radar; Garmin FliteCharts; and Garmin SafeTaxi.
	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) lettting you see clearly even in IFR conditions. Displays divide into 2 pages to help display multiple systems and sensors. Intutive touchscreen interface with shallow menus and audible feedback. Graphical synoptics. Weather, charts, traffic, terrain and global connectivity options. Telligence Voice Command, TOLD, performance planning and paperless cockpit support.

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 4 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 transceivers and 8.33-kHz channel spacing; dual RVSM-compliant digital air-data computer; EICAS; Mode S transponder with TIS; Class B TAWS; XM Wx and/or digital weather radar; Garmin FliteCharts; and Garmin SafeTaxi.
	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. GWX68 radar sold separately. Includes CDU (dual 6.5-in. VGA LCD), digital AHRS, ADC, magnetometer, temperature probe. Optional 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. GWX68 radar sold separately. Includes CDU (dual 6.5-in. VGA LCD), digital AHRS, ADC, magnetometer, temperature probe. Optional enhanced autopilot interface capabilities using the optional GAD 43.

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**	**G1000H**	TCAS I/II, RS 232, RS-422, RS-485; ARINC 429; HSDB, CD/HIS, RMI, discretes, air data	RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, discretes, air data	Varies by installation	Varies by installation	see remarks	N/A	N/A	N/A	Price varies by installation. An all-glass avionics suite designed for OEM installation on a wide range of rotorcraft. 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 Helicopter Synthetic Vision Technology (HSVT) with Pathways navigation; solid-state AHRS; DADC; dual radio modules with WAAS-certified GPS, VHF nav with ILS and VHF com; EICAS; Mode S transponder with extended squitter; HTAWS; satellite weather and communication; solid-state weather radar; video input for FLIR or other camera display. Units hardened for helicopter vibration levels.
	G5000H	TCAS I/II, RS 232, RS-422, RS-485; ARINC 429; HSDB, CD/HIS, RMI, discretes, air data	RS 232, RS 422, RS 485; ARINC 429; HSDB, CD/HIS, RMI, discretes, air data	Varies by installation	Varies by installation	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 two 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. Telligence Voice Command, TOLD, performance planning and paperless cockpit support. Digital document display for electronic charts, flight manual data and more.
Honeywell Aerospace BendixKing Avionics 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 ADHARS, graphical flight planning, electronic checklist, XM weather, vertical nav profile, video inputs, dual WAAS GPS receivers, intergrated EIS, Mode S epdr., dual audio panel with Bluetooth	see remarks	see remarks	see remarks	Integrated flight deck with three 12.0-in. LCDs. Includes digital 3-axis autopilot capable of coupled VNAV, SmartView Synthetic Vision System (SVS), 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.

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**	Stormscope WX-500 (RS-422 Interface) Weather Radar Bendix/ King: ART 2000, 2100;RDS-81/82 Traffic Bendix/ King:TPU66A, 67A; TPA81A*, KTA810,910; KMH820, 920; KT 74 (TIS) Avidyne: TCAD 9900BX Goodrich: TRC899, 487 Terrain Honeywell: MK V*, VI, VII, VIII*, XXI, XXII EGPWS Bendix/King: KGP-560; KMH-820,920 XM Weather Aspen EWR 50 Air data*/ Heading Interface Shadin: Fuel Flow Air Data Computer Aeronetics: 9100 Bendix/King: KCS 55A Collins: PN101; MCS65; MC102, 103 Sperry: C14	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	5.7 in. Active Matrix LCD	see remarks	8.5 lb.	Features wide area augmentation system (WAAS) and localizer performance with vertical guidance (LPV), safety systems including wx radar, enhanced ground proximity warning system (EGPWS), XM Data link Weather, terrain awareness and warning system (TAWS) and traffic collision avoidance system (TCAS).
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. IFPD, 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	Operational Capabilities	Weight (lb.)	Price/Remarks
				Dimensions		Dimensions	
						Power Required	
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	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 managements system, surface management, surveillance video, enhanced vision, systhetic vision and head-up guidance. 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.

2016 Business Airplanes

The FAA expects the general aviation fleet to **grow at 0.2%** for the **next two decades.**

GULFSTREAM AEROSPACE

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

The new business aircraft market continued to fly into troubled skies in 2015, with piston engine aircraft deliveries dropping 6.5%, turboprops down 7.6% and turbofan aircraft shipments flat at 1.6% growth, compared to 2014, according to the General Aviation Manufacturers Association (GAMA). However, billings were up 2.4%. Notably, business aircraft operators are not parking their older equipment. Thus, the size of the turbine aircraft fleet slightly increased.

Sales and deliveries of new aircraft closely track global economic activity. In its "Aerospace Forecast Report Fiscal Years 2016 to 2036," the FAA says "There are a number of headwinds that are buffeting the global economy — the fall in oil prices, recession in Russia and Brazil, and inconsistent performance in other emerging economies, a "hard landing" in China, and lack of further stimulus in the advanced economies." Indeed, a dozen European states, along with Japan, have adopted negative central bank negative interest rates in efforts to stimulate their economies. And while the U.S. has avoided sinking into the morass that has recently entrapped many other nations' economies, "a prolonged period of faster economic growth (*e.g.* >3%) may not be forthcoming."

China has been especially hard hit, aircraft manufacturers say. Many business jets that were purchased by high net worth individuals now have been sold or transferred out of the country. The remaining aircraft, though, are being used actively to support the air transportation needs of the business community.

In the U.S., business aircraft operators face other challenges, including legislative initiatives to institute airspace and airport user fees and attempts to move FAA air traffic control functions to a private corporation with a board of directors dominated by the airlines.

In light of those challenges, the FAA expects the general aviation fleet to grow at a paltry 0.2% per year for the next two decades, with new turbine aircraft deliveries offsetting a projected contraction of the piston aircraft fleet. GAMA also notes that the general aviation pilot population slowly is shrinking, although there was a slight uptick in student starts in 2015. While the GA fleet growth is lackluster, the FAA estimates that turbine aircraft traffic will increase from 2016 to 2036.

On the bright side, fuel prices were

The price of DAHER's new TBM 930 is $4,099,277. Performance data is listed on page 89.

DAHER

lower in 2015 and they're forecast to be stable in 2016. But, the flat economy is having an impact on aircraft pricing. Look closely at the airplane tables in this year's *Handbook* and you'll find that several manufacturers have put the lid on price increases, or even decreased them. Piper, for instance, shaved nearly $5,000 off the four-seat Arrow's retail price, $23,000 off the M350 (nee Malibu Mirage) and a whopping $115,000 off the price of the Matrix, plus $67,000 off the Seneca V and $277,000 off the M500 (nee Meridian).

Textron reduced the price of the Corvalis TTX by $110,000, held the price on the Cessna T206 Turbo Stationair and all but one of the Beech King Airs. The firm actually reduced the price of King Air 350iER by $18,000 and also shaved the price of the Beech G58 Baron by $7,000. Most impressively, Textron held the price on all its Cessna Citations.

Similarly, Embraer held the price on virtually all of its business jets. It ticked up the price of Phenom 100E by a scant $600. Bombardier capped all prices at 2015 levels. Dassault held price increases to a maximum of the U.S. economic inflation rate. Similarly, Embraer held the price on virtually all of its business jets. It ticked up the price of Phenom 100E by a scant $600.

This year, several new aircraft are making their debut in the *Handbook*. Among the single engine piston aircraft, Mooney is introducing the normally aspirated Ovation Ultra and turbocharged Acclaim Ultra. These new models have modified moly steel tube fuselage structures, composite fuselage skins and left and right side doors, both of which are 4-in. wider than the single right door of older models for easier access. They also get upgraded interiors including cup holders and USB outlets.

There are plenty of changes in the single-engine turboprop section. The production conforming Epic Aircraft E1000 single engine turboprop is on track for certification later this year, so it's making its debut in this year's *Handbook*. It sports a carbon fiber airframe, 1,200-shp PWC PT-6A-67A turboprop engine, 325 KTAS maximum cruise speed and 1,650 nm maximum range at long-range cruise. Piper's M600 single-engine turboprop also appears for the first time. It's a derivative of the M500 (nee Meridian) fitted with a new and larger wing that carries 700+ lb. more fuel, an uprated -42 engine with 600 shp and G3000 avionics. DAHER's new TBM930, a derivative of TBM900, is being positioned as a second model, offering G3000 avionics, a plusher interior and a 5-yr. systems warranty. Elsewhere in this issue, you'll find a review of the improvements made to the 2016 Pilatus PC-12NG.

Pilatus PC-24 and Gulfstream G500 are appearing in the turbofan section for the first time. PC-24 is the first turbofan aircraft to be developed by the Swiss utility aircraft maker. Similar to PC-12, it will feature a large rear, left side cargo door, unimproved runway capabilities and rugged construction. It's powered by twin 3,400 lf thrust Williams International FJ44 turbofans and it will have a top cruise speed of 425 KTAS.

The Gulfstream G500, the Savannah manufacturer's second fly-by-wire model, will replace the G450 derivative of the 1980's vintage G-IV in the product lineup. It flies faster, higher and farther on less fuel than the G450, plus it has a larger cabin, considerably lower cabin altitude and better runway performance. Notably, Gulfstream is pricing the G500 only $1.5 million above the G450.

Boeing Business Jet's third-generation Max8 (B737-8) and Max9 (B737-9) are replacing the BBJ2 (B737-800) and BBJ3 (B737-900) in its product line. The new models sport CFMI Leap-1B engines in place of the CFM-56-7 turbofans of the previous models and they

Piper's new M600 powered by a P&WC PT6A-42A is priced at $2,853,000. (It's performance data listed on page 89.)

PIPER AIRCRAFT

have improved winglets, plus myriad small drag reduction improvements. Max8 and Max9 carry slightly less fuel than their predecessors, but they're so much more fuel efficient that they actually have more range than the original and smaller BBJ (B737-700IGW). Because of the performance improvement, they are upgraded to the Ultra Long Range business aircraft category.

While new aircraft deliveries remain stubbornly sluggish, several developments are buoying spirits in the business aircraft industry. In November 2015, EASA regulators issued a draft regulation that would permit commercial single-engine turbine aircraft operations in instrument meteorological conditions. Notably, Europe is the last large business aircraft market that, with few exceptions, does not permit commercial single engine operations in IMC.

After six years, this year ICAO is on track to finish development of uniform CO_2 emission standards for aircraft. Such standardization will facilitate 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 is moving to 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 unleaded avgas will change from the cost per gallon of 100 low lead fuel.

To promote sales of new aircraft, the general and commercial aviation communities joined forces to persuade the U.S. Congress to reauthorize funding for the U.S. Export-Import Bank in December 2015. The Ex-Im Bank provides incentive financing for a number of U.S. manufacturers, including aircraft companies, to spur sales of US made products, such as business aircraft, to overseas customers.

The U.S. Congress also moved to extend permanently the research and tax credit, providing $7.5 billion worth of credits for "qualified research" across a broad range of industries. And it extended bonus depreciation for aircraft purchased and put into service between 2015 and 2020.

The ongoing development of new, faster and longer range, more comfortable, more capable and more economical aircraft positions the business aircraft industry for recovery in coming years. Couple that with moving toward a modernized air traffic management system that balances the interests of all stakeholders, cost-effective environmental protection measures and assured tax incentives for both manufacturers and buyers, and long-term prospects for business aviation look brighter. **BCA**

How to Use the Airplane Charts

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.

DAHER

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.

DASSAULT FALCON JET

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 rearmost 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.

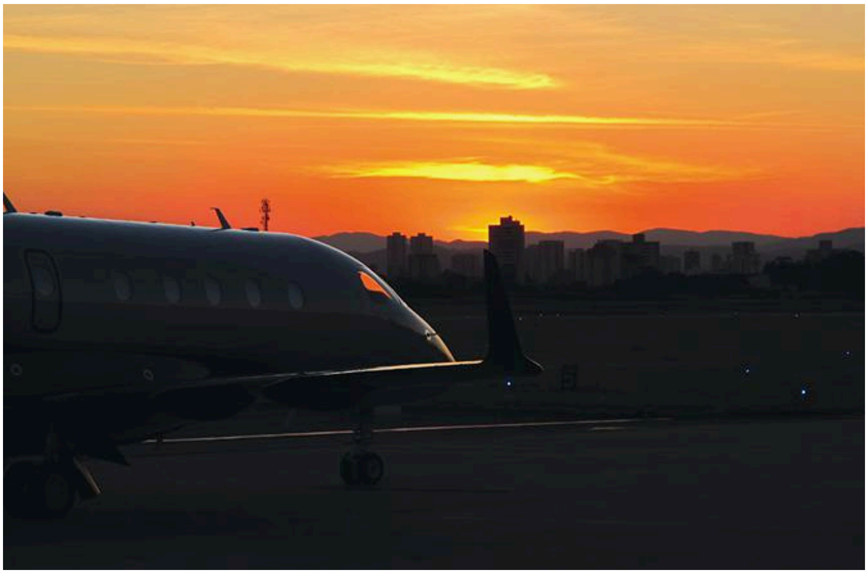
Two width dimensions are shown for multiengine turbine airplanes — one at the widest part of the cabin and the other at floor level. The dimensions, however, are not completely indicative of the usable space in a specific aircraft because of individual variances in interior furnishings.

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.


EMBRAER

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,

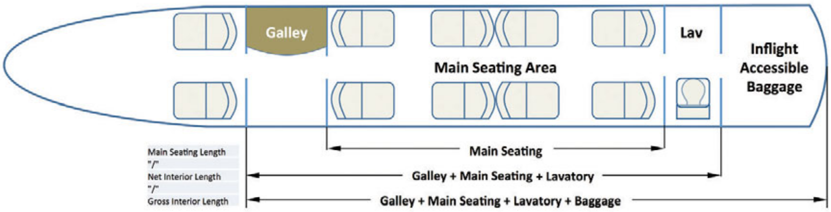
one-engine inoperative (multiengine piston and multiengine turboprop airplanes under 12,500 lb.).

▶ **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).

Cabin Length



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.

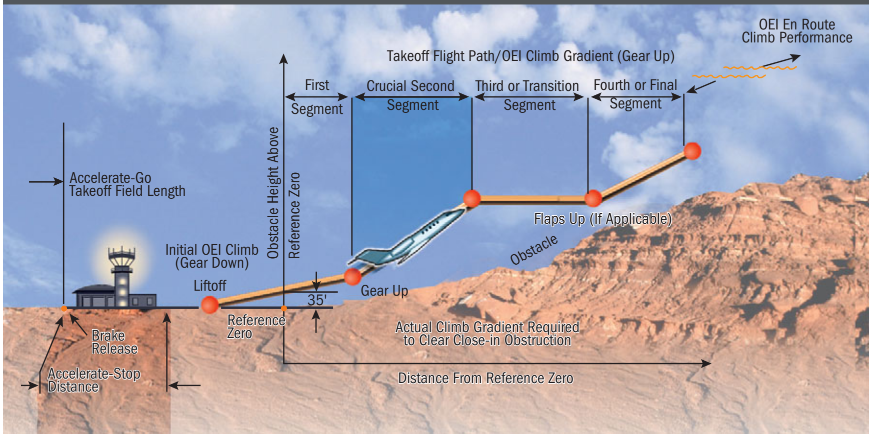
Climb

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.

FAR Part 25 and Part 23 Commuter Category OEI Climb Performance



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 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** — For

▶ **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.

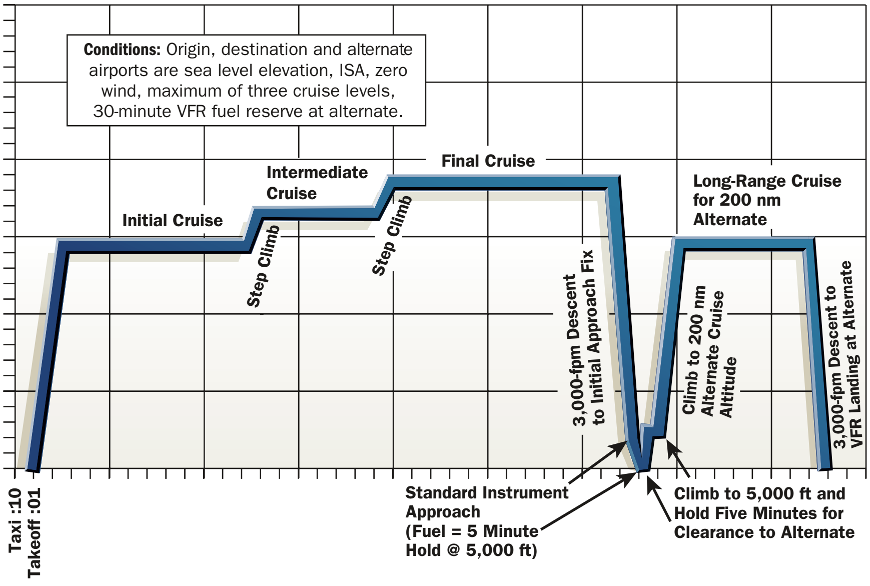
▶ **Max Fuel With Available Payload (Single-Engine Turboprops)** — Based on BOW, plus full fuel and the maximum available payload up to maximum ramp weight. Range is based on arriving at destination with NBAA IFR fuel reserves, but only a 100-mi. alternate is required.

▶ **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.

NBAA IFR RANGE PROFILE



HONDAJET

▶ **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 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.

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.

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 2016 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**

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

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			$369,900	$457,725	$470,000	$519,900
Characteristics		Seating	1+3/4	1+3/3	1+3/3	1+3/4
		Wing Loading	21.0	16.2	17.8	23.5
		Power Loading	15.25	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	Cont IO-360-ES	Lyc IO-360-C1C6	Lyc IO-540-AB1A5	Cont IO-550-N
		Output (hp)	200	200	230	310
		Inspection Interval	2,000t	2,000t	2,000t	2,000t
Weights (lb.)		Max Ramp	3,050	2,758	3,110	3,600
		Max Takeoff	3,050	2,750	3,100	3,600
		Max Landing	3,050	2,750	2,950	3,600
		Zero Fuel	2,900c	2,636b	2,976b	3,400c
		EOW	2,128	1,798	1,968	2,260
		Max Payload	772	838	1,008	1,140
		Useful Load	922	960	1,142	1,340
		Max Baggage	130	200	200	130
		Max Fuel	336	432	522	552
		Available Payload w/Max Fuel	586	528	620	788
		Available Fuel w/Max Payload	150	122	135	200
Limits		V_{NE}	204	183	175	205
		V_{NO}	166	146	140	176
		V_{A}	131	118	110	140
Airport Performance		TO (SL elev./ISA temp.)	2,221	1,600	1,514	1,756
		TO (5,000-ft. elev.@25C)	3,752	3,250	2,708	3,016
		V_{SO}	61	55	49	64
		V_{X}	83	78	65	88
		V_{Y}	96	90	80	108
Climb		Time to Climb (min.)/Altitude	16/FL 100	16/FL 100	15/FL 100	11/FL 100
		Initial Gradient (ft./nm)	581	560	694	775
Ceiling (ft.)		Service	17,500	16,200	18,100	17,500
Cruise	**Long Range**	TAS	140	124	125	160
		Fuel Flow	50	51	61	68
		Altitude	FL 080	FL 100	FL 100	FL 080
		Specific Range	2.800	2.431	2.049	2.353
	Recommended	TAS	152	130	135	171
		Fuel Flow	63	68	69	92
		Altitude	FL 080	FL 090	FL 100	FL 080
		Specific Range	2.413	1.912	1.957	1.859
	High Speed	TAS	159	137	144	180
		Fuel Flow	70	76	83	107
		Altitude	FL 80	FL 060	FL 060	FL 80
		Specific Range	2.271	1.803	1.735	1.682
Ranges	**Seats Full**	Nautical Miles	584	537	789	1,118
		Average Speed	140	121	131	162
		Fuel Used	210	156	411	492
		Specific Range/Altitude	2.781/FL 080	3.442/FL 070	1.920/FL 120	2.272/FL 080
	Tanks Full	Nautical Miles	764	926	912	1,118
		Average Speed	140	121	131	162
		Fuel Used	275	408	471	492
		Specific Range/Altitude	2.778/FL 080	2.270/FL 070	1.936/FL 120	2.272/FL 080
Missions (4 occupants)	**200 nm**	Runway	1,446	1,600	1,216	1,303
		Block Time	1+18	1+29	1+37	1+09
		Fuel Used	100	125	123	127
		Specific Range/Altitude	2.000/FL 080	1.600/FL 070	1.626/FL 120	1.575/FL 080
	500 nm	Runway	1,446	1,600	1,369	1,519
		Block Time	3+17	3+50	3+52	2+49
		Fuel Used	226	278	269	305
		Specific Range/Altitude	2.212/FL 080	1.799/FL 090	1.859/FL 120	1.639/FL 080
Remarks		Suggested Base Price	$369,900	$431,490	$530,000	$519,900
		Certification Basis	FAR 23, 1999 includes Garmin Perspective avionics.	CAR 3, 1976/2001 Garmin G500 standard.	FAR 23, 1996/2001 A 23-6 Garmin G1000 with GFC 700 autopilot.	FAR 23, 2000 Includes Garmin Perspective Avionics.

SINGLE-ENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Mooney	Mooney	*GippsAero*	Textron Aviation
Model			Ovation3 M20R	Ovation Ultra M20U	*Airvan* *GA-8*	Beechcraft Bonanza G36 G36
BCA Equipped Price			$659,000	$689,000	*$726,960*	$799,000
Character-istics		Seating	1+3/4	1+3/4	*1+6/7*	1+4/5
		Wing Loading	19.3	19.3	*20.7*	20.2
		Power Loading	10.86	10.86	*13.33*	12.17
		Noise (dBA)	77.6	NA	*84.9*	76.7
External Dimensions (ft.)		Length	26.9	26.9	*29.3*	27.5
		Height	8.3	8.3	*12.8*	8.6
		Span	36.1	36.1	*40.7*	33.5
Internal Dimensions (ft.)		Length	8.1	8.1	*11.6*	12.6
		Height	3.7	3.7	*3.7*	4.2
		Width	3.6	3.6	*4.2*	3.5
Power		Engine	Cont IO-550-G-AP	Cont IO-550-G-AP	*Lyc* *IO-540-K1A5*	Cont IO-550-B
		Output (hp)	310	310	*300*	300
		Inspection Interval	2,200t	2,200t	*2,000t*	1,900t
Weights (lb.)		Max Ramp	3,374	3,374	*4,014*	3,663
		Max Takeoff	3,368	3,368	*4,000*	3,650
		Max Landing	3,200	3,200	*4,000*	3,650
		Zero Fuel	3,197b	3,197b	*3,849b*	3,509b
		EOW	2,260	2,260	*2,241*	2,625
		Max Payload	937	937	*1,608*	884
		Useful Load	1,114	1,114	*1,773*	1,038
		Max Baggage	120	120	*180*	670
		Max Fuel	600	600	*540*	444
		Available Payload w/Max Fuel	514	514	*1,233*	594
		Available Fuel w/Max Payload	177	177	*166*	154
Limits		V_{NE}	195	195	*185*	203
		V_{NO}	174	174	*143*	165
		V_A	127	127	*121*	139
Airport Perfor-mance		TO (SL elev./ISA temp.)	2,300	2,300	*1,860*	1,913
		TO (5,000-ft. elev.@25C)	3,400	3,400	*3,670*	3,450
		V_{SO}	59	59	*57*	59
		V_X	75	75	*70*	84
		V_Y	105	105	*86*	100
Climb		Time to Climb (min.)/Altitude	10/FL 100	10/FL 100	*15/FL 100*	14/FL 100
		Initial Gradient (ft./nm)	NA	NA	*787*	730
Ceiling (ft.)		Service	NA	NA	*20,000*	18,500
Cruise	Long Range	TAS	163	163	*127*	160
		Fuel Flow	50	50	*78*	71
		Altitude	FL 120	FL 120	*FL 120*	FL 080
		Specific Range	3.260	3.260	*1.628*	2.254
	Recommended	TAS	186	186	*135*	167
		Fuel Flow	84	84	*88*	86
		Altitude	FL 120	FL 121	*FL 080*	FL 080
		Specific Range	2.214	2.214	*1.534*	1.942
	High Speed	TAS	196	196	*142*	174
		Fuel Flow	114	114	*101*	94
		Altitude	FL 080	FL 80	*FL 060*	FL 080
		Specific Range	1.719	1.719	*1.406*	1.851
Ranges	Seats Full	Nautical Miles	1,075	1,075	*487*	208
		Average Speed	161	161	*124*	153
		Fuel Used	438	438	*339*	111
		Specific Range/Altitude	2.454/FL 120	2.454/FL 121	*1.437/FL 120*	1.874/FL 040
	Tanks Full	Nautical Miles	1,465	1,465	*690*	859
		Average Speed	173	173	*125*	159
		Fuel Used	558	558	*464*	403
		Specific Range/Altitude	2.625/FL 120	2.625/FL 121	*1.487/FL 120*	2.132/FL 080
Missions (4 occupants)	200 nm	Runway	1,230	1,230	*1,860*	1,688
		Block Time	1+13	1+13	*1+38*	1+11
		Fuel Used	115	115	*157*	130
		Specific Range/Altitude	1.739/FL 050	1.739/FL 050	*1.274/FL 120*	1.538/FL 060
	500 nm	Runway	1,290	1,290	*1,860*	1,900
		Block Time	2+58	2+58	*3+55*	2+54
		Fuel Used	221	221	*339*	304
		Specific Range/Altitude	2.262/FL 100	2.262/FL 100	*1.475/FL 120*	1.645/FL 060
		Suggested Base Price	$659,000	$689,000	*$726,960*	$799,000
Remarks		Certification Basis	CAR 3/FAR 23, 1955/94; STC SA02483CH Includes Garmin G1000 avionics.	CAR 3/FAR 23, 1955/94; STC SA02483CH Includes Garmin G1000 avionics; composite fuselage shell with left and right doors.	*FAR 23 A 54 Includes Garmin G500. All data preliminary.*	CAR 3, 1956/69/83/2005 A/C system standard; Garmin G1000.

SINGLE-ENGINE PISTONS TURBOCHARGED

Manufacturer			Cirrus	Textron Aviation	Textron Aviation	Mooney	GippsAero	Mooney
Model			SR22T SR 22	Turbo Stationair CE-T206H	Cessna TTx CE-T240	Acclaim Type S M020TN	GA8 Airvan TC GA8-320 TC	Acclaim Ultra M020V
BCA Equipped Price			$619,900	$645,000	$689,000	$719,000	$761,030	$769,000
Characteristics		Seating	1+3/4	1+5/5	1+3/3	1+3/3	1+6/7	1+3/3
		Wing Loading	23.5	20.7	25.5	19.2	20.7	19.2
		Power Loading	11.43	11.61	11.61	12.03	13.13	12.03
		Noise (dBA)	80.3	75.8	81.4	78.0	85.4	78.0
External Dimensions (ft.)		Length	26.0	28.3	25.2	26.9	28.3	26.9
		Height	8.9	9.3	9.0	8.3	9.3	8.3
		Span	38.3	36.0	36.0	36.4	36.0	36.4
Internal Dimensions (ft.)		Length	8.0	9.3	7.9	8.1	11.6	8.1
		Height	4.1	4.1	4.1	3.7	3.7	3.7
		Width	4.1	3.7	4.0	3.6	4.2	3.6
Power		Engine	Cont TSIO-550-K	Lyc TIO-540-AJ1A	Cont TSIO-550-C	Cont TSIO-550-G	Lyc TIO-540-AH1A	Cont TSIO-550-G
		Output (hp)	315	310	310	280	320	280
		Inspection Interval	2,000t	2,000t	2,000t	2,200t	1,800t	2,200t
Weights (lb.)		Max Ramp	3,609	3,617	3,600	3,374	4,214	3,374
		Max Takeoff	3,600	3,600	3,600	3,368	4,200	3,368
		Max Landing	3,600	3,600	3,420	3,200	4,000	3,200
		Zero Fuel	3,400c	3,429b	3,300c	3,173b	4,053b	3,173b
		EOW	2,342	2,336	2,530	2,378	2,349	2,378
		Max Payload	1,058	1,093	770	795	1,704	795
		Useful Load	1,267	1,281	1,070	996	1,865	996
		Max Baggage	130	180	120	120	180	120
		Max Fuel	552	522	612	612	540	612
		Available Payload w/Max Fuel	715	759	458	384	1,325	384
		Available Fuel w/Max Payload	209	188	300	201	161	201
Limits		V_{NE}	205	182	230	195	185	195
		V_{NO}	176	149	181	174	143	174
		V_A	140	125	158	127	121	127
Airport Performance		TO (SL elev./ISA Temp.)	1,517	1,740	1,900	1,900	1,840	1,900
		TO (5,000-ft. elev.@25C)	2,268	2,470	2,460	3,300	2,788	3,300
		V_{SO}	64	57	61	60	61	60
		V_X	88	69	82	80	71	80
		V_Y	103	89	110	105	81	105
Climb		Time to Climb (min.)/Altitude	7/FL 100	11/FL 100	7/FL 100	7/FL 100	13/FL 100	7/FL 100
		Initial Gradient (ft./nm)	782	724	701	770	825	770
Ceilings (ft.)		Certificated	25,000	25,000	25,000	25,000	20,000	25,000
		Service	25,000	27,000	25,000	25,000	20,000	25,000
Cruise	Long Range	TAS	171	137	208	215	125	215
		Fuel Flow	76	85	78	99	68	99
		Altitude	FL 250	FL 240	FL 250	FL 250	FL 200	FL 250
		Specific Range	2.250	1.612	2.667	2.172	1.838	2.172
	Recommended	TAS	201	155	227	227	130	227
		Fuel Flow	98	99	130	128	78	128
		Altitude	FL 250	FL 240	FL 250	FL 180	FL 200	FL 180
		Specific Range	2.051	1.566	1.746	1.773	1.667	1.773
	High Speed	TAS	213	164	235	242	135	242
		Fuel Flow	110	114	152	130	98	130
		Altitude	FL 250	FL 200	FL 250	FL 250	FL 200	FL 250
		Specific Range	1.936	1.439	1.546	1.862	1.378	1.862
Ranges	Seats Full	Nautical Miles	1,021	219	680	500	233	500
		Average Speed	171	138	202	178	125	178
		Fuel Used	486	198	350	259	220	259
		Specific Range/Altitude	2.101/FL 250	1.106/FL 200	1.943/FL 250	1.931/FL 160	1.059/FL 200	1.931/FL 160
	Tanks Full	Nautical Miles	1,021	655	1,270	1,122	618	1,122
		Average Speed	171	138	204	200	125	200
		Fuel Used	486	459	572	539	459	539
		Specific Range/Altitude	2.101/FL 250	1.427/FL 240	2.220/FL 250	2.082/FL 250	1.346/FL 200	2.082/FL 250
Missions (4 occupants)	200 nm	Runway	1,405	1,396	1,730	1,300	1,743	1,300
		Block Time	1+08	1+23	1+03	1+05	1+35	1+05
		Fuel Used	197	163	159	139	125	139
		Specific Range/Altitude	1.015/FL 100	1.227/FL 150	1.258/FL 150	1.439/FL 120	1.600/FL 120	1.439/FL 120
	500 nm	Runway	1,699	1,597	1,880	1,380	1,743	1,380
		Block Time	2+28	3+22	2+24	2+54	3+30	2+54
		Fuel Used	360	385	338	259	373	259
		Specific Range/Altitude	1.389/FL 180	1.299/FL 240	1.479/FL 250	1.931/FL 250	1.340/FL 200	1.931/FL 250
		Suggested Base Price	$619,900	$664,350	$689,000	$719,000	$597,500	$769,000
Remarks		Certification Basis	FAR 23, 2010 Includes Garmin Perspective Global Connect worldwide weather.	FAR 23, 1998 Includes Garmin G1000 with GFC700 autopilot; new interior.	FAR 23 includes Garmin G2000, SVT, AP, TAWS, TAS, ESP, A/C, Ti LE, leather.	CAR 3, 1955/89/2006 Includes Garmin G1000 avionics.	FAR 23, 1998 Garmin G500; KC 225. All data preliminary.	CAR 3, 1955/89/2006 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			$899,000	$1,155,500
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		V_{NE}	198	198
		V_{NO}	168	168
		V_A	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
		V_{SO}	58	58
		V_X	81	81
		V_Y	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	$939,950	$1,078,875
Remarks		Certification Basis	FAR 23, 1983/88 Garmin G1000 standard; FIKI optional.	FAR 23, 1983/88 Garmin G1000 with SVS and FIKI standard.

MULTIENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			**Vulcanair SpA**	**Vulcanair SpA**
Model			**P.68C P68C**	**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		V_{NE}	194	197
		V_{NO}	154	157
		V_A	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
		V_{MCA}	60	60
		V_{DEC}	70	70
		V_{XSE}	82	82
		V_{YSE}	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 80
		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. 2015 data.	EASA 23, 2009 Garmin G950; STEC 55X DFCS. 2015 data.

MULTIENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Textron Aviation
Model			**Beechcraft Baron G58**
BCA Equipped Price			$1,387,500
Characteristics		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	4,010
		Max Payload	1,205
		Useful Load	1,514
		Max Fuel	1,164
		Available Payload w/Max Fuel	350
		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 80
		Specific Range	1.053
Ranges	Max Payload	Nautical Miles	243
		Average Speed	176
		Trip Fuel	226
		Specific Range/Altitude	1.075/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	2,878
		Block Time	1+02
		Fuel Used	227
		Specific Range/Altitude	0.881/FL 060
	500 nm	Runway	2,957
		Block Time	2+31
		Fuel Used	531
		Specific Range/Altitude	0.942/FL 060
		Suggested Base Price	$1,387,500
Remarks		Certification Basis	CAR 3, 1957/69/83/2005 A/C system standard; Garmin G1000.

MULTIENGINE PISTONS TURBOCHARGED

Manufacturer			Vulcanair SpA	Piper Aircraft
Model			**P68C TC**	**Seneca V PA-34-220T**
BCA Equipped Price			$877,500	$979,000
Characteristics		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 Performance		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	$972,400
Remarks		Certification Basis	FAR 23, 1982 Garmin G950 glass cockpit; STEC 55X DFGS. 2015 data.	FAR 23, 1971/80/97 Garmin G600 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	$1,998,900	$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	—	—	12,300	—	—
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	257	175	185
		Fuel Flow	379	379	241	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 (w/available payload)	Nautical Miles	965	288	953	1,005	291
		Average Speed	156	153	180	175	155
		Trip Fuel	1,795	581	841	2,130	676
		Specific Range/Altitude	0.538/FL 100	0.496/FL 100	1.133/FL 280	0.472/FL 120	0.430/FL 100
	Ferry	Nautical Miles	970	970	1,072	1,236	816
		Average Speed	156	156	220	164	156
		Trip Fuel	1,800	1,800	978	2,130	1,772
		Specific Range/Altitude	0.539/FL 100	0.539/FL 100	1.096/FL 280	0.580/FL 200	0.460/FL 100
Missions (4 passengers)	300 nm	Runway	1,468	1,468	2,250	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	2,400	1,468	1,792
		Flight Time	3+17	3+17	2+32	3+30	3+19
		Fuel Used	1,260	1,260	661	1,140	1,462
		Specific Range/Altitude	0.476/FL 100	0.476/FL 100	0.908/FL 280	0.526/FL 120	0.410/FL 100
	1,000 nm	Runway	NP	NP	2,438	1,467	NP
		Flight Time	NP	NP	4+34	5+47	NP
		Fuel Used	NP	NP	920	1,878	NP
		Specific Range/Altitude	NP	NP	1.087/FL 280	0.532/FL 120	NP
		Suggested Base Price	NA	NA	$1,998,900	$2,075,000	NA
Remarks		Certification Basis	FAR 23, 1984/98 **BCA* estimated price. Garmin G1000 with GFC700 autopilot.	FAR 23, 1984/98 *Export only. Garmin G1000 with GFC700 autopilot.	FAR 23 A 52 *1,000 nm - 3 pax 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***	**Socata**	**Socata**	**Pilatus**
Model			**M600 PA-46-500TP**	***Epic E1000***	**TBM 900 TBM 700 N**	**TBM 930 TBM 700 N**	**PC-12 NG PC-12/47E**
BCA Equipped Price			$2,853,000	*$2,995,000*	$3,889,626	$4,099,277	$4,888,275
Characteristics		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	3,930	*4,600*	4,829	4,829	6,782
		Max Payload	920	*800*	1,203	1,203	2,257
		Useful Load	2,120	*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	378	*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 Performance		TO (SL elev./ISA temp.)	2,350	*1,600*	2,380	2,380	2,600
		TO (5,000-ft. elev.@25C)	3,691	*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	25/FL 250	*10/FL 250*	13/FL 250	13/FL 250	20/FL 250
		Initial Gradient (ft./nm)	836	*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	12,300	*18,000*	14,390	14,390	13,100
Cruise	**Long Range**	TAS	179	*265*	252	252	225
		Fuel Flow	135	*268*	241	241	268
		Altitude	FL 280	*FL 280*	FL 310	FL 310	FL 300
		Specific Range	1.326	*0.989*	1.046	1.046	0.840
	High Speed	TAS	257	*330*	330	330	285
		Fuel Flow	241	*402*	412	412	497
		Altitude	FL 280	*FL 280*	FL 260	FL 260	FL 200
		Specific Range	1.066	*0.821*	0.801	0.801	0.573
NBAA IFR Ranges (100-nm alternate)	**Full Fuel** (w/available payload)	Nautical Miles	953	*1,650*	1,514	1,514	1,608
		Average Speed	180	*265*	252	252	261
		Trip Fuel	841	*1,599*	1,599	1,599	2,282
		Specific Range/Altitude	1.133/FL 280	*1.032/FL 310*	0.947/FL 310	0.947/FL 310	0.705/FL 300
	Ferry	Nautical Miles	1,072	*1,594*	1,594	1,594	1,650
		Average Speed	220	*252*	252	252	264
		Trip Fuel	978	*1,598*	1,598	1,598	2,294
		Specific Range/Altitude	1.096/FL 280	*0.997/FL 310*	0.997/FL 310	0.997/FL 310	0.719/FL 300
Missions (4 passengers)	**300 nm**	Runway	2,250	*1,765*	1,765	1,765	1,563
		Flight Time	1+22	*1+00*	1+00	1+00	1+10
		Fuel Used	379	*440*	440	440	549
		Specific Range/Altitude	0.792/FL 280	*0.682/FL 280*	0.682/FL 280	0.682/FL 280	0.546/FL 260
	600 nm	Runway	2,400	*2,005*	2,005	2,005	1,753
		Flight Time	2+32	*1+55*	1+55	1+55	2+16
		Fuel Used	661	*830*	830	830	975
		Specific Range/Altitude	0.908/FL 280	*0.723/FL 280*	0.723/FL 280	0.723/FL 280	0.615/FL 270
	1,000 nm	Runway	2,438	*2,380*	2,380	2,380	2,026
		Flight Time	4+34	*3+10*	3+10	3+10	3+46
		Fuel Used	920	*1,320*	1,320	1,320	1,520
		Specific Range/Altitude	1.087/FL 280	*0.758/FL 290*	0.758/FL 290	0.758/FL 290	0.658/FL 280
		Suggested Base Price	$2,853,000	*NA*	$3,658,336	$3,899,887	$4,055,000
Remarks		Certification Basis	FAR 23 A 52 Garmin G3000 with SVS.	*FAR 23 pending Garmin G1000.*	FAR 23, 1990/2006/07/14 Pilot door standard, 5-blade propeller; multi-seat; Garmin G1000; 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	100	*92*	100
		V_{YSE}	105	108	*95*	108
Climb		Time to Climb (min.)/Altitude	7/FL 100	NA/FL 250	*6/FL 100*	18/FL 250
		Initial Engine-Out Rate (fpm)	270	NA	*290*	460
		Initial All-Engine Gradient (ft./nm)	1,500	NA	*1,107*	1,900
		Initial Engine-Out Gradient (ft./nm)	180	NA	*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 100*	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** (w/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 (w/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 (w/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	0.516/FL 280	*0.347/FL 100*	0.503/FL 270
		Suggested Base Price	$2,485,900	NA	*NA*	NA
Remarks		Certification Basis	FAR 23, 1986 Garmin G950; STEC 2100 autopilot. 2015 data.	ST01902CH; SA3593NM; SA4010NM; SA3593NM; SA01902CH; SA01456WI-D; SA02133SE.	*EASA/FAR 23 pending.*	CAR 3, 1959/2007 Pro Line Fusion std.; STC SA10747SC weight increase; SA02054SE winglets; SA3593NM swept props; SA4010NM dual aft strakes; 1,000-nm mission, 755 lb.

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	$6,900,000	$7,395,000
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		V_{MO}	260	170	260
		V_A	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
		V_{MCA}	86	66	100
		V_{DEC}	94	NA	106
		V_{XSE}	115	NA	132
		V_{YSE}	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** (w/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 (w/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 (w/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 standard; STC SA02131SE.	EASA/FAR 23 A 57, 2010	EASA 23, 2014; FAR 23, 2015 Includes Rockwell Collins Pro Line 21; TCAS I; Iridium satcom; RVSM approved. 2015 data.

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** (w/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 (w/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 (w/4 passengers)	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; STC SA11103SC for IGW.	FAR 23, 1989 Commuter category Rockwell Collins Pro Line Fusion + Wi-Fi; RVSM approved.	FAR 23, 1989/2007 Commuter category 17,500-lb. MTOW optional; 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; 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	*30.9*	33.5
		Height	*10.5*	11.0
		Span	*38.3*	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	*3,700*	3,923
		Max Payload	*1,200*	999
		Useful Load	*2,340*	2,111
		Max Fuel	*2,000*	1,680
		Available Payload w/Max Fuel	*340*	431
		Available Fuel w/Max Payload	*1,140*	1,112
Limits		MMO	*0.540*	0.640
		Trans. Alt. FL/VMO	*FL 195/250*	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	*2,500*	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** (w/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 (w/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 (w/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 pending* *All data preliminary.*	FAR 23, 2006/2015 1,000-nm mission flown with 3 passengers; *V50 used in lieu of V2.

NOTICE TO READERS

During recent years, the U.S. Federal Trade Commission has conducted investigations into the practice of certain industries in fixing and advertising list prices. It is the position of the FTC that it is deceptive to the public and against the law for list prices of any product to be specified or advertised in a trade area if the majority of sales are made at less than those prices.

BCA is not in a position to know the prices for most of the sales in each trading area in the United States for each of the products in this issue. Therefore, the prices shown in the tables and text in the Purchase Planning Handbook are based on suggested list prices furnished to us by the manufacturers or distributors, or on prices estimated by the editors. It may be possible to purchase some items in your trading area at prices less than those reported in this issue of BCA. Also, almost all manufacturers and distributors caution that prices are subject to change without notice.

JETS <20,000-LB. MTOW

Manufacturer			Textron Aviation	Embraer	Honda Aircraft Co.	Textron Aviation	Nextant Aerospace
Model			Cessna Citation Mustang CE-510	Phenom 100E EMB-500	HondaJet HA-420	Cessna Citation M2 CE-525	Nextant 400 XTi BE 400A
***BCA* Equipped Price**			$3,350,000	$4,161,600	$4,500,000	$4,500,000	$5,304,500
Character-istics		Seating	1+5/5/—	1+5/7/7	1+5/6/NA	1+7/7/—	2+7/9/—
		Wing Loading/Power Loading	41.2/2.96	52.5/3.12	60.0/2.59	44.6/2.72	67.6/2.67
		Noise (EPNdB): Lateral/Flyover/Approach	73.9/85.0/86.0	70.4/81.4/86.1	85.4/72.9/87.5	85.9/73.2/88.5	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	14.9	13.9	13.9
		Span	43.2	40.4	39.8	47.3	43.5
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	6.7/9.8/9.8	9.0/11.0/11.0	12.1/12.1/NA	8.8/11.0/11.0	15.5/15.5/—
		Height/Dropped Aisle Depth	4.5/0.3	4.9/0.3	4.8/NA	4.8/0.4	4.8/flat floor
		Width: Max/Floor	4.6/3.1	5.1/3.6	5.0/NA	4.8/3.1	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	66/500	46/725	26/450
Power		Engines	2 P&WC PW615F	2 P&WC PW 617F-E	2 GE Honda HF-120-H1A	2 Wms Intl FJ44-1AP-21	2 Wms Intl FJ44-3AP
		Output (lb. each)/Flat Rating	1,460/ISA+10C	1,695/ISA+10C	2,050/ISA+10C	1,965/ISA+7C	3,052/ISA+7C
		Inspection Interval/Manu. Service Plan Interval	3,500t/—	3,500t/—	NA/—	3,500t/5,000	5,000t/—
Weights (lb.)		Max Ramp	8,730	10,626	10,680	10,800	16,500
		Max Takeoff	8,645	10,582	10,600	10,700	16,300
		Max Landing	8,000	9,877	9,860	9,900	15,700
		Zero Fuel	6,750c	8,554c	8,800c	8,400c	13,000c
		BOW	5,600	7,220	7,279	6,990	10,950
		Max Payload	1,150	1,334	1,521	1,410	2,050
		Useful Load	3,130	3,406	3,401	3,810	5,550
		Max Fuel	2,580	2,804	2,845	3,296	4,912
		Available Payload w/Max Fuel	550	602	556	514	638
		Available Fuel w/Max Payload	1,980	2,072	1,880	2,400	3,500
Limits		MMO	0.630	0.700	0.720	0.710	0.780
		Trans. Alt. FL/VMO	FL 271/250	FL 280/275	FL 302/270	FL 305/263	FL 290/320
		PSI/Sea-Level Cabin	8.3/21,280	8.3/21,280	8.8/23,060	8.5/22,027	9.1/24,000
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,110	3,123	3,934	3,210	3,821
		TOFL (5,000-ft. elev.@25C)	6,600	6,609	6,108	5,580	5,088
		Mission Weight	8,645	10,582	10,600	10,700	14,500p
		NBAA IFR Range	984	1,071	1,223	1,204	1,197
		V2	97	98	120	111	116
		VREF	88	94	105	101	105
		Landing Distance	2,137	2,466	2,795	2,340	2,960
Climb		Time to Climb/Altitude	20/FL 370	24/FL 370	17/FL 370	18/FL 370	16/FL 370
		FAR 25 Engine-Out Rate (fpm)	432	560	933	618	305
		FAR 25 Engine-Out Gradient (ft./nm)	267	298	400	334	158
Ceilings (ft.)		Certificated	41,000	41,000	43,000	41,000	45,000
		All-Engine Service	41,000	41,000	43,000	41,000	45,000
		Engine-Out Service	26,900	24,045	27,000	26,800	27,500
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	319/498	332/525	360/558	323/516	406/740
		Altitude/Specific Range	FL 390/0.641	FL 410/0.632	FL 430/0.645	FL 410/0.626	FL 450/0.549
	High Speed	TAS/Fuel Flow (lb./hr.)	339/609	389/851	420/972	401/920	447/968
		Altitude/Specific Range	FL 350/0.557	FL 330/0.457	FL 330/0.432	FL 350/0.436	FL 430/0.462
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	716	701	600	812	1,024
		Average Speed	294	319	347	361	367
		Trip Fuel	1,300	1,411	1,230	1,706	2,411
		Specific Range/Altitude	0.551/FL 410	0.497/FL 410	0.488/FL 430	0.476/FL 410	0.425/FL 450
	Max Fuel (w/available payload)	Nautical Miles	1,141	1,181	1,282	1,357	1,895
		Average Speed	304	326	361	372	384
		Trip Fuel	1,947	2,163	2,273	2,675	3,953
		Specific Range/Altitude	0.586/FL 410	0.546/FL 410	0.564/FL 430	0.507/FL 410	0.479/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	963	1,050	1,065	1,183	1,801
		Average Speed	301	324	361	370	383
		Trip Fuel	1,664	1,960	1,976	2,352	3,706
		Specific Range/Altitude	0.579/FL 410	0.536/FL 410	0.539/FL 430	0.503/FL 410	0.486/FL 450
	Ferry	Nautical Miles	1,204	1,234	1,358	1,400	1,981
		Average Speed	315	325	358	378	381
		Trip Fuel	1,965	2,183	2,290	2,705	3,986
		Specific Range/Altitude	0.613/FL 410	0.565/FL 410	0.593/FL 430	0.518/FL 410	0.497/FL 450
Missions (4 passen-gers)	**300 nm**	Runway	2,498	2,722	3,564	2,625	3,015
		Flight Time	1+00	0+55	0+53	0+52	0+48
		Fuel Used	670	741	676	804	786
		Specific Range/Altitude	0.448/FL 370	0.405/FL 390	0.444/FL 430	0.373/FL 370	0.382/FL 390
	600 nm	Runway	2,700	2,860	3,732	2,692	3,044
		Flight Time	1+56	1+46	1+38	1+38	1+30
		Fuel Used	1,135	1,263	1,179	1,362	1,323
		Specific Range/Altitude	0.529/FL 390	0.475/FL 390	0.509/FL 430	0.441/FL 390	0.454/FL 430
	1,000 nm	Runway	3,110	3,050	3,909	3,009	3,101
		Flight Time	3+19	3+05	2+40	2+42	2+28
		Fuel Used	1,754	1,874	1,863	2,018	2,145
		Specific Range/Altitude	0.570/FL 410	0.534/FL 410	0.537/FL 430	0.496/FL 410	0.466/FL 450
Remarks		Certification Basis	FAR 23, 2006 1,000-nm mission flown with 713-lb. payload.	FAR 23, 2008	FAR 23, 2015	FAR 23, 2013	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	58.6/2.67	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	18,078	17,230
		Max Takeoff	13,870	13,950	17,650	17,968	17,110
		Max Landing	12,750	12,725	16,250	16,865	15,660
		Zero Fuel	10,510c	10,500c	NA	13,999c	12,500c
		BOW	8,540	8,917	NA	11,583	10,280
		Max Payload	1,970	1,583	2,500	2,416	2,220
		Useful Load	5,530	5,133	NA	6,495	6,950
		Max Fuel	4,710	4,850	5,965	5,353	5,828
		Available Payload w/Max Fuel	820	283	915	1,142	1,122
		Available Fuel w/Max Payload	3,560	3,550	NA	4,079	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	3,138	3,140
		TOFL (5,000-ft. elev.@25C)	4,750	8,784	4,430	5,114	5,180
		Mission Weight	13,870	13,125	17,750	17,968	16,788
		NBAA IFR Range	1,827	1,915	NA	2,019	1,948
		V2	114	112	NA	112	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	14/FL 370	14/FL 370
		FAR 25 Engine-Out Rate (fpm)	808	312	NA	911	839
		FAR 25 Engine-Out Gradient (ft./nm)	425	167	NA	462	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** (w/available fuel)	Nautical Miles	1,172	1,635	NA	1,247	1,425
		Average Speed	368	402	NA	397	407
		Trip Fuel	2,552	2,908	NA	3,109	3,753
		Specific Range/Altitude	0.459/FL 450	0.562/FL 470	NA/NA	0.401/FL 450	0.380/FL 450
	Max Fuel (w/available payload)	Nautical Miles	1,814	2,598	NA	1,877	1,913
		Average Speed	377	410	NA	409	413
		Trip Fuel	3,846	4,241	NA	4,416	4,904
		Specific Range/Altitude	0.472/FL 450	0.613/FL 490	NA/NA	0.425/FL 450	0.390/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	1,825	2,205	NA	1,903	1,927
		Average Speed	276	408	NA	411	416
		Trip Fuel	3,767	3,713	NA	4,447	4,920
		Specific Range/Altitude	0.484/FL 450	0.594/FL 490	NA/NA	0.428/FL 450	0.392/FL 450
	Ferry	Nautical Miles	1,900	2,667	NA	1,944	1,955
		Average Speed	383	411	NA	418	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	0.435/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, 2004/2014 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	FAR 23, 2010 Commuter category

JETS ≥20,000-LB. MTOW

Manufacturer			Textron Aviation	Bombardier	Textron Aviation	Bombardier	Gulfstream Aerospace
Model			**Cessna Citation X Elite CE-750**	**Learjet 70 Model 45**	**Cessna Citation XLS+ CE-560XL**	**Learjet 75 Model 45**	**Gulfstream 150 G150**
BCA Equipped Price			$6,500,000	$11,300,000	$12,750,000	$13,800,000	$15,700,000
Characteristics		Seating	2+8/11/—	2+6/7/7	2+9/12/—	2+8/9/9	2+7/8/9
		Wing Loading/Power Loading	68.5/2.67	69.6/2.79	54.6/2.45	69.6/2.79	82.3/2.95
		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	80.7/91.2/91.9
External Dimensions (ft.)		Length	72.3	56.0	52.5	58.0	56.8
		Height	19.3	14.0	17.2	14.0	19.1
		Span	63.9	50.9	56.3	50.9	55.6
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	13.3/17.7/17.7
		Height/Dropped Aisle Depth	5.7/0.7	4.9/flat floor	5.7/0.7	4.9/flat floor	5.5/4.5
		Width: Max/Floor	5.5/3.9	5.1/3.2	5.5/3.9	5.1/3.2	5.5/4.3
Baggage		**Internal:** Cu. ft./lb.	variable/variable	15/150	10/100	15/150	25/TBD
		External: Cu. ft./lb.	82/775	50/500	80/700	50/500	55/1,100
Power		Engines	2 RR AE3007C1	2 Hon TFE731-40BR	2 P&WC PW545C	2 Hon TFE731-40BR	2 Hon TFE731-40AR-200G
		Output (lb. each)/Flat Rating	6,764/ISA+15C	3,850/ISA+23C	4,119/ISA+10C	3,850/ISA+23C	4,420/ISA+13C
		Inspection Interval/Manu. Service Plan Interval	4,500t*/—	6,000t/—	5,000t/—	6,000t/—	6,000c/—
Weights (lb.)		Max Ramp	36,400	21,750	20,400	21,750	26,250
		Max Takeoff	36,100	21,500	20,200	21,500	26,100
		Max Landing	31,800	19,200	18,700	19,200	21,700
		Zero Fuel	24,400c	16,000c	15,100c	16,000c	17,500c
		BOW	22,100	13,900	12,860	14,050	15,200
		Max Payload	2,300	2,100	2,240	1,950	2,300
		Useful Load	14,300	7,850	7,540	7,700	11,050
		Max Fuel	12,931	6,062	6,740	6,062	10,300
		Available Payload w/Max Fuel	1,369	1,788	800	1,638	750
		Available Fuel w/Max Payload	12,000	5,750	5,300	5,750	8,750
Limits		MMO	0.920	0.810	0.750	0.810	0.850
		Trans. Alt. FL/VMO	FL 307/350	FL 270/330	FL 265/305	FL 270/330	FL 300/330
		PSI/Sea-Level Cabin	9.3/25,230	9.4/25,700	9.3/25,230	9.4/25,700	8.8/23,000
Airport Performance		TOFL (SL elev./ISA temp.)	5,140	4,440	3,560	4,440	5,018
		TOFL (5,000-ft. elev.@25C)	7,350	5,191	5,430	5,272	8,278
		Mission Weight	34,980p	20,632	20,200	20,782	26,100
		NBAA IFR Range	2,980	2,045	1,740	2,026	2,988
		V2	137	125	118	125	131
		VREF	112	112	106	113	115
		Landing Distance	2,730	2,326	2,740	2,338	2,442
Climb		Time to Climb/Altitude	18/FL 370	15/FL 370	15/FL 370	15/FL 370	17/FL 370
		FAR 25 Engine-Out Rate (fpm)	486	430	765	430	438
		FAR 25 Engine-Out Gradient (ft./nm)	213	207	389	207	201
Ceilings (ft.)		Certificated	51,000	51,000	45,000	51,000	45,000
		All-Engine Service	43,000	45,200	45,000	44,700	42,400
		Engine-Out Service	26,000	28,400	28,600	27,900	26,400
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	470/1,529	437/970	353/865	437/977	430/1,184
		Altitude/Specific Range	FL 470/0.307	FL 470/0.451	FL 450/0.408	FL 470/0.447	FL 430/0.363
	High Speed	TAS/Fuel Flow (lb./hr.)	513/2,229	452/1,080	431/1,238	451/1,079	475/1,938
		Altitude/Specific Range	FL 410/0.230	FL 470/0.419	FL 410/0.348	470/0.418	FL 350/0.245
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,703	1,728	1,150	1,728	2,335
		Average Speed	462	425	385	425	415
		Trip Fuel	9,973	4,575	3,663	4,575	7,265
		Specific Range/Altitude	0.271/FL 470	0.378/FL 470	0.314/FL 450	0.378/FL 470	0.321/FL 450
	Max Fuel (w/available payload)	Nautical Miles	3,070	1,881	1,719	1,881	3,011
		Average Speed	462	426	395	426	418
		Trip Fuel	11,055	4,901	5,233	4,901	8,903
		Specific Range/Altitude	0.278/FL 490	0.384/FL 470	0.328/FL 450	0.384/FL 470	0.338/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	3,125	2,045	1,719	2,026	2,988
		Average Speed	463	426	395	427	418
		Trip Fuel	11,078	5,064	5,168	5,058	8,850
		Specific Range/Altitude	0.282/FL 490	0.404/FL 470	0.333/FL 450	0.401/FL 470	0.338/FL 450
	Ferry	Nautical Miles	3,221	2,150	1,785	2,129	3,122
		Average Speed	463	427	403	427	419
		Trip Fuel	11,118	5,099	5,268	5,093	8,945
		Specific Range/Altitude	0.290/FL 490	0.422/FL 490	0.339/FL 450	0.418/FL 490	0.349/FL 450
Missions (4 passengers)	**300 nm**	Runway	3,536	3,588	2,734	3,598	3,623
		Flight Time	0+41	0+45	0+46	0+45	0+50
		Fuel Used	1,837	1,072	1,246	1,075	1,230
		Specific Range/Altitude	0.163/FL 370	0.280/FL 470	0.241/FL 390	0.279/FL 470	0.244/FL 450
	600 nm	Runway	3,580	3,632	2,758	3,642	3,783
		Flight Time	1+16	1+24	1+29	1+23	1+32
		Fuel Used	2,855	1,805	2,094	1,810	1,974
		Specific Range/Altitude	0.210/FL 430	0.332/FL 470	0.287/FL 410	0.331/FL 470	0.304/FL 450
	1,000 nm	Runway	3,672	3,691	3,028	3,701	3,971
		Flight Time	2+03	2+18	2+26	2+18	2+28
		Fuel Used	4,469	2,787	3,211	2,792	2,998
		Specific Range/Altitude	0.224/FL 430	0.359/FL 470	0.311/FL 430	0.358/FL 470	0.334/FL 450
Remarks		Certification Basis	FAR 25, 1996/2002; JAR 25, 1999/2002 *Engine flight hour inspection.	FAR 25; EASA CS 25	FAR 25, 2008	FAR 25; EASA CS 25	FAR 25 A 108, 2005; EASA CS 25, 2007

JETS ≥20,000-LB. MTOW

Manufacturer			Textron Aviation	Embraer	Textron Aviation	Embraer	Textron Aviation
Model			**Cessna Citation Latitude CE-680A**	**Legacy 450 EMB-545**	**Cessna Citation Sovereign+ CE-680**	**Legacy 500 EMB-550**	**Cessna Citation X+ CE-750**
BCA Equipped Price			$16,250,000	$16,570,000	$17,895,000	$19,995,000	$23,365,000
Characteristics		Seating	2+9/9/10	2+7/9/9	2+9/12/12	2+8/12/12	2+9/12/—
		Wing Loading/Power Loading	56.8/2.61	NA/NA	56.7/2.60	78.6/2.73	69.4/2.60
		Noise (EPNdB): Lateral/Flyover/Approach	87.7/73.5/87.7	NA/NA/NA	87.8/71.9/87.9	72.8/85.5/89.9	87.7/72.4/89.3
External Dimensions (ft.)		Length	62.3	64.6	63.5	68.1	73.6
		Height	20.9	21.1	20.3	21.2	19.2
		Span	72.3	66.4	72.3	66.4	69.2
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	15.9/21.8/21.8	17.4/20.6/24.0	17.4/25.3/25.3	21.3/24.1/27.5	18.3/25.2/25.2
		Height/Dropped Aisle Depth	6.0/flat floor	6.0/flat floor	5.7/0.7	6.0/flat floor	5.7/0.7
		Width: Max/Floor	6.4/4.1	6.8/4.7	5.5/3.9	6.8/4.7	5.5/3.9
Baggage		**Internal:** Cu. ft./lb.	26/NA	40/330	35/415	45/330	22/NA
		External: Cu. ft./lb.	100/1,000	110/NA	100/1,000	110/882	82/775
Power		Engines	2 P&WC PW306D	2 Hon HTF7500E	2 P&WC PW306D	2 Hon HTF7500E	2 RR AE3007C2
		Output (lb. each)/Flat Rating	5,907/ISA+16C	6,540/ISA+18C	5,907/ISA+16C	7,036/ISA+18C	7,034/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	6,000t/—	OC/—	6,000t/—	OC/—	4,500t*/—
Weights (lb.)		Max Ramp	31,050	NA	31,025	38,537	36,900
		Max Takeoff	30,800	NA	30,775	38,360	36,600
		Max Landing	27,575	NA	27,575	34,524	32,000
		Zero Fuel	21,200c	NA	21,000c	26,499	24,978c
		BOW	18,656	NA	18,235	23,699	22,114
		Max Payload	2,544	2,800	2,765	2,800	2,864
		Useful Load	12,394	NA	12,790	14,838	14,786
		Max Fuel	11,394	NA	11,390	13,058	12,931
		Available Payload w/Max Fuel	1,000	800	1,400	1,780	1,855
		Available Fuel w/Max Payload	9,850	NA	10,025	12,038	11,922
Limits		M_{MO}	0.800	0.830	0.800	0.830	0.935
		Trans. Alt. FL/V_{MO}	FL 298/305	FL 395/320	FL 298/305	FL 295/320	FL 307/350
		PSI/Sea-Level Cabin	9.7/25,400	9.7/26,520	9.3/25,230	9.7/26,520	9.3/25,230
Airport Performance		TOFL (SL elev./ISA temp.)	3,580	3,907	3,530	4,084	5,250
		TOFL (5,000-ft. elev.@25C)	5,070	NA	4,760	5,415	7,317
		Mission Weight	30,675	NA	30,250	37,919	35,645
		NBAA IFR Range	2,700	NA	3,093	3,131	3,396
		V_2	115	NA	117	120	139
		V_{REF}	95	NA	96	102	116
		Landing Distance	2,085	NA	2,144	2,114	2,727
Climb		Time to Climb/Altitude	15/FL 370	14/FL 370	13/FL 370	14/FL 370	13/FL 370
		FAR 25 Engine-Out Rate (fpm)	652	NA	735	891	614
		FAR 25 Engine-Out Gradient (ft./nm)	340	NA	377	403	267
Ceilings (ft.)		Certificated	45,000	45,000	47,000	45,000	51,000
		All-Engine Service	43,000	44,000	45,000	44,000	47,000
		Engine-Out Service	26,260	29,740	28,189	25,900	
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	368/1,114	438/1,404	368/1,059	440/1,441	470/1,470
		Altitude/Specific Range	FL 430/0.330	FL 450/0.312	FL 450/0.347	FL 450/0.305	FL 470/0.320
	High Speed	TAS/Fuel Flow (lb./hr.)	432/1,765	462/1,621	448/1,756	467/1,741	520/2,453
		Altitude/Specific Range	FL 390/0.245	FL 430/0.285	FL 390/0.255	430/0.268	FL 410/0.212
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,135	NA	2,484	2,603	2,838
		Average Speed	394	NA	396	438	463
		Trip Fuel	7,901	NA	8,170	9,908	9,952
		Specific Range/Altitude	0.270/FL 450	NA/NA	0.304/FL 470	0.263/450	0.285/FL 490
	Max Fuel (w/available payload)	Nautical Miles	2,645	NA	2,996	2,998	3,241
		Average Speed	401	NA	400	440	464
		Trip Fuel	9,586	NA	9,658	11,151	11,108
		Specific Range/Altitude	0.276/FL 450	NA/NA	0.310/FL 470	0.269/450	0.292/FL 490
	Four Passengers (w/available fuel)	Nautical Miles	2,678	2,900	3,069	3,125	3,372
		Average Speed	401	NA	402	433	465
		Trip Fuel	9,594	NA	9,679	11,222	11,157
		Specific Range/Altitude	0.279/FL 450	NA/FL 450	0.317/FL 470	0.278/FL 450	0.302/FL 490
	Ferry	Nautical Miles	2,731	NA	3,138	3,153	3,463
		Average Speed	405	NA	405	440	465
		Trip Fuel	9,628	NA	9,708	11,250	11,195
		Specific Range/Altitude	0.284/FL 450	NA/NA	0.323/FL 470	0.280/FL 450	0.309/FL 490
Missions (4 passengers)	**300 nm**	Runway	2,760	NA	2,591	2,822	3,725
		Flight Time	0+46	NA	0+45	0+45	0+41
		Fuel Used	1,610	NA	1,506	1,545	1,827
		Specific Range/Altitude	0.186/FL 390	NA/NA	0.199/FL 390	0.194/FL 450	0.164/FL 370
	600 nm	Runway	2,845	NA	2,600	2,817	3,775
		Flight Time	1+29	1+26	1+26	1+26	1+16
		Fuel Used	2,573	2,478	2,404	2,478	2,937
		Specific Range/Altitude	0.233/FL 430	0.242/FL 450	0.250/FL 430	0.242/FL 450	0.204/FL 430
	1,000 nm	Runway	2,951	NA	2,650	2,963	3,849
		Flight Time	2+25	NA	2+21	2+21	2+02
		Fuel Used	3,989	NA	3,750	3,750	4,680
		Specific Range/Altitude	0.251/FL 430	NA/NA	0.267/FL 430	0.267/FL 450	0.214/FL 430
Remarks		Certification Basis	FAR 25, 2015 Garmin G5000.	RBAC/FAR 25, 2015; 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.

JETS ≥20,000-LB. MTOW

Manufacturer			Gulfstream Aerospace	Embraer	Bombardier	Dassault	Embraer
Model			**Gulfstream 280 G280**	**Legacy 600 EMB-135BJ**	**Challenger 350 BD-100-1A10**	**Falcon 2000S Falcon 2000EX**	**Legacy 650 EMB-135BJ***
***BCA* Equipped Price**			$24,500,000	$26,000,000	$26,673,000	$28,900,000	$31,600,000
Character-istics		Seating	2+9/10/19	2+13/14/19	2+10/11/19	2+10/10/19	2+13/14/19
		Wing Loading/Power Loading	80.0/2.60	90.0/3.12	77.6/2.77	77.7/2.93	97.2/2.97
		Noise (EPNdB): Lateral/Flyover/Approach	75.2/89.5/90.5	79.7/86.8/91.3	87.6/75.3/89.6	75.1/91.8/90.5	78.0/86.9/91.7
External Dimensions (ft.)		Length	66.8	86.4	68.7	66.3	86.4
		Height	21.3	22.2	20.0	23.2	21.8
		Span	63.0	69.5	69.0	70.2	69.5
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	30.3/42.4/49.1
		Height/Dropped Aisle Depth	6.1/4.5	6.0/2.5	6.0/flat floor	6.2/flat floor	6.0/2.5
		Width: Max/Floor	6.9/5.4	6.9/5.2	7.2/5.1	7.7/6.3	6.9/5.2
Baggage		**Internal:** Cu. ft./lb.	154/1,980	286/1,441	106/750	131/1,600	286/1,441
		External: Cu. ft./lb.	—/—	—/—	—/—	8/92	—/—
Power		Engines	2 Hon HTF7250G	2 RR AE 3007 A1E	2 Hon HTF 7350	2 P&WC PW308C	2 RR AE 3007A2
		Output (lb. each)/Flat Rating	7,624/ISA+17C	7,953/ISA+22C	7,323/ISA+15C	7,000/ISA+15C	9,020/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	7,000c/—	OC/—
Weights (lb.)		Max Ramp	39,750	49,758	40,750	41,200	53,727
		Max Takeoff	39,600	49,604	40,600	41,000	53,572
		Max Landing	32,700	40,785	34,150	39,300	44,092
		Zero Fuel	28,200c	35,274c	28,200c	29,700c	36,156c
		BOW	24,200	30,081	24,800	24,750	31,217
		Max Payload	4,000	5,193	3,400	4,950	4,939
		Useful Load	15,550	19,677	15,950	16,450	22,510
		Max Fuel	14,600	18,170	14,045	14,600	20,600
		Available Payload w/Max Fuel	950	1,507	1,905	1,850	1,910
		Available Fuel w/Max Payload	11,550	14,484	12,550	11,500	17,571
Limits		MMO	0.850	0.800	0.830	0.862	0.800
		Trans. Alt. FL/VMO	FL 280/340	FL 276/320	FL 290/320	FL 250/370	FL 276/320
		PSI/Sea-Level Cabin	9.2/25,000	8.4/21,650	8.8/23,338	9.3/25,300	8.4/21,650
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	4,750	5,614	4,829	4,325	5,741
		TOFL (5,000-ft. elev.@25C)	7,320	7,604	6,451	6,055	7,979
		Mission Weight	39,600	49,604	39,495	39,950	53,572
		NBAA IFR Range	3,600	3,453	3,250	3,600	3,953
		V2	137	139	133	123	144
		VREF	115	113	111	106	115
		Landing Distance	2,373	2,301	2,302	2,295	2,346
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	630	552	528	633
		FAR 25 Engine-Out Gradient (ft./nm)	371	272	249	257	259
Ceilings (ft.)		Certificated	45,000	41,000	45,000	47,000	41,000
		All-Engine Service	45,000	40,900	44,000	43,265	41,000
		Engine-Out Service	27,500	23,276	27,800	22,187	23,128
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	459/1,488	424/1,879	459/1,590	437/1,400	425/1,901
		Altitude/Specific Range	FL 450/0.308	FL 410/0.226	FL 450/0.289	FL 470/0.312	FL 410/0.224
	High Speed	TAS/Fuel Flow (lb./hr.)	482/1,925	455/2,545	470/1,832	482/2,075	459/2,570
		Altitude/Specific Range	FL 430/0.250	FL 370/0.179	FL 430/0.257	FL 410/0.232	FL 370/0.179
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,577	2,417	2,719	2,450	3,076
		Average Speed	448	414	447	426	417
		Trip Fuel	9,591	12,242	10,689	9,640	15,238
		Specific Range/Altitude	0.269/FL 450	0.197/FL 410	0.254/FL 450	0.254/FL 450	0.202/FL 410
	Max Fuel (w/available payload)	Nautical Miles	3,636	3,376	3,235	3,445	3,839
		Average Speed	452	407	449	429	417
		Trip Fuel	12,757	16,065	12,206	12,740	18,380
		Specific Range/Altitude	0.285/FL 450	0.210/FL 410	0.265/FL 450	0.270/FL 470	0.209/FL 410
	Four Passengers (w/available fuel)	Nautical Miles	3,646	3,430	3,250	3,540	3,919
		Average Speed	451	406	448	430	415
		Trip Fuel	12,761	16,094	12,212	12,740	18,422
		Specific Range/Altitude	0.286/FL 450	0.213/FL 410	0.266/FL 450	0.278/FL 470	0.213/FL 410
	Ferry	Nautical Miles	3,724	3,485	3,307	3,615	3,980
		Average Speed	452	402	450	430	414
		Trip Fuel	12,789	16,122	12,236	12,740	18,450
		Specific Range/Altitude	0.291/FL 450	0.216/FL 410	0.270/FL 450	0.284/FL 470	0.216/FL 410
Missions (4 passen-gers)	**300 nm**	Runway	2,957	3,522	3,611	2,795	3,346
		Flight Time	0+47	0+48	0+47	0+47	0+49
		Fuel Used	1,505	1,894	1,583	1,525	1,773
		Specific Range/Altitude	0.199/FL 450	0.158/FL 410	0.190/FL 450	0.197/FL 470	0.169/FL 410
	600 nm	Runway	2,997	3,716	3,656	2,855	3,518
		Flight Time	1+26	1+37	1+26	1+27	1+34
		Fuel Used	2,412	3,044	2,577	2,465	3,146
		Specific Range/Altitude	0.249/FL 450	0.197/FL 410	0.233/FL 450	0.243/FL 470	0.191/FL 410
	1,000 nm	Runway	3,136	3,789	3,718	2,920	3,573
		Flight Time	2+18	2+36	2+18	2+20	2+33
		Fuel Used	3,645	4,731	3,925	3,755	4,815
		Specific Range/Altitude	0.274/FL 450	0.211/FL 410	0.255/FL 450	0.266/FL 470	0.208/FL 410
Remarks		Certification Basis	FAR 25, 2012; EASA CS 25, 2013	FAR 25, 2002	FAR 25 A 98; JAR 25 Chg 15 Pro Line 21 advanced.	FAR/EASA CS 25, 2013 EASy II flight deck; 2016 delivery price.	FAR 25, 2011 *Factory modification DCA 145-000-00020/2008

JETS ≥20,000-LB. MTOW

Manufacturer			Bombardier	Dassault	Gulfstream Aerospace	Dassault	*Gulfstream Aerospace*
Model			**Challenger 650 CL-600-2B16**	**Falcon 2000LXS Falcon 2000EX**	**Gulfstream 450 GIV-X**	**Falcon 900LX Falcon 900EX**	***Gulfstream 500 GVII***
BCA **Equipped Price**			$32,350,000	$34,150,000	$43,150,000	$43,800,000	*$44,650,000*
Character-istics		Seating	2+12/13/19	2+8/10/19	2+14/16/19	2+12/12/19	*2+13/18/19*
		Wing Loading/Power Loading	98.6/2.61	81.2/3.06	78.4/2.69	92.9/3.27	*80.9/2.54*
		Noise (EPNdB): Lateral/Flyover/Approach	86.2/81.2/90.3	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	68.4	66.3	89.3	66.3	*91.2*
		Height	20.7	23.2	25.2	24.8	*25.5*
		Span	64.3	70.2	77.8	70.2	*86.3*
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	15.4/25.6/28.3	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	6.0/flat floor	6.2/flat floor	6.0/flat floor	6.2/flat floor	*6.2/flat floor*
		Width: Max/Floor	7.9/6.9	7.7/6.3	7.0/5.4	7.7/6.3	*7.6/6.1*
Baggage		**Internal:** Cu. ft./lb.	112/900	131/1,600	169/2,000	127/2,866	*230/2,250*
		External: Cu. ft./lb.	—/—	8/92	—/—	—/—	*—/—*
Power		Engines	2 GE CF34-3B	2 P&WC PW308C	2 RR Tay Mk 611-8C	3 Hon TFE731-60	*2 P&WC PW814GA*
		Output (lb. each)/Flat Rating	9,220*/ISA+15C	7,000/ISA+15C	13,850/ISA+15C	5,000/ISA+17C	*15,144/ISA+15C*
		Inspection Interval/Manu. Service Plan Interval	OC/—	7,000c/—	12,000t or OC/—	6,000c/—	*10,000t/—*
Weights (lb.)		Max Ramp	48,300	43,000	75,000	49,200	*77,250*
		Max Takeoff	48,200	42,800	74,600	49,000	*76,850*
		Max Landing	38,000	39,300	66,000	44,500	*64,350*
		Zero Fuel	32,000c	29,700c	49,000c	30,864c	*52,100c*
		BOW	27,250	24,750	43,200	26,750	*46,600*
		Max Payload	4,750	4,950	5,800	4,114	*5,500*
		Useful Load	21,050	18,250	31,800	22,450	*30,650*
		Max Fuel	19,852	16,660	29,281	20,905	*28,850*
		Available Payload w/Max Fuel	1,198	1,590	2,519	1,545	*1,800*
		Available Fuel w/Max Payload	16,300	13,300	26,000	18,336	*25,150*
Limits		MMO	0.850	0.862	0.880	0.870	*0.925*
		Trans. Alt. FL/VMO	FL 222/348	FL 250/370	FL 280/340	FL 250/370	*NA/NA*
		PSI/Sea-Level Cabin	8.8/23,000	9.3/25,300	9.6/26,700	9.6/25,300	*10.7/31,900*
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	5,640	4,675	5,600	5,360	*5,200*
		TOFL (5,000-ft. elev.@25C)	9,233	6,840	8,200	7,615	*NA*
		Mission Weight	47,802	42,010	74,600	48,255	*76,850*
		NBAA IFR Range	4,011	4,100	4,328	4,685	*5,000*
		V2	147	126	150	134	*NA*
		VREF	117	106	123	111	*NA*
		Landing Distance	2,365	2,295	2,663	2,455	*NA*
Climb		Time to Climb/Altitude	21/FL 370	17/FL 370	16/FL 370	19/FL 370	*15/FL 370*
		FAR 25 Engine-Out Rate (fpm)	581	463	712	716	*NA*
		FAR 25 Engine-Out Gradient (ft./nm)	237	221	285	320	*NA*
Ceilings (ft.)		Certificated	41,000	47,000	45,000	51,000	*51,000*
		All-Engine Service	38,250	42,315	42,400	39,630	*NA*
		Engine-Out Service	20,000	21,010	25,000	24,980	*NA*
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	424/1,832	437/1,485	459/2,585	431/1,665	*488/2,440*
		Altitude/Specific Range	FL 410/0.231	FL 450/0.294	FL 450/0.178	FL 430/0.259	*FL 450/0.200*
	High Speed	TAS/Fuel Flow (lb./hr.)	470/2,448	483/2,325	476/3,055	474/2,225	*516/3,467*
		Altitude/Specific Range	FL 370/0.192	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** (w/available fuel)	Nautical Miles	3,011	2,915	3,549	3,790	*4,129*
		Average Speed	417	427	452	422	*478*
		Trip Fuel	14,256	11,438	22,622	16,340	*22,365*
		Specific Range/Altitude	0.211/FL 410	0.255/FL 450	0.157/FL 450	0.232/FL 430	*0.185/FL 470*
	Max Fuel (w/available payload)	Nautical Miles	3,974	3,990	4,216	4,565	*5,000*
		Average Speed	419	430	453	421	*480*
		Trip Fuel	17,939	14,798	26,023	18,909	*26,172*
		Specific Range/Altitude	0.222/FL 410	0.270/FL 470	0.162/FL 450	0.241/FL 430	*0.191/FL 490*
	Four Passengers (w/available fuel)	Nautical Miles	4,011	4,065	4,328	4,650	*5,075*
		Average Speed	419	430	452	420	*480*
		Trip Fuel	17,953	14,798	26,087	18,909	*26,200*
		Specific Range/Altitude	0.223/FL 410	0.275/FL 470	0.166/FL 450	0.246/FL 430	*0.194/FL 490*
	Ferry	Nautical Miles	4,085	4,155	4,382	4,740	*5,137*
		Average Speed	419	431	453	419	*480*
		Trip Fuel	17,982	14,798	26,116	18,909	*26,222*
		Specific Range/Altitude	0.227/FL 410	0.281/FL 470	0.168/FL 450	0.251/FL 430	*0.196/FL 490*
Missions (4 passen-gers)	**300 nm**	Runway	3,389	2,795	3,225	2,730	*NA*
		Flight Time	0+47	0+47	0+46	0+47	*0+45*
		Fuel Used	1,595	1,525	2,599	1,595	*2,274*
		Specific Range/Altitude	0.188/FL 410	0.197/FL 470	0.115/FL 450	0.188/FL 450	*0.132/FL 490*
	600 nm	Runway	3,421	2,855	3,258	2,865	*NA*
		Flight Time	1+27	1+27	1+25	1+27	*1+22*
		Fuel Used	2,835	2,465	4,113	2,625	*3,561*
		Specific Range/Altitude	0.212/FL 410	0.243/FL 470	0.146/FL 450	0.229/FL 470	*0.168/FL 490*
	1,000 nm	Runway	3,483	2,920	3,304	2,880	*NA*
		Flight Time	2+19	2+20	2+18	2+20	*2+12*
		Fuel Used	4,532	3,755	6,176	4,070	*5,313*
		Specific Range/Altitude	0.221/FL 410	0.266/FL 470	0.162/FL 450	0.246/FL 470	*0.188/FL 490*
Remarks		Certification Basis	FAR 25, 1980/83/87/95/2006/15 Pro Line 21 Advanced; *9,220-lb. max takeoff; 8,729-lb. normal takeoff.	FAR/EASA CS 25, 2013 EASy II flight deck; 2016 delivery price.	FAR 25, 2004; EASA CS 25, 2004	FAR 25/EASA 25, 1979/2010 EASy II flight deck; 2016 delivery price.	*FAR 25/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
Character-istics		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	86.4/92.7/92.5	83.7/90.3/92.6	85.5/93.4/95.5
External Dimensions (ft.)		Length	96.8	118.9	76.1	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 Perfor-mance		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	FL 350/0.081
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/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 (w/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 (w/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 passen-gers)	**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; 2016 delivery price.	FAR 25, 1999 *Also available with 26,500-lbf IAEV2527M-A5 engines; includes 2 additional center tanks and VIP cabin. 2015 data.

ULTRA-LONG-RANGE JETS

Manufacturer			Dassault	Gulfstream Aerospace	Bombardier	Gulfstream Aerospace	Gulfstream Aerospace
Model			Falcon 8X Falcon 7X	Gulfstream 550 GV-SP	Global 6000 BD-700-1A10	Gulfstream 650 GVI	Gulfstream 650ER GVI
BCA Equipped Price			$57,500,000	$61,500,000	$62,310,000	$66,800,000	$68,800,000
Characteristics		Seating	3+12/14/19	4+16/18/19	4+13/15/19	4+16/19/19	4+16/19/19
		Wing Loading/Power Loading	95.9/3.62	80.1/2.96	97.5/3.37	77.6/2.95	80.7/3.07
		Noise (EPNdB): Lateral/Flyover/Approach	NA/NA/NA	79.3/90.2/90.8	88.7/83.5/89.7	77.5/89.8/88.3	78.7/89.6/88.3
External Dimensions (ft.)		Length	80.2	96.4	99.4	99.8	99.8
		Height	25.6	25.8	25.5	25.7	25.7
		Span	86.3	93.5	94.0	99.6	99.6
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	29.7/42.7/50.1	30.3/42.6/50.1	27.3/43.3/48.3	32.7/46.8/53.6	32.7/46.8/53.6
		Height/Dropped Aisle Depth	6.2/flat floor	6.0/flat floor	6.2/flat floor	6.3/flat floor	6.3/flat floor
		Width: Max/Floor	7.7/6.3	7.0/5.4	7.9/6.5	8.2/6.7	8.2/6.7
Baggage		**Internal:** Cu. ft./lb.	140/2,004	226/2,500	195/1,000	235/2,500	235/2,500
		External: Cu. ft./lb.	—/—	—/—	—/—	—/—	—/—
Power		Engines	3 P&WC PW307D	2 RR BR700-710C4-11	2 RR BR700-710A2-20	2 RR BR700-725A1-12	2 RR BR700-725A1-12
		Output (lb. each)/Flat Rating	6,722/ISA+17C	15,385/ISA+15C	14,750/ISA+20C	16,900/ISA+15°C	16,900/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	7,200c/—	8,000t or OC/—	OC/—	10,000t/—	10,000t/—
Weights (lb.)		Max Ramp	73,200	91,400	99,750	100,000	104,000
		Max Takeoff	73,000	91,000	99,500	99,600	103,600
		Max Landing	62,400	75,300	78,600	83,500	83,500
		Zero Fuel	41,000c	54,500c	58,000c	60,500c	60,500c
		BOW	36,100	48,700	52,560	54,500	54,500
		Max Payload	4,900	5,800	5,440	6,000	6,000
		Useful Load	37,100	42,700	47,190	45,500	49,500
		Max Fuel	34,900	40,994	44,716	44,200	48,200
		Available Payload w/Max Fuel	2,200	1,706	2,474	1,300	1,300
		Available Fuel w/Max Payload	32,200	36,900	41,750	39,500	43,500
Limits		MMO	0.900	0.885	0.890	0.925	0.925
		Trans. Alt. FL/VMO	FL 270/370	FL 270/340	FL 303/340	FL 290/340	FL 290/340
		PSI/Sea-Level Cabin	10.2/29,200	10.2/29,200	10.3/30,125	10.7/31,900	10.7/31,900
Airport Performance		TOFL (SL elev./ISA temp.)	6,000	5,910	6,476	5,858	6,299
		TOFL (5,000-ft. elev.@25C)	8,605	9,070	7,880	9,000	11,139
		Mission Weight	72,400	91,000	94,513p	99,600	103,600
		NBAA IFR Range	NA	6,738	5,594	6,912	7,437
		V2	137	147	142	146	148
		VREF	106	112	110	114	114
		Landing Distance	2,150	2,240	2,243	2,680	2,680
Climb		Time to Climb/Altitude	20/FL 370	18/FL 370	21/FL 370	19/FL 370	21/FL 370
		FAR 25 Engine-Out Rate (fpm)	NA	594	474	NA	NA
		FAR 25 Engine-Out Gradient (ft./nm)	NA	242	200	NA	NA
Ceiling (ft.)		Certificated	51,000	51,000	51,000	51,000	51,000
		All-Engine Service	NA	42,700	42,400	42,700	41,000
		Engine-Out Service	NA	25,820	18,000	25,000	25,000
Cruise	**Long Range**	TAS	NA	459	470	488	488
		Fuel Flow	NA	2,563	3,046	2,825	2,883
		Altitude	NA	FL 450	FL 450	FL 450	FL 450
		Specific Range	NA	0.179	0.154	0.173	0.169
	High Speed	TAS	NA	488	499	516	516
		Fuel Flow	NA	3,228	3,796	3,136	3,136
		Altitude	NA	FL 430	FL 410	FL 450	FL 450
		Specific Range	NA	0.151	0.131	0.165	0.165
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	5,650	5,767	5,882	5,934	6,459
		Average Speed	454	452	464	842	481
		Trip Fuel	29,746	33,993	40,415	36,285	40,285
		Specific Range/Altitude	0.190/FL 470	0.170/FL 490	0.146/FL 470	0.164/FL 490	0.160/FL 490
	Max Fuel (w/available payload)	Nautical Miles	6,355	6,698	6,200	6,981	7,507
		Average Speed	454	454	464	482	482
		Trip Fuel	32,489	38,202	41,472	41,129	45,129
		Specific Range/Altitude	0.196/FL 470	0.175/FL 490	0.149/FL 470	0.170/FL 510	0.166/FL 510
	Eight Passengers (w/available fuel)	Nautical Miles	6,450	6,708	6,124	6,912	7,437
		Average Speed	454	453	464	481	482
		Trip Fuel	32,489	38,205	41,437	40,820	44,820
		Specific Range/Altitude	0.199/FL 470	0.176/FL 490	0.148/FL 470	0.169/FL 510	0.166/FL 510
	Ferry	Nautical Miles	NA	6,853	6,233	7,105	7,636
		Average Speed	NA	454	464	482	482
		Trip Fuel	NA	38,251	41,487	41,168	45,168
		Specific Range/Altitude	NA/NA	0.179/FL 510	0.150/FL 470	0.173/FL 510	0.169/FL 510
Missions (8 passengers)	**1,000 nm**	Runway	2,655	3,436	2,852	3,241	3,241
		Flight Time	2+17	2+20	2+13	2+10	2+10
		Fuel Used	4,840	5,599	6,842	5,942	5,942
		Specific Range/Altitude	0.207/FL 470	0.179/FL 490	0.146/FL 470	0.168/FL 510	0.168/FL 510
	3,000 nm	Runway	3,505	3,599	3,858	3,591	3,591
		Flight Time	6+39	6+42	6+20	6+17	6+17
		Fuel Used	13,705	15,474	19,538	16,280	16,280
		Specific Range/Altitude	0.219/FL 470	0.194/FL 490	0.154/FL 470	0.184/FL 510	0.184/FL 510
	6,000 nm	Runway	5,525	5,277	6,293	5,241	5,241
		Flight Time	13+12	13+15	12+39	12+28	12+28
		Fuel Used	29,885	33,428	41,053	34,622	34,622
		Specific Range/Altitude	0.201/FL 470	0.179/FL 490	0.146/FL 490	0.173/FL 510	0.173/FL 510
Remarks		Certification Basis	FAR/EASA 25 pending EASy III flight deck; DFCS; 2016 introductory price; all data preliminary.	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	FAR 25, 2014

ULTRA-LONG-RANGE JETS

Manufacturer			**Boeing**	**Airbus**	***Boeing***	***Boeing***
Model			**BBJ 737-700IGW**	**ACJ319 A319-133**	***BBJ MAX8 737-8***	***BBJ MAX9 737-9***
BCA Equipped Price			$79,000,000	$87,000,000	$95,300,000	$103,300,000
Character-istics		Seating	4+19/55/149	4+19/19/156	4+19/71/189	4+19/75/220
		Wing Loading/Power Loading	127.5/3.13	127.8/3.12	135.1/3.24	145.2/3.48
		Noise (EPNdB): Lateral/Flyover/Approach	85.4/94.9/95.8	85.4/94.6/94.2	NA/NA/NA	NA/NA/NA
External Dimensions (ft.)		Length	110.3	111.0	129.7	138.3
		Height	41.2	38.6	40.3	40.3
		Span	117.4	111.8	117.8	117.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	72.7/79.2/—	78.0/78.0/—	91.9/98.5/98.5	100.6/107.2/107.2
		Height/Dropped Aisle Depth	79.3/flat floor	7.4/flat floor	7.1/flat floor	7.1/flat floor
		Width: Max/Floor	11.6/10.7	12.2/11.6	11.6/10.7	11.6/10.7
Baggage		**Internal:** Cu. ft./lb.	NA/NA	160/NA	NA/NA	NA/NA
		External: Cu. ft./lb.	159/NA	NA/NA	713/NA	874/NA
Power		Engines	2 CFMI CFM56-7B27E	2 CFMI CFM56-5B7/3*	2 CFMI LEAP-1B	2 CFMI LEAP-1B
		Output (lb. each)/Flat Rating	27,300/ISA+15C	27,000/ISA+29C	28,000/ISA+15C	28,000/ISA+15°C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	OC/—
Weights (lb.)		Max Ramp	171,500	169,530	181,700	195,200
		Max Takeoff	171,000	168,650	181,200	194,700
		Max Landing	134,000	137,790	152,800	163,900
		Zero Fuel	126,000c	128,970c	145,400c	156,500c
		BOW	98,040	96,450**	110,000	118,080
		Max Payload	27,960	32,520	35,400	38,420
		Useful Load	73,460	73,080	71,700	77,120
		Max Fuel	71,737	72,560	69,814	73,325
		Available Payload w/Max Fuel	1,723	520	1,886	3,795
		Available Fuel w/Max Payload	45,500	40,560	36,300	38,700
Limits		MMO	0.820	0.820	0.820	0.820
		Trans. Alt. FL/VMO	FL 260/340	FL 250/350	FL 260/340	FL 260/340
		PSI/Sea-Level Cabin	9.0/24,000	8.3/22,000	9.0/24,000	9.0/24,000
Airport Performance		TOFL (SL elev./ISA temp.)	6,085	6,170	6,630	8,200
		TOFL (5,000-ft. elev.@25C)	10,330	8,360	NA	NA
		Mission Weight	171,000	168,650	NA	NA
		NBAA IFR Range	6,297	6,000	NA	NA
		V2	141	137	NA	NA
		VREF	117	111	122	124
		Landing Distance	2,360	2,220	2,440	2,570
Climb		Time to Climb/Altitude	25/FL 370	22/FL 360	24/FL 350	26/FL 330
		FAR 25 Engine-Out Rate (fpm)	NA	NA	NA	NA
		FAR 25 Engine-Out Gradient (ft./nm)	NA	NA	NA	NA
Ceiling (ft.)		Certificated	41,000	41,000	41,000	41,000
		All-Engine Service	NA	36,000	NA	NA
		Engine-Out Service	NA	18,000	NA	NA
Cruise	**Long Range**	TAS	452	447	455	457
		Fuel Flow	4,679	4,695	NA	NA
		Altitude	FL 390	FL 370	FL 380	FL 360
		Specific Range	0.097	0.095	NA	NA
	High Speed	TAS	470	470	471	471
		Fuel Flow	5,550	5,830	NA	NA
		Altitude	FL 370	FL 370	FL 360	FL 360
		Specific Range	0.085	0.081	NA	NA
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	3,306	2,679	2,692	2,628
		Average Speed	437	434	NA	NA
		Trip Fuel	39,508	33,677	NA	NA
		Specific Range/Altitude	0.084/FL 390	0.080/FL 370	NA/FL 370	NA/FL 350
	Max Fuel (w/available payload)	Nautical Miles	6,285	6,134	6,521	6,300
		Average Speed	443	442	NA	NA
		Trip Fuel	66,854	66,673	NA	NA
		Specific Range/Altitude	0.094/FL 410	0.092/FL 410	NA/FL 390	NA/FL 390
	Eight Passengers (w/available fuel)	Nautical Miles	6,270	6,002	6,555	6,376
		Average Speed	443	442	NA	NA
		Trip Fuel	66,723	65,558	NA	NA
		Specific Range/Altitude	0.094/FL 410	0.092/FL 410	NA/FL 390	NA/FL 410
	Ferry	Nautical Miles	6,348	6,200	6,619	6,441
		Average Speed	442	442	NA	NA
		Trip Fuel	66,886	67,207	NA	NA
		Specific Range/Altitude	0.095/FL 410	0.092/FL 410	NA/FL 390	NA/FL 410
Missions (8 passengers)	**1,000 nm**	Runway	3,485	4,075	NA	NA
		Flight Time	2+27	2+26	NA	NA
		Fuel Used	10,478	10,370	NA	NA
		Specific Range/Altitude	0.095/FL 410	0.096/FL 410	NA/NA	NA/NA
	3,000 nm	Runway	4,290	4,280	NA	NA
		Flight Time	6+54	6+54	NA	NA
		Fuel Used	29,534	30,070	NA	NA
		Specific Range/Altitude	0.102/FL 410	0.100/FL 410	NA/NA	NA/NA
	6,000 nm	Runway	5,855	6,160	NA	NA
		Flight Time	13+34	13+35	NA	NA
		Fuel Used	63,311	65,528	NA	NA
		Specific Range/Altitude	0.095/FL 410	0.092/FL 410	NA/NA	NA/NA
Remarks		Certification Basis	FAR 25 A 77, 1967/98 Split scimitar winglets.	FAR 25, 1999 *Also available with 26,500-lbf IAEV2527M-A5 engines; includes 6 additional center tanks plus VIP cabin. **Spec weight. 2015 data.	FAR 25 A TBD All data preliminary.	FAR 25 A TBD All data preliminary.

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FAR Part 91 Maintenance Programs

"Current" isn't, and neither is "mandatory"

THERE ARE TWO MAINTENANCE QUESTIONS THAT ARE POSED TO me again and again: First, "Are Mandatory Service Bulletins really mandatory?" and its counterpart: "When the manufacturer updates the maintenance program, do I have to comply with the changes?"

The owners of N-registered aircraft keep asking because the actual answers are ambiguous, and depending on the procedure involved, the "just do it" option of compliance can be awfully expensive.

Mandatory Service Bulletins: Under FAR Part 91, if a manufacturer issues a new "mandatory" Service Bulletin, a Part 91 aircraft operator is not required to follow the SB. However, should that bulletin later become an FAA Airworthiness Directive, then compliance becomes required at that time.

Current Inspection Program Recommended by the Manufacturer: Owners and operators of large and turbine aircraft must follow an inspection program in accordance with Part 91.409. Most of those Part 91 owners and operators elect to follow a "current inspection program recommended by the manufacturer" under Part 91.409(f)(3).

The word "current" causes confusion. Numerous FAA Legal Interpretations have clarified that the agency holds the word "current" to mean the program as it existed at the time the operator or owner adopted it. So, if you purchased a 2005 aircraft in 2010, the "current" inspection program to follow would have been the one that existed in 2010. Once you select the current inspection program under Part 91.409(f)(3), that program remains the one you must follow regardless of any revision the manufacturer makes subsequently — unless the revision is mandated by an FAA-issued AD or other FAA rule.

So, a "mandatory" Service Bulletin could be part of your current inspection program if, at the time that you adopted the program (that is, when you purchased your aircraft) any Service Bulletin(s) that contain inspection requirements are included, whether they appear directly in the program or are incorporated into it by reference.

Inspection Versus Maintenance: Inspections are an element of aircraft maintenance. Insight into the regulatory difference between inspection and other maintenance procedures is found in FAR Parts 43 and 91. For example, Appendix D to Part 43 provides the "Scope and Detail of Items . . . to Be Included in Annual and 100-Hour Inspections." Note that the Appendix's subparagraphs (b) through (u) require only "inspecting" the listed items; no corrective maintenance items are specified in the Appendix D inspection program. It is (hopefully) obvious that defects found during the inspection must be corrected by appropriate maintenance action.

Further context for the inspection/other maintenance dichotomy is found in Part 91.405(a), which requires that:

> *Each owner or operator of an aircraft (a) Shall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in Part 43 of this chapter.*

Most of those Part 91 owners and operators elect to follow a **"current inspection program recommended by the manufacturer"....**

Maintenance on most noncommercial aircraft is governed by Parts 43 and 91. Part 43.13 is the overarching maintenance performance rule. Although following a manufacturer's maintenance manual is generally a best practice, other methods, techniques and practices may be employed, as well. In a pertinent part, Part 43.13(a) states: "Each person performing maintenance, alteration or preventive maintenance on an aircraft, engine, propeller or appliance shall use the methods, techniques and practices prescribed in the current manufacturer's maintenance manual or Instructions for Continued Airworthiness [ICA] prepared by its manufacturer, *or other methods,* techniques and practices acceptable to the administrator, except as noted in Part 43.16." (Emphasis added.) The FAA has stated in legal interpretations that the option to use other methods, techniques and practices acceptable to the administrator means a maintenance provider is not bound to follow only the manufacturer's maintenance information so long as what is used is acceptable to the FAA.

100-Hr. Inspections: The FAA Legal Interpretations that find that manufacturers' maintenance Service Bulletins are not part of the "current" inspection program also apply to aircraft inspected under the provisions of Part 91.409(a) and (b) (which include annual and 100-hr. inspections).

FAR Part 121 and 135 Aircraft: Maintenance programs for airline and on-demand charter operations often contain requirements for following later-issued maintenance manual revisions and, sometimes, manufacturer-issued Service Bulletins.

The FAA has stated that if a manufacturer refuses to perform needed work unless its own Service Bulletins are followed, you may take your airplane to another authorized maintenance facility. The "current" and "mandatory" interpretation issues are contentious to say the least. Fortunately, FAA interpretations allow owner/operators to exercise their own judgment. **BCA**

Advertisers' Index

On Duty

Edited by Jessica A. Salerno *jessica.salerno@penton.com*

News of promotions, appointments and honors involving professionals within the business aviation community

▶ **Blackhawk Modifications, Inc.,** Waco, Texas, has promoted **Donnie Holder** to vice president of Marketing as the company expands the marketing department. Holder has been with the Blackhawk since 2004, most recently as vice president of Information Technology. He reports to **Edwin Black,** senior vice president of Global Sales and Marketing.


DONNIE HOLDER

▶ **Comlux, Hergiswill, Switzerland,** appointed **Frederic Dubant** to executive vice president Commercial of the Comlux Group.


FREDERIC DUBANT

▶ **Corporate Angel Network,** White Plains, New York, elected **Dawne S. Hickton,** former vice chair, president and CEO of RTI International Metals, Inc., to the board of directors of CAN.

▶ **Dallas Airmotive,** Dallas, Texas, named **Gregory Parson** regional rotorcraft sales manager for the East Coast.

▶ **Duncan Aviation,** Lincoln, Nebraska, announced that **Austin Chambers** is the new Gulfstream/Embraer Airframe Service Sales representative in Battle Creek. **Brian Leffers** is the new Avionics and Instrument manager responsible for daily oversight and leadership to the avionics and instruments repair facility in Lincoln.

▶ **FirstFlight,** Elmira/Corning, New York, announced that **Bob Salluzzo** will fill the newly created position of COO based at the company's headquarters at Elmira/Corning Regional Airport.

▶ **Grandview Aviation,** Baltimore, Maryland, announced the **Emily Sandoz** joined the company as charter sales coordinator.


EMILY SANDOZ

▶ **Million Air Dallas,** appointed **Bob Schmidt** president. **Jack Hopkins,** the current president, will retire after 32 years with the company.

▶ **Ogarajets,** Atlanta, announced **Dane McGuffee** has joined the company as sales director.

▶ **Pan Am International Flight Academy,** Miami, Florida, announced that **Takeshi Negishi** has been named president and CEO based at the company's headquarters in Miami.

▶ **Rockwell Collins,** Cedar Rapids, Iowa, named **Jeff Sare** vice president, Air Transport Cabin Solutions Sales and Marketing. In his new role, Sare will lead a sales and marketing team focused on the company's complete portfolio of PAVES IFE and connectivity solutions.


JEFF SARE

▶ **Sandel Avionics,** Vista, California, announced the **Steve Fulton** has expanded his role at the company to Avilon senior flight test pilot and PBN advisor. Fulton was a Technical Fellow for GE Aviation Systems and co-founder of Naverus, Inc. **BCA**


STEVE FULTON

Fred George
Senior Editor
fred.george@penton.com

Embraer Phenom 300

Soaring to the **top of the light-jet class**

EMBRAER

SIX YEARS AGO, THE $7 MILLION Embraer Phenom 300 entered service, instantly redefining the value proposition in the light-jet segment. Excluding its shorter lavatory, the dimensions of the main passenger seating area compare favorably with the Learjet 70, including maximum height because of Phenom 300's 4-in. dropped aisle. Its 66-cu.-ft. aft baggage compartment is the largest in the light-jet class and there is another 10 cu. ft. of luggage storage split between the nose compartment and lavatory. Its runway performance is closely matched to Citation CJ4. When flown at the same cruise speeds as CJ3, its fuel efficiency is almost identical. Typically equipped with 200 lb. of options and other gear, it can fly four passengers 1,800+ nm and land with 100-nm NBAA IFR reserves.

SB 505-00-0008 boosts maximum weights by 400+ lb., if you need more tanks-full payload. But, the tradeoff is longer takeoff field lengths and landing distances.

Up front, 2009 through 2013 Phenom 300 aircraft have Embraer Prodigy cockpits using Garmin G1000 avionics with three, 12.4-in. displays. In 2013, cockpits were upgraded with Prodigy Touch, based on G3000 with touch screen controllers in the center console. Both versions are approved for single-pilot operations.

Cabin layouts usually consist of a central four-chair club section, two forward-facing chairs in the aft cabin and a full-width aft lavatory with optional belted potty seat. Some aircraft have short galleys with an additional aft facing passenger seat or two-place divan on the right side. The cabin windows are the largest in the light-jet glass, with two in the lavatory that flood the compartment with daylight. Notably, the toilet is externally serviced. But, the fresh water tank for the optional lavatory sink must be internally replenished.

Passenger accommodations are comfortable, but cabin windows on early serial number aircraft can partially frost over during high-altitude cruise. When tray tables are extended, the sidewall pocket doors remain awkwardly propped open atop the tables near the side walls. And the aircraft could use USB power outlets at every seat to charge personal electronic devices. Overall, Embraer still has opportunities for improvement with respect to interior function, fit and finish in the light-jet class.

Systems design is a strong suit. The 9.4 psi pressurization system provides a 6,600-ft. cabin altitude at 45,000 ft., the aircraft's maximum cruise altitude. A robust vapor cycle air-conditioner effectively cools the cabin in very warm weather and there is two-zone temperature control. Anti-ice protection for both wing and horizontal stabilizer leading edges is provided by bleed air heat. Single-point pressure refueling helps prevent fuel contamination in inclement weather. The primary flight controls are manually operated, but the rudder is hydraulically boosted and there are fly-by-wire controlled, multi-function hydraulic spoilers. Left and right starter-generators, plus two batteries, power the split-buss DC system. All interior and exterior lights are long-life LEDs. UTC Aerospace (nee Goodrich]) SmartProbes supply digital air data to the avionics suite.

The Phenom 300 is kind to pilots. Checklists are short, systems operations are automated and handling characteristics are benign. Trailing link landing gear make for smooth touchdowns. But, be careful with the brakes. They can be a touch grabby.

The aircraft can climb directly to FL 450 in ISA conditions. Plan on flying 380 nm and burning 1,500 lb. the first hour. Second and subsequent hours, you'll cruise 425 nm while burning 1,000 lb./hr. Comfortable range is 4.5 hr.

This aircraft is rugged, having a 28,000 cycle/35,000 hr. design life. The aircraft also is comparatively easy to maintain, being a fully validated MSG 3 design with 600 hr./12-month basic inspection intervals. Embraer Executive Care, including parts and labor, averages $275 per hour, zero to 60 months in service; $430 per flight hour, 60-120 months in service. TBO for the twin PW535E turbofans is 5,000 hr. Pratt & Whitney ESP Gold costs about $364.70 both engines per hour.

Only about 5% of the 340 Phenom 300 aircraft are on the resale market. Average utilization is 300 hr. per year for owner/operators. According to Penton's *Aircraft Bluebook,* asking prices range from $6 to $8 million, depending upon options, age, flight time and condition. Standard configuration for the aircraft is comparatively sparse. Installed options and service bulletin status make a large difference in resale price.

Prime competitors include the Citation CJ3 and CJ4 with smaller cabin cross sections, but better runway performance than the heavy-weight Phenom 300 aircraft; the two-pilot Learjet 70 with a flat-floor, slightly more range and higher speed, but needing longer runways and having significantly higher operating costs; and the Nextant 400XTi with a flat-floor, a slightly smaller cabin, but having competitive range and better fuel efficiency, though needing longer runways.

The Phenom 300 has one of the highest resale values in the light-jet class. The reason is clear. This aircraft offers a superior blend of performance, cabin comfort, dispatch reliability and fuel efficiency. And it commands a proportionate price. **BCA**

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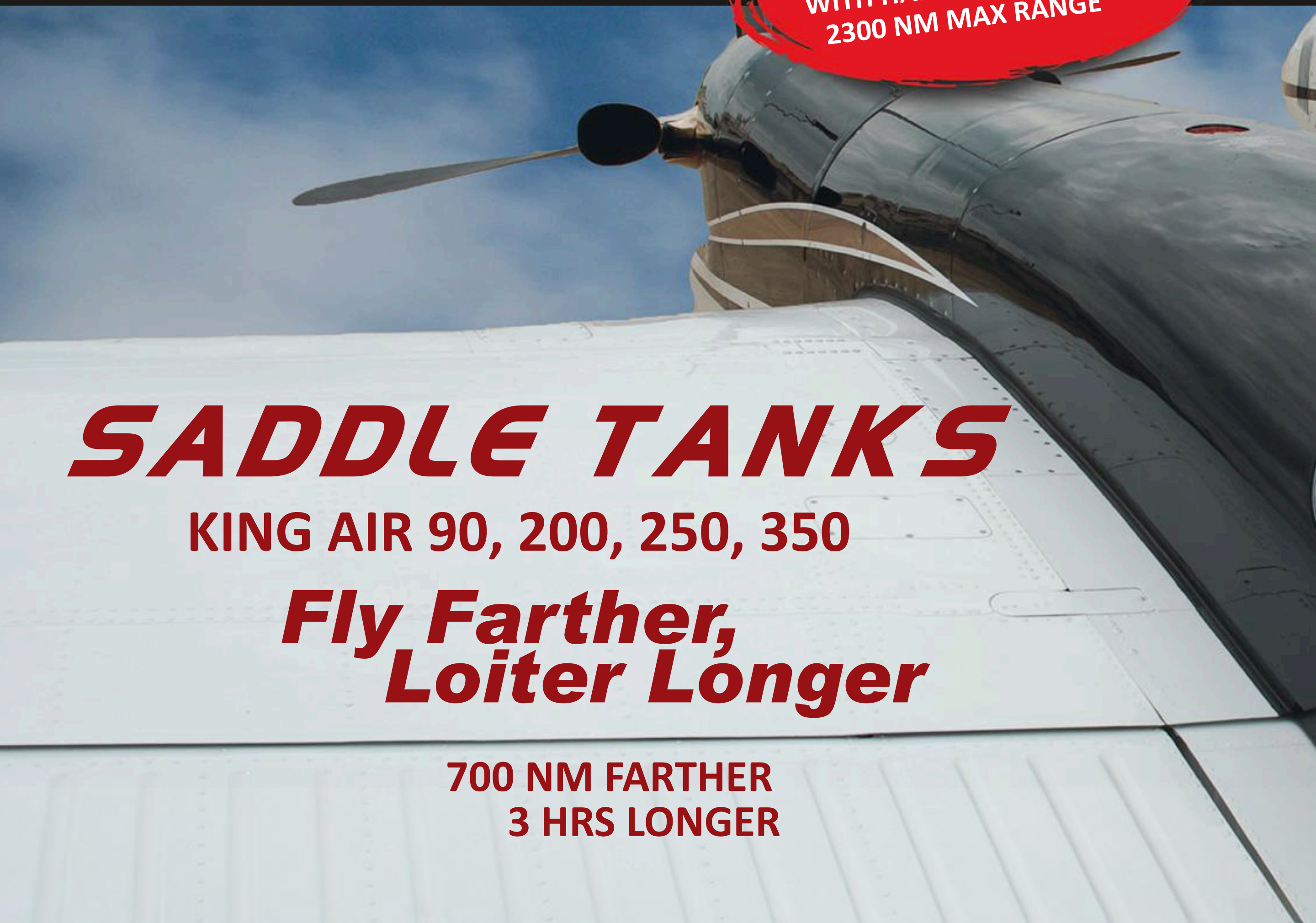

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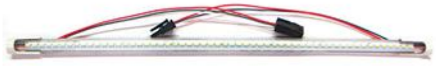

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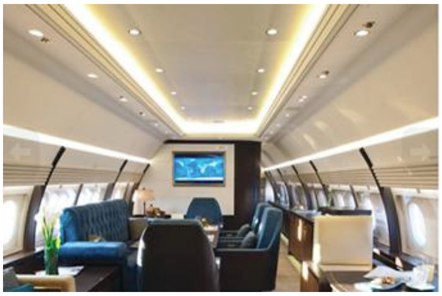

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Into the Blue

Fifty-two percent of the **jet category reported in Aircraft Bluebook** continues to **demonstrate a decline in prices**

Aircraft Bluebook At-a-Glance
Gulfstream G200
By Chris Reynolds, ASA | Aircraft Bluebook

***Aircraft Bluebook* At-a-Glance has reviewed the current market status of the Gulfstream G200 business jet. Research for this study was obtained in part from *Aircraft Bluebook, Aircraft Bluebook's Historical Value Reference*, the FAA's registry website and various trade services.**

Demand

Currently the Gulfstream G200 fleet is approximately 245 aircraft. When this article was written, approximately 36 G200 aircraft, representing approximately 15% of the fleet, were reported for sale.

Pricing

Current offerings for the G200 range from mid-$3 million to mid-$8 million; airframe time varies from 1,000 hr. to greater than 9,000 hr., depending on the year and model. Over the last year, approximately 35 sales appear to have occurred. Equipment, time/condition and engine maintenance programs can significantly affect time on market and marketable value. In the spring 2016 *Aircraft Bluebook* edition, a 2006 Gulfstream G200 had a reported average retail value of $6.8 million.

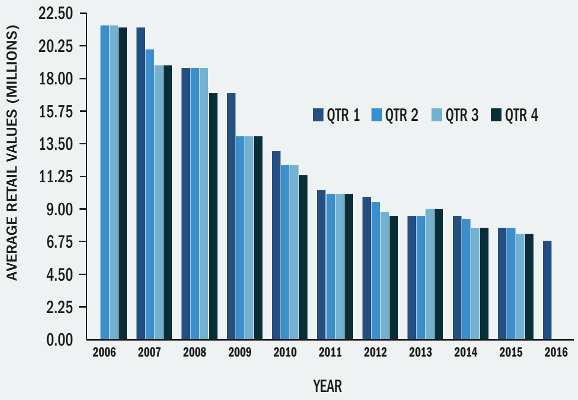
Residual Values

A 2006 Gulfstream G200, whose market values have been tracked since the second quarter of 2006, was reported new with an average equipped price of $21,646,000. *Aircraft Bluebook's Historical Value Reference* has demonstrated the G200 market value performance by quarter in the graph for this 2006 model.

Average Retail Values

(millions U.S. dollars)

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
2006		$21.65	$21.65	$21.5
2007	$21.5	20.0	18.9	18.9
2008	18.7	18.7	18.7	17.0
2009	17.0	14.0	14.0	14.0
2010	13 .0	12.0	12.0	11.3
2011	10.3	10.0	10.0	10.0
2012	9.8	9.5	8.8	8.5
2013	8.5	8.5	9.0	9.0
2014	8.5	8.3	7.7	7.7
2015	7.7	7.7	7.3	7.3
2016	6.8			



Other historical values can be obtained at Aircraft Bluebook's website, *www.aircraftbluebook.com*

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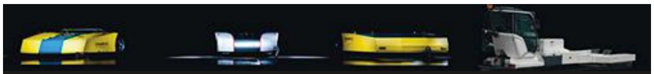

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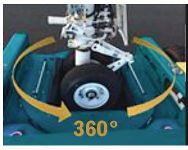

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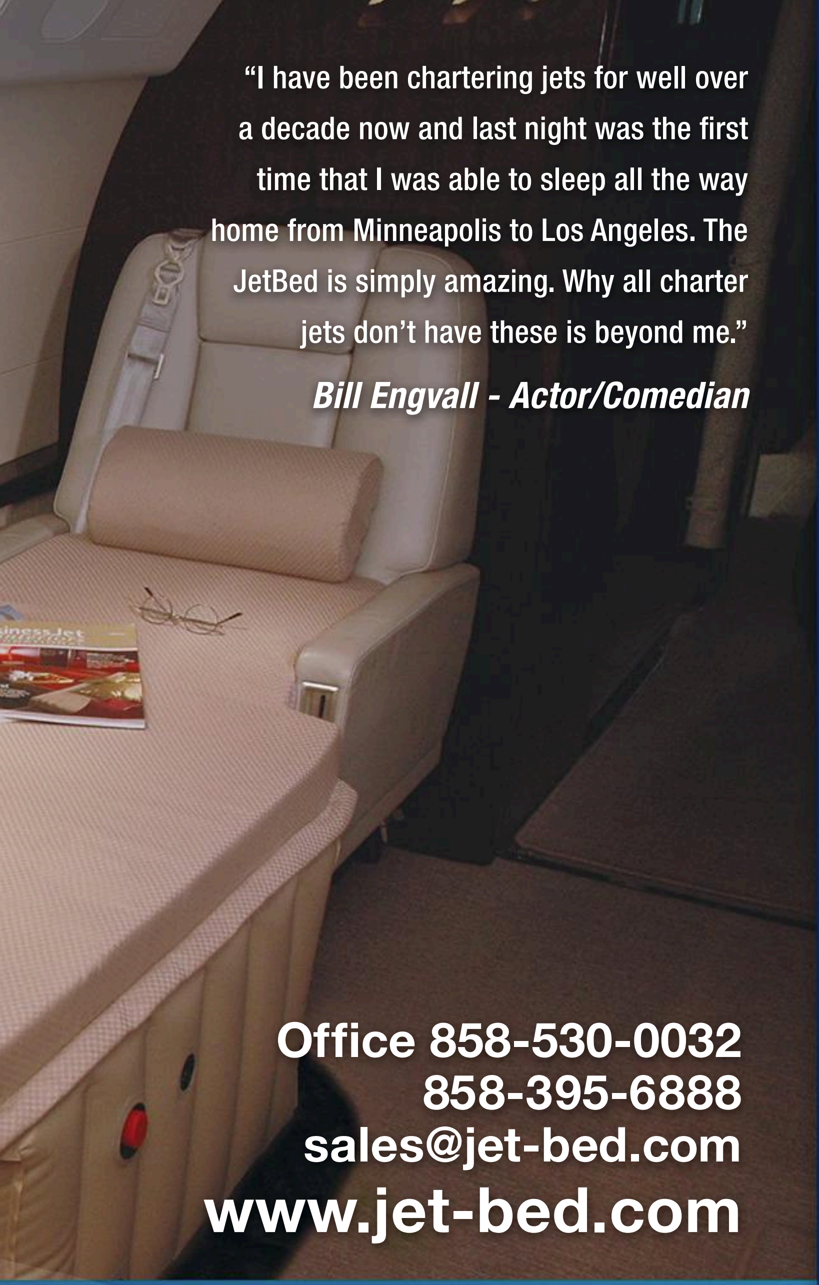

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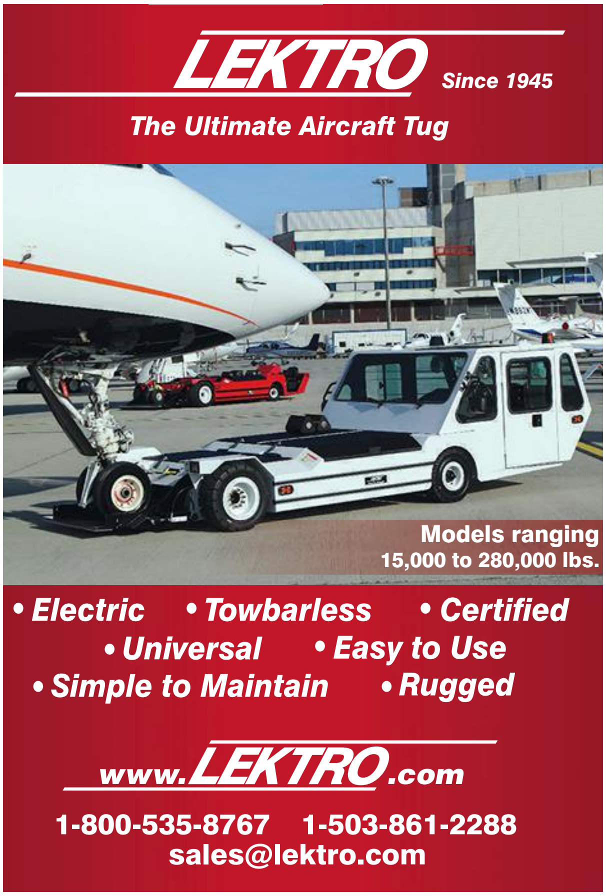

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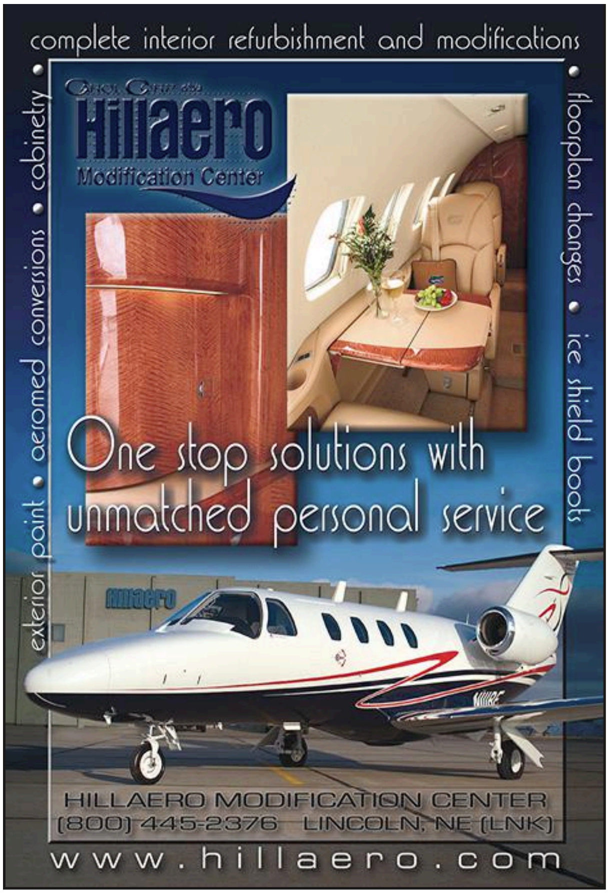

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May 1966 News

Perhaps our question **really is:** How much is the pilot expected to **compensate for airplane deficiencies** and when he doesn't compensate enough, is he or the airplane **really to blame?** – *BCA Staff*

Edited by Jessica A. Salerno *jessica.salerno@penton.com*

Pan Am orders 25 Boeing 747s for $525 million. The company plans to introduce the 490-passenger Boeing 747 in late 1969.

Modified Aero Commanders: Extensive restyling and modifying of Aero commander aircraft are offered now by BACC. Modifications include stylized nacelle fairing, and landing gears doors. Soon to be available will be exhaust system for reduced cabin noise and pilot front entrance door. Kits are available.

Jet nose for Apache: Modifications of Piper's Apache are said by Wilson Aero Products to improve appearance and performance. Benefits are 20-25 mph more speed at cruise, lower single-engine control speed, yaw elimination in turbulence, increased range and doubling the normal single-engine rate of climb.

Grumman Gulfstream II will be produced in new facility outside Savannah, Georgia. The move is Grumman's first outside of Long Island, New York area. Southeaster Georgia coast has become a mecca for corporate speculators betting on overexpansion of Cape Kennedy and proximity of area to the Atlantic Missile Range and to orbital plane of easterly space shots launched from Cape Kennedy.

Two-year study of six representation light aircraft at NASA's Flight Research Center, Edwards AFB, point out deficiencies in flying qualities, particularly in rough air, instrument flight condition. Aircraft involved were Aero Commander 680FP, Cessna 310I and 210, Piper Apache 23-160 and Beech Debonair and Bonanza. Some 22 pilots took part in the research.

Jerrie Mock flew a Cessna Super Skylane from Honolulu to Columbus, Ohio. The flight was 4,550 sm and surpassed the women's record held by three Russian ladies. **BCA**

THE ARCHIVE

Twelve minutes from far suburban point to the business district of New York City is the lure of Ventura Air service, port Washington, whose Cessna 185 floatplane graces our cover. Ventura has three chartered flight and charges $.040 (Yes, that is correct—Ed.) per air mile if there are four passengers with a minimum of $23 roundtrip if there is only one passenger.

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