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Business & Commercial Aviation

2020

PURCHASE PLANNING HANDBOOK

Production Aircraft Comparison
Performance Tables

AND

A Look at the Trends and New
Developments in Avionics

ALSO IN THIS ISSUE

Bombardier Global 7500

Smoke Signals

Under Pressure

Mountain Wave Monsters

One Too Many

AVIATION WEEK
NETWORK

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Business & Commercial Aviation

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Courtesy of Bombardier Business Aircraft

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Business & Commercial Aviation

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Fab Four

Well done, gentlemen. **Again.**

PLEASE CONSIDER WHAT FOLLOWS CONFIRMATION OF YOUR good judgment in choosing sound operational advice, but there's more than a little pride on our part as well.

At *BCA,* our primary role is delivering expert advice and insight to help readers conduct business aviation operations safely, efficiently and to the enhancement of the organizations and people who employ them. Beyond that, the information must be presented in a logical and appealing way to help in its comprehension and application. Of course, the subjects must be relevant and timely, too.

While every person on our masthead helps advance our work, those in the fore are our writers. They serve as our line pilots, investigators, technocrats, instructors, counselors and field representatives. They're the people who recognize an informational need, a hard-learned lesson worth sharing, a technology deserving of explanation and dissemination. For the most part, my job is to say, "Yes, write that."

There is nothing casual about writing for *BCA*. And once begun, our writers tend to stay for decades. Which is why their names become so familiar — Ross Detwiler, Kent Jackson, Dick Aarons and the late, great Torch Lewis, John Wiley and Archie Trammel, among the many.

BCA was honored with two Neal Awards in April — Best Instruction Content and Best Technical Content. **A repeat performance for several of our writers.**

But for this go-round, I'm focusing on just four — James Albright, David Esler, Fred George and Patrick Veillette — for good cause.

A number of organizations bestow awards upon journalists for excelling at their craft and *BCA*ers have been honored and humbled to receive more than a few over the years. Almost all were presented by aerospace concerns, and thus judged by av professionals intimately familiar with the material presented, its import and accuracy.

But there's also Connectiv, an association that monitors business journalism across all industries — banking, healthcare, legal, architecture, insurance, retail, restaurants, fashion, engineering, real estate, farming, aerospace and on and on. For the past 65 years it has celebrated the best of the best in multiple categories, from art direction, to news coverage, to podcasts, presenting the winners with its Jesse Neal Awards, often described as the Pulitzers of U.S. business media. This year the judges received more than 500 submissions.

On April 17, the Aviation Week Network was honored with three Neals. One went to *Aviation Week & Space Technology* for its superb coverage of Boeing's 737 MAX calamity. The other two — for Best Instructional Content and for Best Technical Content — went to *BCA* for stories researched and written by Messrs. Albright, Esler, George and Veillette — a repeat performance for the first three who won a Neal in 2016.

While their bylines are familiar, to appreciate why these writers are so good at what they do, it's instructive to know from whence they came.

James Albright earned an engineering degree at Purdue University before joining the U.S. Air Force where he flew KC-135s, E-4Bs (Boeing 747) and C-20s (Gulfstream III). An instructor, he also headed the service's first combat-rated VIP squadron and after 20 years, retired as a lieutenant colonel. An ATP, since turning civilian, he has flown the CL-604, GIV, GV and G450, and heads a flight department now operating a G500. His website, **www.code7700.com**, is highly regarded among aviation professionals of all stripes.

David Esler began filing stories for a local paper while a freshman at Wilkes University in Pennsylvania and save for a three-year stint as a U.S. Army officer, he's been writing professionally ever since. This is his 27th year with *BCA*. A Commercial pilot with multiengine and instrument ratings, he earlier applied his aviation and writing skills at the Sierra Academy of Aeronautics in Oakland, California. A not-so-secret passion is backpacking in the Grand Canyon.

Fred George graduated from the University of California at Los Angeles and headed cross country for flight training at NAS Pensacola. Presently, he was sent to the fleet as an F-4 Phantom II pilot. Once ashore for keeps, he instructed in Citations and flew Lear charters before launching a series of seminars for flight department managers. That work caught the attention of *BCA* where, save for a few years with me at *Flying* magazine, he's remained. An ATP with six type ratings, he's logged 7,700 hr. and doubles as the chief aircraft evaluation editor at Av Week.

Patrick Veillette is a U.S. Air Force Academy graduate with a master's degree and a Ph.D. in engineering. During his 35-year military, firefighting and civilian flying career, he's logged 20,000+ hr. in more than 240 aircraft types including jets, turboprops, balloons, sailplanes and helicopters. An ATP, CFI and designated pilot examiner, he holds three type ratings and is an active safety investigator. He lectures extensively and today is an adjunct instructor of aviation academics at Utah Valley University in Orem, Utah.

Expert, award-winning aviator-journalists. I salute them all and am proud and privileged to be their colleague. **BCA**

Readers' Feedback

More to Come

I want to thank Richard Aarons for his 30 years of research and writing the "Cause & Circumstance" articles. They have become one of the most valued teaching opportunities for me and my fellow pilots. He's truly made a difference in our industry.

Mike Pape
Citation/Falcon/King Air/CAM
Boise, Idaho

Editor's note: We wholly agree with your assessment. And we are pleased to note that Dick will continue to deliver *Cause & Circumstance* features albeit much less frequently.

Appreciate POL

Thanks for **"Part 91 Department Inspections" (Point of Law, April 2020)**. Once again, you give cogent and germane advice on FAA ramp checks. Kent Jackson writes a good column. I appreciate his pithy style.

David Hook
President
Planehook Aviation Services
San Antonio, Texas

He, She, It's

I mean this in the most amicable fashion, we must avoid at all cost the inner machinery (to wit Spellcheck) of the Word program, as witnessed in the use of 'it's', when one in fact means to write 'its'. This particular toothache ranks up there with the split infinitive, which also causes reactions similar to those caused by sucking on lemons.

Note the improper use on page 8 of the March 2020 issue, contained in your italicized quote: ". . . but for most of it's history, civil aviation has advanced . . ." Then, on page 18, bullet point four contains: ". . . but it's significance to our business cannot be overstated."

To be sure, 'it's' can only be used in place of (an abbreviation) of 'It is'. All other references must use the non-apostrophed 'its'.

James R. O. McIntyre
Montreal, Canada

Editor's response: My editor/writer bride and I regularly moan about the growing grammatical and spelling slovenliness that has become broadly accepted. The errors occur regularly in emails and text messaging (of course), advertising, brochures, press releases and, alas, print publications. That mine is similarly at fault gives me great pain. Changing an "its" into an "it's" does indeed occur often automatically, but actual humans are also at fault.

I'm not sure of the cause of the "it's" in the column cited, but in going back through my files, it appears in what seems to be the initial, unedited version. So, alarmingly, the original sin of commission may be mine. However, I also reviewed it, sent it to subject, who inserted some updates, and I adjusted it accordingly, then circulated it internally among others to review before releasing it for print. So, the failure is shared widely. As for the callout citing my March "Viewpoint," the actual column was correct as printed. So, I was misquoted in my own publication. Oy! I should send a letter of complaint to the editor.

Safety

Three Fundamentals for When Things Go Wrong

How to survive the unsurvivable

Excellent Albright

I thoroughly enjoyed **"Three Fundamentals for When Things Go Wrong" (March 2020).** It was excellent.

My first experience of 'sitting on your hands' came during my CAA Instrument Rating examiner course

> *"I remember thinking, "Do something!" as the pressure mounted, but he always took his time and everything was accomplished in a calm and measured way. Big lesson for me. . . ."*
>
> *Mark Blois-Brooke*

back in 1985. It was an intense course and I was lucky to get a place with my limited experience at the time. I was keen to show how switched on and quick I was in the old Hawker simulator.

I was paired with an old British West Indies Airways L1011 captain, just coming up to retirement. He had the island mentality — you simply could not rush this guy. I remember thinking, "Do something!" as the pressure mounted, but he always took his time and everything was accomplished in a calm and measured way. Big lesson for me.

My favorite maxims that I pass on to students new to jet equipment, in addition to siting on your hands, are:

"Know the aeroplane, know what's going on around you, fly the aeroplane – and always leave yourself an out."

And Airbus's "Golden Rules" :

▶ "Fly, navigate and communicate — in this order and with appropriate task sharing.

▶ Use the appropriate level of automation at all times.

▶ Understand the FMA at all times.

▶ Take action if things do not go as expected."

Blue skies.

Mark Blois-Brooke
Former Chief Pilot
TAG Aviation
Farnborough, United Kingdom

Drone Delivered TP

After reading **"Pixie Powered" (Viewpoint, March 2020),** it occurred to me that one of the household items you suggest could be brought to one's front step by drones is toilet paper. I am certain in your part of the country, just as here in Kansas, that item is in high demand, and the store shelves are continually empty. It seems a shame that COVID-19 did not wait until your prophesy was fulfilled!

John M. Davis
Wichita, Kansas

If you would like to submit a comment on an article in BCA, or voice your opinion on an aviation related topic, send an email to ***jessica.salerno@informa.com*** *or* ***william.garvey@informa.com***

GE Honda Aero Engines

FL450 ADVANCED SILENT TOUGH EFFICIENT RELIABLE

Accelerating Innovation:
The All New HF120

Two names synonymous with invention have joined forces to create unprecedented performance—a product igniting change in the industry—the all-new 2,000-pound thrust class turbofan power plant. Built to last, the HF120 delivers advanced technology designed for speed, endurance, and the smoothest ride.

FL450: The fastest engine in its class, the HF120 enables effortless climb to FL450 and beyond. Its high fan and core pressure ratio provides increased aircraft speed and reduced climb time to higher cruising altitudes. With a low thrust lapse rate, the engine allows for initial climb in excess of 4,000 feet per minute and reduces time to climb by 40%.

ADVANCED: The engine represents decades of research and development. A wide-chord, swept titanium blisk fan with composite fan outer guide vanes and the use of innovative turbine blade and combustor materials are just some of the unique features the HF120 brings to the light jet market.

SILENT (Inside & Outside): Smart placement of the rotor dynamic resonant frequencies outside of the engine taxi and flight settings minimizes unwanted cabin noise. Tight tolerance controls and exceptional build quality deliver low fan and core vibration levels. Low levels of vibration transmission to the fuselage result in a quiet cabin and the smoothest flying ride in its class.

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

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

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

The HF120 enjoys enviable operational success. It's an incredible machine built to set a new standard for the light jet market—ready for applications beyond its current aircraft installation. ◘

gehonda.com For More Information, Contact **GE Honda** at (513) 552-7820 @ge_honda

INTELLIGENCE

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NEWS / ANALYSIS / TRENDS / ISSUES

GULFSTREAM AEROSPACE'S DEVELOPMENT OF ITS FLAGSHIP G700 large jet is accelerating with the first flights of its second and third test aircraft as the program moves toward certification and customer deliveries. The second test aircraft flew for the first time March 20, while the third test aircraft took its first voyage on May 8, flying over Savannah, Georgia, for 3 hr., 2 min., and reaching an altitude of 45,000 ft. and a speed of Mach 0.85. "The G700 flight test program is running very well, and a reflection of the extensive testing we conducted in our ground labs," said Mark Burns, Gulfstream president. The three test aircraft have flown more than 100 hr. since Feb. 14. The G700 has reached a maximum altitude of 54,000 ft. and a maximum speed of Mach 0.94. The aircraft are being tested for envelope expansion, flutter testing, flying qualities and flight control, as well as mechanical systems, flights into known icing and environmental control systems, along with other testing. Gulfstream announced the G700 program at the NBAA Convention in October. First deliveries of the $75 million large jet are expected in 2022.

ON APRIL 27, THE FAA ISSUED AN ADVISORY CIRCULAR REVISING the relationship between FAR Part 142 training centers and charter operators, facilitating approvals and qualification processes. The guidance also creates a Training Standardization Working Group composed of industry and agency experts that is to develop standardized training procedures for the most common aircraft types. The guidance in "AC 142-1 — Standardized Curricula Delivered by Part 142 Training Centers" was developed by the agency after the National Air Transportation Association (NATA), NBAA, Part 135 operators and training centers recommended the concept through the Air Carrier Training Aviation Rulemaking Committee. **"NATA is pleased about this exciting advancement in Part 135 training that provides efficiency and safety gains for both operators and the FAA alike,"** said NATA President and CEO Timothy Obitts. "This is the result of a tremendous four-year effort from many industry stakeholders, and we are pleased that the FAA is implementing the recommendations." Meanwhile, NBAA President and CEO Ed Bolen said, "By working jointly with operators, training centers and NATA, we are proud to have developed a concept of standardized curriculum that will revolutionize training for Part 135 operators." The standardized curricula are voluntary and charter operators can continue with their current training programs. However, the FAA anticipates most Part 135 operators will choose to use the new standardized curricula and training centers that promote continuous improvement through data. The concept also supports the NTSB's initiative to increase safety in Part 135 operations.

JOBY AVIATION, AN EARLY LEADER IN THE ELECTRIC vertical-takeoff-and-landing (eVTOL) market, is flight testing an aircraft intended to serve as an air taxi, but one for which the Pentagon has an interest in logistics support. A tilt-prop eVTOL design with four propellers on the main wing and two on its V-tail, the aircraft is to fly four passengers and a pilot 150 mi., with 30-min. reserves, at more than 200 mph. The manufacturer hopes to win FAA certification by 2023. Founded in 2009, Joby raised $590 million in funding in January, taking the total investment to more than $750 million, including $10 million to $20 million from the Defense Department. Joby is building a factory near Monterey, California, that it says will be capable of producing more than 250 aircraft a year.

Jet-A and Avgas Per-Gallon Fuel Prices

May 2020

Jet-A

Region	*High*	*Low*	*Average*
Eastern	$7.22	$3.13	$5.18
New England	$6.93	$2.38	$4.69
Great Lakes	$6.86	$2.74	$4.58
Central	$6.10	$2.80	$3.94
Southern	$7.46	$3.65	$5.31
Southwest	$7.00	$1.90	$4.36
NW Mountain	$7.52	$2.30	$4.49
Western Pacific	$7.96	$3.60	$5.26
Nationwide	**$7.13**	**$2.81**	**$4.72**

Avgas

Region	*High*	*Low*	*Average*
Eastern	$8.25	$4.20	$6.04
New England	$7.45	$4.50	$5.64
Great Lakes	$8.59	$2.99	$5.83
Central	$7.59	$3.85	$4.93
Southern	$8.99	$3.95	$5.95
Southwest	$7.19	$3.73	$5.31
NW Mountain	$6.45	$3.99	$5.26
Western Pacific	$8.52	$4.31	$5.90
Nationwide	**$7.88**	**$3.94**	**$5.61**

The tables above show results of a fuel price survey of U.S. fuel suppliers performed in May 2020. 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 Group/U.S. Inc. at (513) 852-5110 or on the internet at www.argus.aero

For the latest news and information, go to **AviationWeek.com/BCA**

Alaska's North Slope SAR Adds Pilatus PC-24

Alaska's North Slope Borough Search and Rescue Department (SAR) has added a new Pilatus PC-24 business jet to its fleet to provide medical care for 9,800 residents across a 95,000-sq.-mi. territory, the northernmost region of the U.S. The aircraft includes five passenger seats and tandem stretchers. The department provides medevac operations, search and rescue, and other emergency missions.

Clay Lacy Completes 10th Phenom 120-Month Inspection

Clay Lacy Aviation recently completed its 10th 10-year/120-month inspection on Embraer Phenom 100 and 300 aircraft, with five additional inspections underway. Inspections are being completed at the company's FAR Part 145 Repair Stations at Van Nuys Airport and McClellan-Palomar Airport near San Diego. Popular additions to the work include seat reupholstery, new carpet, baggage area refurbishment, Gogo Avance L3 internet and, for the Phenom 100, a Garmin G1000 NXi upgrade that will be available for the Phenom 300 later this year.

▶ **AERION SUPERSONIC HAS SELECTED MELBOURNE, FLORIDA,** as the future site for the development, production and support of the Mach 1.4 AS2 business jet and a planned family of follow-on derivatives. **The $300 million site, covering 60 acres, will be completed over a phased development plan that is expected to generate at least 675 jobs in the state by 2026.** Groundbreaking of the greenfield site, to be called Aerion Park, will take place by the end of July. Building construction is to be timed to enable initial assembly of the AS2 to begin in 2023 ahead of rollout in 2024. First flight of the supersonic jet is currently targeted for later that same year with entry-into-service in 2026. As well as providing space for assembly, the Aerion Park campus will house facilities for research and development, maintenance and a completion center. The site will also support flight testing, including supersonic runs over the Atlantic Ocean through the adjacent U.S. Navy-run Jacksonville Range Complex operating areas. The site is intended to be a global center of excellence for supersonic flight, says Aerion President/CEO Tom Vice. In line with Aerion's plan to make the AS2 low noise and carbon neutral, the site "will also be a state-of-the-art campus for environmental sustainability," he adds. "We're maximizing the use of renewable energy, mostly solar, to power the park and our goal is to achieve zero waste as well as to significantly minimize water usage by recycling or collecting it for use in manufacturing." Aerion, which has been based in Nevada since its founding 16 years ago, was also attracted to the Melbourne area because of the region's existing engineering and manufacturing talent. "It has the right business climate, global access and a unique cluster of innovative aerospace and technology companies based up and down the Space Coast," Vice said. "And of course, we wanted ready access to overwater supersonic flight testing." According to the company, Florida is also providing an unspecified level of investment and support in the venture. Work will begin first on completing design and engineering facilities, including a systems integration lab and an "iron bird" flight controls and hydraulics integration lab. **The site will assemble the AS2 from systems and subassemblies provided by a growing group of suppliers and partners** including Boeing, which will support engineering, manufacturing and flight testing. Others include engine developer GE Aviation; Honeywell Aerospace, which is providing the avionics; and Safran, which is developing the landing gear and nacelles. GKN Aerospace and Fokker Technologies will provide electrical wiring and the empennage structure, while Spirit AeroSystems will supply the forward fuselage. Spain-based Aeronnova Aerospace will provide the mid-fuselage structure, while Potez Aeronautique of France is supplying doors. Systems and components will also be provided by Eaton and Parker, while Siemens Digital Industries Software has been selected to support design and development. Vice adds that "having a fully integrated site covering design to manufacturing to completions and support ties everything together at the back end with a single integrated business system. That enables the digital thread, the creation of a digital twin and the formation of a fully integrated digital enterprise system." This, he says, will enable the company to begin manufacturing simulations "while we're still in the design phase, knowing that manufacturing will be in the building next door." The digital approach is also expected to improve training for assembly workers as well as help the design engineering group develop follow-on supersonic derivatives.

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Daher Introduces Autoland for TBM 940s

Daher's line of 2020 TBM 940 turboprops will come equipped with HomeSafe, an emergency autoland system, the company announced during a video press conference May 6. The feature will come factory standard. The emergency system, which automatically lands the aircraft should the pilot become incapacitated, is available as a retrofit for TBM 940 aircraft built in 2019 at an introductory cost of $85,000. Installation will take two or three weeks.

Gulfstream G600 Earns EASA Approval

Gulfstream Aerospace Corp.'s G600 has earned type certificate approval from the European Union Aviation Safety Agency (EASA), enabling aircraft registrations and deliveries to begin for EU customers. At its high-speed cruise of Mach 0.90, the G600 can carry passengers 5,500 nm nonstop — enough range to travel from London to Los Angeles or from Paris to Hong Kong. At its long-range cruise speed of Mach 0.85, it can fly 6,500 nm. Its maximum operating speed is Mach 0.925. The aircraft, which entered service on Aug. 8, 2019, has earned 23 city-pair speed records.

▶ **CITING WIDESPREAD TRAVEL RESTRICTIONS COMBINED WITH** continuing stay-at-home orders and other "circumstances beyond our control" relating to the COVID-19 pandemic, Experimental Aircraft Association (EAA) Chairman and CEO Jack Pelton said cancellation of this year's annual AirVenture Oshkosh 2020 was "the only option." The event, scheduled for July 20-26 at Oshkosh, Wisconsin, was expected to draw some 600,000 visitors along with thousands of aircraft. Historically, it is the largest airshow in North America and among the most important aviation gatherings in the world. The decision came in the first week of May when volunteers were to begin preparing the grounds of Wittman Regional Airport, setting up tents and infrastructure to accommodate the weeklong crowds. Staff would also be printing wristbands, campers' guides, programs and other information, Pelton said, but with Wisconsin under a stay-at-home order until May 26, "none of this can happen now. . . . The reopening of the state also has no specific dates, creating uncertainty about mass gatherings in July," he continued. "Ultimately, preserving the health and safety of all who would attend — and all the varying guidelines between states and countries from where our participants arrive — along with the massive commitments needed now for an event to meet EAA's high standards, made cancellation the only option for this year." **The association said all pre-sold AirVenture 2020 admissions and camping reservations can be rolled over to next year's event now or are eligible for refunds. The next AirVenture is scheduled for July 26-Aug. 1, 2021.** "Those of us involved in aviation know very well the importance of information gathering and planning prior to any flight, and I looked at AirVenture in much the same way before reaching this decision," Pelton said, adding there were too many uncertainties "to commit to an event that welcomes hundreds of thousands of visitors" from more than 90 countries. "There is no way to describe the disappointment I feel for everyone who sees AirVenture as aviation's family reunion each year," he continued. "You can be assured that EAA is already eagerly looking forward to gathering along the AirVenture flightline" next summer. The decision is the latest in a series of COVID-19 cancellations including Sun 'n Fun, the European Business Aviation Convention and Exhibition, NATA Air Charter Summit and Aviation Business Conference, CBAA Convention & Exhibition and the Farnborough International Airshow, among others.

▶ **TEXTRON AVIATION IS POSTPONING PARTICIPATION IN** trade shows and events for this year, including the NBAA Convention & Exhibition (NBAA-BACE) in October, as a result of the pandemic. Rather, the company said it is focusing resources on its workforce and on supporting customers. **However, a spokesperson said trade shows are important and the company will participate at another time.** Meanwhile, many business and general aviation trade shows scheduled for spring, including the Asian Business Aviation Convention & Exhibition, Sun 'n Fun and the European Business Aviation Convention & Exhibition, were canceled. The NBAA exhibition, scheduled for Oct. 6-8 at the Orange County Convention Center in Orlando, Florida, is business aviation's largest trade show. "We continue to plan with our exhibitors for an outstanding show with participants' safety and well-being as our highest priority," said Dan Hubbard, NBAA spokesperson, adding the event "will be especially important in a year that has proven difficult to connect and communicate with customers in a meaningful way." A Bombardier spokeswoman says the company plans to exhibit, although it continues to monitor the situation. Gulfstream is moving forward with plans to exhibit, while an Embraer spokeswoman said it would be fair to say the company is undecided.

O2 Aero Acquisitions Acquires Shaw Aerox

O2 Aero Acquisitions has purchased Shaw Aerox, a manufacturer of portable oxygen systems and accessories. Terms were not disclosed. Scott Ashton, O2 Aero's managing director, has been named president and CEO. Shaw Aerox has been rebranded as Aerox Aviation Oxygen Systems and provides oxygen delivery systems and products for general aviation, emergency medical services, medical and original equipment manufacturers.

Gulfstream G650 Training at FlightSafety Dallas

FlightSafety International has announced that training for the Gulfstream G650 is now underway at its Dallas Learning Center using a new FS1000 simulator. Dallas is FlightSafety's fifth G650 training location and this is the sixth full-flight simulator the company has built to serve operators of the aircraft around the world. The FS1000 simulator features a CrewView collimated glass mirror display and VITAL 1150 visual system, electric motion cueing system and advanced instructor operating station.

EHANG HAS PARTNERED WITH THE CITY OF HEZHOU in southeastern China to build the first dedicated vertiport for its two-seat EHang 216 autonomous air vehicle (AAV). The air taxis will operate aerial tourism flights from a so-called E-port. Planned to be operational by year's end, the three-story building will have four pads on the roof, enabling simultaneous takeoffs and landings. The plan also includes delivery of 20 EHang 216s, the company says. "Hezhou is a beautiful city with rich tourism resources and we are excited to enhance their appeal with our AAVs. As we progress, we intend to create more commercial applications for EHang AAVs, such as aerial sightseeing," said Hu Huazhi, founder, chairman and CEO of EHang. With a cruise speed of 62 mph, the 16-rotor EHang 216 has a design flight time of 21 min. and range of 19 nm carrying its 485-lb. maximum payload. Now publicly traded, EHang said in its 2019 annual report filed April 20 that it is not yet allowed to begin commercial operation of its electric vertical-takeoff-and-landing (eVTOL) air taxis. However, the company has approval from the Civil Aviation Administration of China to conduct trial flights. As of March 31, the report says, E**Hang had completed more than 4,000 trial or demonstration flights with its "passenger-grade" eVTOLs in China, Europe and the U.S.** As of the end of 2019, the company had delivered 63 EHang 216s and one single-seat EHang 116 to customers for testing, training and demo flights. It had orders in hand for another 33 vehicles at the end of the year, the report says. EHang has forged urban air mobility (UAM) partnerships with four cities: Guangzhou in China, Linz in Austria, and Seville and Lliria in Spain. "We expect to establish strategic partnerships with more city governments in 2020 to expand our UAM network globally," the annual report says.

THE U.S. AIR FORCE IS INTERESTED IN THE EMERGING electric vertical-takeoff-and-landing (eVTOL) aircraft technology. The service is examining vehicles able to carry one to two people or more than 500 lb. of cargo and eVTOL air taxis carrying three to eight people more than 100 mi. at a speed greater than 100 mph. And it says it intends to field a small number of commercially developed aircraft in fiscal 2023. In April, Will Roper, the service's acquisition chief, said, "We want to have 30 vehicles in the Air Force by 2030." Under Agility Prime, a public-private partnership, the Defense Department will provide access to test resources and expertise to help companies toward FAA certification. In return, the Air Force, Marine Corps and other government agencies will get to assess the performance and capabilities of commercial eVTOLs with an eye to procuring some for military and public-use missions. The Air Force is particularly interested in the promise of eVTOL to provide lower acquisition and support costs, reduced acoustic and infrared signatures, and simplified flight control. Missions being studied include transporting ballistic-missile operators to remote launch control centers; perimeter security at large bases; "lateral logistics," moving packages and personnel between squads; disaster support to civilian agencies; and conducting combat rescues.

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Magellan Jets Offers Complimentary Carbon Offsets

Magellan Jets has partnered with TerraPass, which specializes in carbon offsetting solutions, to offer carbon offsetting for its private aviation portfolio. The company has offset 100% of its operations. Magellan Jets is also offering complimentary offsets on all 50-hr. memberships purchased during the second quarter of 2020, and for any heavy jet membership.

KlasJet Partners with Bluebird Nordic for Cargo Services

KlasJet, a private and corporate jet charter provider, has added cargo services to its operations through a collaboration with Bluebird Nordic, a cargo airline. Bluebird's newly acquired Boeing 737-300, nicknamed Merlin, will allow KlasJet to carry out cargo services around the world. The company also will retain its charter operations. Adding cargo services will allow KlasJet to carry the special gear, medical supplies, personal protective equipment and other items when transporting a team of medics during the COVID-19 pandemic.

STARTUP SKYRYSE IS FLIGHT-TESTING SOFTWARE for the first application of its FlightOS automation system as it progresses toward certification of the aircraft-agnostic fly-by-wire (FBW) architecture. Skyryse CEO Mark Groden said the FAA has been "very responsive" and has conducted a "high quantity of meetings" with the company via web conferencing. The FlightOS automation system has been installed on three different types of helicopter, including the Robinson R44, and the company anticipates FAA supplemental type certification (STC) of its first retrofit this year. The Los Angeles-based outfit is working to provide simplified flight control and a higher level of automation by building on an FBW backbone that can be retrofitted into existing aircraft or installed in new platforms. It says it's talking to airframers about using FlightOS to bring envelope protection, instrument flight rules, zero-visibility landing, emergency management and other capabilities to light aircraft at a price attractive to a large number of customers. While Skyryse has identified market segments such as firefighting that would benefit from advanced flight capabilities, the fleets are small and fragmented, so it is focusing on platforms — such as helicopters — that have a wide range of applications. FBW is acknowledged to improve safety and capability but is traditionally expensive. The aircraft-agnostic approach helps reduce the cost of FlightOS by spreading investment over multiple types.

THE EUROPEAN COMMISSION (EC) HAS PUBLISHED AN AMENDED regulation that lays out requirements to equip aircraft for automatic dependent surveillance-broadcast (ADS-B) and postpones the compliance date for new aircraft by six months because of the coronavirus pandemic. Europe's Surveillance Performance and Interoperability regulation applies to aircraft with a maximum takeoff weight exceeding 5,700 kg (12,566 lb.) or with a maximum cruise speed greater than 250 kt. Aircraft must be fitted with ADS-B Out transponders compliant with Mode S Enhanced Surveillance capability to provide downlink aircraft parameters. Already amended twice since its original publication in 2011, the rule's latest version required operators to equip their aircraft for ADS-B Out by June 7 of this year. The latest amendment extends the compliance date for new-build aircraft to Dec. 7. **Operators of aircraft with certificates of airworthiness (CoA) issued before Dec. 7, 2020, have until June 7, 2023, to equip for ADS-B Out but must establish a retrofit compliance plan by Dec. 7**, according to the amended regulation. Aircraft with CoA issued before 1995 or that will cease operating in EU airspace by October 2025 are exempt from the regulation.

AIR BP, THE AVIATION DIVISION OF BP, IS DONATING 3 million gal. of jet fuel to FedEx and Alaska Airlines for the delivery of medical supplies and other essential goods. In Australia, Air BP has donated 35,000 N95 masks to the Royal Flying Doctor Service (RFDS). In France, it is donating 60,000 liters of jet fuel for flights transporting medical staff and equipment between French hospitals. In the UK, the company is providing free jet fuel for helicopters supporting the pandemic battle. In China, Air BP has been providing support through its two joint ventures: South China Blue Sky, which has fueled more than 800 relief and repatriation flights, and Shenzhen Chengyuan Aviation Oil Co., which has supplied fuel for charter flights carrying medical and relief equipment. Air BP also donated $2 million to the WHO's COVID-19 Solidarity Response Fund.

INTERVIEW BY **WILLIAM GARVEY**

Questions for Timothy R. Obitts

1 **One month in office and COVID-19 strikes. Short honeymoon.**

Obitts: We've been going from 7 a.m. to 11 p.m. six days a week helping members and non-members alike. I have characterized NATA as a nimble association with a high impact, and we are really living up to that analogy. NATA has an excellent team all working from home and communicating effectively with one another using video-conferencing and other tools. Much of our time is spent advocating for relief for our members and then helping to explain those programs to people who are seeking to apply. My legal background has come in handy during this crisis in understanding the legislatives texts and in problem solving. Both our airport business and air charter committees have been extremely active. Everyone's been hurting — some FBOs have lost 95% of their business. And while charter operators were busy at first bringing people home, everything came to a halt on Tuesday, March 17. It's as if someone flipped a switch and turned everything off.

2 **Have the CARES Act and Payroll Protection Programs helped?**

Obitts: To a degree. But the big boys, the airlines, got the lion's share of the money. The charter operators who filed their applications before the priority deadline got some help — about 76% of their payrolls, which is the same percentage that the Part 121 airlines received, and it's an outright grant — which is quite helpful. But many Part 135 companies filed after the priority deadline, and we are working with Treasury to see what will happen to those applications. One person, a non-member, called to say his bank had messed up his application for protection and now he was going to have to fire 80% of his employees. It was quite emotional. I called him back the following day to check on him. Most general aviation airports received $30,000 or less under CARES, which is not enough for them to survive this downturn. Rural sections of the country depend on those airports and related services and they all are suffering.

3 **Is there a way forward?**

Obitts: We're promoting a proposal that would deliver $2 billion in relief for general aviation airports and $5 billion to general aviation businesses. It would require recipients to maintain their payrolls and rehire furloughed workers through the end of the year. They need it.

4 **Oil is now down to zero dollars. Will that help?**

Obitts: Not really. Currently, the flight activity is limited, so few are buying avgas or Jet-A. My larger concern is whether the credit that fuel suppliers are extending operators and FBOs will dry up. No one knows at this point.

5 **That's certainly a dark assessment of things. Anything positive?**

Obitts: Sure. Actually, people are starting to look at travel for May, waiting on restrictions to start easing. Our industry has proven that it is resilient. The convenience, cleanliness and safety of the charter and fractional operations, and the FBO facilities they use, are unmatched. So, I think there will actually be greater demand for their services than before the crisis. And another thing, in the face of these seemingly insurmountable challenges, you are seeing more and more of the better side of humanity revealed. I've been pleasantly surprised that this crisis has brought out so much positivity in so many people. We're all in this together and everybody is seeking and trying to help each other. **BCA**


NATA

Timothy R. Obitts

President & CEO, National Air Transportation Association (NATA), Washington, D.C.

A graduate of the California Western School of Law, Obitts was an attorney with Gammon & Grange, a national firm specializing in nonprofit and communications law, for 17 years, eventually becoming its managing partner. During that time, he was also corporate counsel and general counsel for many nonprofits and trade associations, handling a wide array of issues that affected their daily activities. Moreover, he lobbied legislators and staff members on Capitol Hill along with federal agencies. He also co-founded nonprofits and is a board member of several. He joined NATA as senior vice president in 2014, was promoted to COO in 2016, and was elevated to his current position this past January.

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

One Too Many

One engine inoperative and **loss of control** fatal to four

BY **ROSS DETWILER** rossdetwiler.com

On Feb. 3, 2014, at about 1655 CST, a Gulfstream Commander 690C (N840V), operated by a private pilot, was destroyed when it struck the ground near Bellevue, Tennessee, while on approach to Nashville's John C. Tune Airport (KJWN). The pilot and three passengers were killed.

The flight had departed Great Bend Municipal Airport (KGBD), Great Bend, Kansas, where the aircraft was based. The group, all members of an agricultural company, were bound for a trade show; the pilot was the company president. The FAR Part 91 flight was conducted in instrument conditions.

According to the FAA, on the date of the accident, the pilot flew the airplane from Clarence E. Page Municipal Airport (KRCE), Oklahoma City, where it had been undergoing maintenance, which included a 150-hr. periodic inspection, to KGBD. The group then departed for Nashville at about 1445.

About 1628, the ATC controller cleared N840V direct to FUNJO. The pilot replied, "What is it?", and the controller responded by spelling out the individual letters of the word. FUNJO was the initial approach fix (IAF) for the RNAV Runway 2 approach at KJWN and was located 12.7 nm south of the airport.

Subsequently, the controller instructed the pilot to maintain 3,000 ft. until FUNJO, and cleared him for the RNAV Runway 2 approach. The pilot did not respond. The controller repeated the clearance, and the pilot stated, "I'd like to climb and uh review the approach and uh do it again."

At 1629:38, the on-the-job training instructor (OJTI) directed the pilot to maintain 3,000 ft. and turn right heading 020 deg. The pilot responded "Right heading zero two zero." About 1631, the pilot informed the controller, "You can direct me back; I've got FUNJO on my system." The pilot was subsequently provided a clearance for the GPS Runway 2 approach. The controller noted that the pilot had not flown the correct assigned heading but did not correct him as no traffic or terrain intersection was noted.

At 1637, the controller asked the pilot if he was established on the approach and the pilot responded that he was. The controller then advised him that the airplane was about one-half mile east of the final approach course, and the pilot replied, "That's correct; I'm a little east of course."

At 1642, the pilot reported that he was executing a missed approach. About 1653, the pilot was cleared for a third GPS approach to Runway 2.

Weather conditions were conducive to super-cooled liquid water droplets, and the airplane likely encountered moderate or greater icing conditions. Several pilot reports (PIREPs) for moderate, light, trace and negative icing were reported to ATC but were not distributed publicly into the National Airspace System (NAS), and there was no airmen's meteorological information (AIRMET) issued for icing. The NTSB report goes into some systemic problems getting verbal reports into PIREP format. However, the pilot received standard and abbreviated weather briefings for the flight, and his most recent weather briefing included three PIREPs for icing conditions in the area of the accident site.

At 1655:37, the controller informed the pilot that radar services were terminated, instructed him to report cancellation of IFR in the air or on the ground, and advised him that traffic was 10 mi. in trail. The pilot did not respond, and there were no further transmissions received from the aircraft.

Radar data showed that the airplane was established on the final approach course as it passed the IAF; however, before it reached the final approach fix, its airspeed slowed to about 111 kt., and it began a left turn with a 25-deg. bank angle. About 18 sec. later, while still in the turn, the airplane slowed to 108 kt. and began descending rapidly. The airplane's rate of descent exceeded 10,000 ft. per minute, and it impacted the ground about 9 mi. from the destination airport. The airplane had turned to a heading of about 210 deg. before radar contact was lost.

Due to impact damage to the cockpit, the positions of the switches for the ice protection systems at the time of the accident could not be determined. Although the airplane's airspeed of 108 kt. when the steep descent began was above its published stall speed of 77 kt., both bank angle and ice accretion would have increased the stall speed.

GOOGLE EARTH

In addition, the published minimum control airspeed was 93 kt.

It is likely that, after the airplane passed the IAF, the left engine lost power, the airspeed began to decay, and the asymmetric thrust resulted in a left turn. At any rate, as the airspeed continued to decay, it decreased below either stall speed or minimum control airspeed, and the airplane entered an uncontrolled descent.

Pilot Information

The 62-year-old pilot held a private pilot certificate with multiengine and instrument ratings. His logbook was not located. However, when his most-recent third-class medical certificate was issued on Feb. 23, 2012, he reported a total flight experience of 3,000 hr., 30 of which were logged during the previous six months.

According to training records, he successfully completed a Turbo Commander 690 recurrent course in May 2013. At that time, he reported 3,205 hr. of total flight experience, which included 1,392 hr. in multiengine airplanes and 436 hr. of instrument flight experience. In addition, he reported 719 hr. flown in the accident airplane and 20 hr. flown during the previous 12 months.

Aircraft Information

The high-wing, all-metal, pressurized airplane, serial number 11727, was manufactured in 1982. It was powered by two Executive Wings Inc. supplemental type certificate modified Garrett TPE331-5-511K, 715-hp engines, equipped with Hartzell three-blade constant speed props.

According to maintenance records, the airplane underwent a 150-hr. periodic inspection on Feb. 1, 2014. At the time of the accident, the airframe and both engines had been operated for about 4,460 total hours since new. The airplane had been operated for about 70 hr. during the 13 months that preceded the accident.

The pilot operating handbook noted the airplane was equipped with deicing and anti-icing systems. The former included wing and empennage deice boots and prop deice. The anti-icing system included heated stall warning, rudder horn anti-ice, rudder tab anti-ice, generator inlet anti-ice, electrically heated windshield and pitot-static heaters. The anti-icing systems should be placed in operation prior to entering flight conditions conducive to the formation of ice. Engine inlet heaters used hot engine compressor bleed air to prevent icing. The ice protection systems were controlled by switches in the "ICE PROTECTION" group on the cockpit overhead switch panel.


Final flight path of N840V

The following warning was included under the Engine Inlet Anti-Ice Systems:

"Warning: When icing conditions may be encountered, do not delay operation of the engine inlet heat systems. Turn the systems on before any ice accumulates. Engine inlet heat must be on if icing conditions exist or are anticipated."

The airplane was also equipped with a negative torque sensing (NTS) system that was designed to reduce drag caused by a windmilling propeller in the event of a loss of engine power by moving the blades toward the feathered position to reduce drag and yaw.

Honeywell Operating Information Letter OI331-11R11, issued on Sept. 16, 2013, emphasized proper use of engine inlet anti-ice and provided additional information on the use of engine ignition in icing conditions. The operating letter stated, in part, that engine inlet anti-ice should be used during all flight phases during potential icing conditions. Further, icing conditions should be considered to exist when flying in precipitation or visible moisture (including clouds or fog) with an outside air temperature of 10C or 50F, or colder. In addition, it warned, "If the use of anti-ice is inadvertently delayed after encountering icing conditioning, ice may accumulate on engine and airframe inlet surfaces. In such instances, subsequent application of engine inlet anti-ice can cause ice shedding and ingestion, which may cause flameout. . . ."

Meteorological Information

ACCIDENT TIME 1657 CST

[1700 CST] KJWN 032300Z AUTO 35004KT 6SM OVC008 05/M04 A3029 RMK A01 $

[1705 CST] KJWN 032305Z AUTO 01004KT 6SM OVC008 05/M04 A3029 RMK A01 $

[1710 CST] KJWN 032310Z AUTO

36005KT 6SM OVC008 05/M04 A3029 RMK

AIRMET Sierra, issued at 1445, was valid at the time of the accident, and forecasted IFR conditions around the accident site with ceilings below 1,000 ft. and visibilities below 3 mi. There were no AIRMETs for icing conditions valid at the time of the accident. The pilot received standard and abbreviated weather briefings from Lockheed Martin Flight Service. The last weather briefing requested by the pilot was at 1538 and included three PIREPs for icing conditions in the Nashville area that were applicable to the pilot's flight.

Geostationary Operational Environmental Satellite number 13 (GOES-13) data indicated abundant cloud cover over the accident site with approximate cloud-top heights of 19,500 ft. around the time of the accident.

Weather PIREPs that were publicly available in the NAS for the vicinity of the accident site, from about 3 hr. before the accident to about the time of the accident, were reviewed. Seven contained icing information that ranged from trace rime to a light to moderate mixed icing, with the reported icing conditions only occurring between 2,000 and 3,500 ft.

In addition, the current icing potential (CIP) images produced by the NWS Aviation Weather Center depicted light to moderate icing was likely at 2,000 to 3,000 ft. around the time of the accident. It was noted that CIP data was intended to be supplemental to other icing advisories such as AIRMETs and SIGMETs).

There were reports from a witness driving in the airport area that, at the time of the accident, he noticed icy patches and slush on the roads.

Wreckage Information

The airplane's impact with the ground created a crater measuring 11-ft. long, 11-ft. wide and 6-ft. deep. There were broken tree branches that contained 45-deg. angled cuts at a height of about 50 ft. The airplane struck the earth at an approximate 70-deg. angle, and consistent with being in an inverted position. The wreckage was severely fragmented with debris scattered on a course of about 320 deg., for about 450 ft. In addition, a post-crash fire consumed a majority of the airframe.

Both propellers remained attached to their respective gearboxes, which separated from both engines. All three left prop blades separated from the hub. Two right prop blades remained attached to the hub, and one blade had separated. Both propeller assemblies were severely impact damaged and displayed evidence of rotational scoring; however, it was noted that the right propeller blades displayed a significantly greater degree of rotational scoring, tears and missing blade tips than the left blades.

Both engines were damaged by the impact and fire. Their respective fuel pumps and fuel control units were separated. They did not display any evidence of catastrophic failure and were forwarded to the engine manufacturer for further examination under the supervision of an NTSB investigator.

A subsequent teardown examination of both engines did not reveal any preimpact conditions that would have prevented normal operation. The type and degree of damage to the left engine was indicative of an engine that was not operating, with rotation consistent with a windmilling prop at the time of impact. The type and degree of damage to the right engine was indicative of an engine that was operating under power at the time of impact.

Extensive tests performed on the gyros in the airplane showed that they both appeared to be operating at impact.

Medical and Pathological Information

An autopsy was performed on the pilot by the Office of the Medical Examiner, Center for Forensic Medicine, Nashville. This report did not indicate any medical condition that might have prevented the pilot from normal operations.

Probable Cause and Findings

The NTSB determined the probable cause(s) of the accident to be:

The pilot's failure to maintain airspeed with one engine inoperative, which resulted in a loss of control while on approach. Contributing to the accident were airframe ice accumulation due to conditions conducive to icing and the loss of engine power on one engine for reasons that could not be determined due to the extent of damage to the airplane. **BCA**

Accidents in Brief

Compiled by Jessica A. Salerno

Selected accidents and incidents in May and April 2020. The following NTSB information is preliminary.

▶ **May 2 — About 0203 CDT, a** Model 369E MD Helicopter (N8375F) was destroyed when it was involved in an accident near Houston, Texas. The pilot sustained serious injuries and the other crewmember was killed. The helicopter was operated as a FAR Part 91 public aircraft flight. According to initial information from the FAA, a Houston Police Department helicopter was on a local flight near the George Bush Intercontinental/Houston Airport (IAH), near Houston, Texas, and its pilot had contacted ATC. The pilot was using flight following while he was conducting a search flight for a person near a bayou. A Department of Public Safety (DPS) helicopter contacted the controller, asked for clearance into the airspace near IAH, and was given that clearance. The DPS helicopter crewmember asked if the controller was still in contact with the police helicopter. The controller advised that radar contact was lost with the police helicopter. The DPS helicopter crewmember advised that there was an indication that the helicopter had impacted terrain.

An FAA inspector examined the wreckage site and documented it. The helicopter had impacted an unoccupied building and terrain. The wreckage was recovered and retained for further detailed examination. The helicopter was equipped with an augmented reality mapping system. The data recording device from that mapping system has been retained to see if it contains information pertinent to the accident flight.

According to a video taken by a witness, the helicopter rotated while in the air and descended. The conditions present in the video were consistent with the observatory indications.

▶ **May 2 — About 1600 CDT, a** Yakovlev YAK-52 a (N27YK) was destroyed when it was involved in an accident near Zelmer Memorial Airpark Inc (5K1), Palmyra, Illinois. The pilot was fatally injured. The airplane was operated as a Part 91 personal flight.

A witness who was driving north of 5K1 observed the airplane descending towards the airport "way too fast to be landing." He lost sight of the airplane as it descended behind a tree line. A few moments later he saw the airplane climb into sight 200-300 ft. AGL about 1.5 mi., do a full revolution and then roll and descend steeply into the ground. A pilot witness observed the airplane make a low pass at 5K1 towards the south 20-30 ft. AGL. He described the airplane pitching up 5-10 deg. to 100-200 ft. AGL when it was past the end of the runway and making a slow roll to the left. As the airplane passed (180 deg.) he did not think the pilot had enough altitude to perform the maneuver. He lost sight of the airplane as it descended and was passing about 270 deg. of roll. Another witness was mowing his yard when he saw the airplane traveling parallel to the ground when it began a left roll and then "nose-dived" steeply towards the ground about one-half mile from his location.

The airplane wreckage was located about 20 ft. from the initial impact point. The impact crater was 12-18 inches in depth and the direction of travel from the impact crater to the wreckage was about 240 deg. The wreckage was moved to a secure location for examination at a later date.

▶ **April 25 — At 1240 EDT, a Hughes** 369D helicopter (N9159F) was heavily damaged when it was involved in an accident near Pylesville, Maryland. The pilot was not injured. The helicopter was operated by Haverfield Aviation as a Part 133 rotorcraft external load operation.

The pilot reported that while he was performing human external cargo (HEC) long-line operations, he was requested by ground personnel to support the movement of a conductor powerline nearby. He proceeded to the landing zone which was about 300-400 ft. from the area requiring assistance, dropped off the HEC, and via the long line, he picked up a conductor hook, all from a hover, and continued to the area that needed support. After the conductor was moved to the area needed, the pilot maneuvered to remove the hook, but prior to the hook becoming free from the conductor, the helicopter entered a left yaw and the engine began "spooling down."

The pilot reported that he subsequently heard the "engine out alarm" and entered an autorotation by "slamming the collective down" and immediately pulling the belly band release levers, which was the first of two release levers that needed to be pulled to release the long line. As the helicopter entered the flare, he pulled the collective up to complete the autorotation landing, however the long line remained attached to the conductor wire and became taught, which rolled the helicopter onto its left side, where the main rotor blades impacted the ground.

Multiple witnesses on the ground reported that they heard the helicopter's engine go "quiet" shortly before the autorotation.

The pilot reported that the loss of engine power occurred about 150 ft. AGL and the helicopter impacted the ground about 4-5 sec. later. The pilot reported that he did not have sufficient time to pull the main hook emergency release lever (the second release lever) located on the cyclic control, which was why the line remained attached to the helicopter. He added that the cyclic was also equipped with a red push button that could release the main hook, however, the circuit breaker for this electrically activated release was pulled due to HEC operations being performed just prior to the accident.

▶ **April 24 — about 1520 EDT, an** Israel Aircraft Industries 1125 Astra SP, Venezuelan registration YV3427, was heavily damaged when it was involved in an accident at Fort Lauderdale Executive Airport (FXE), Fort Lauderdale, Florida. The airline transport pilot, commercial rated copilot, and one passenger were not injured. The airplane was operated as a Part 91 personal flight.

The pilot reported that he was conducting a takeoff on Runway 27 with the intended destination of Simón Bolívar International Airport (CCS), Maiquetía, Venezuela. During the takeoff roll, at rotation speed, the airplane did not respond when the pilot pulled back on the control yoke. He tried to rotate again, and the airspeed was in excess of V_1, about 130 kt.

With no response, he performed a rejected takeoff with maximum braking and full reverse thrust. The airplane departed the end of Runway 27, proceeded through the overrun, and into the grass beyond the runway. The airplane pivoted to the left and came to a stop in the grass, near the perimeter access road. The crew and passengers exited the airplane and were met by first responders.

The passenger cabin was loaded with cargo, which was offloaded and weighed. First responders observed fuel leaking from the right-wing fuel tank. The wreckage was retained for further investigation. The airplane was equipped with a cockpit voice recorder; it was removed and shipped to the NTSB Vehicle Recorders Laboratory, Washington, D.C. for readout.

▶ **April 20 — At approximately 0800** local time, a Sikorsky S-61N (N908CH) experienced a loss of control in flight and rolled on its side during an emergency landing at Camp Dwyer, Afghanistan. The three crew members onboard were seriously injured and the helicopter sustained substantial damage. The flight was operating under the provisions of Part 135 as a cargo flight under contract to the Department of Defense. In accordance with ICAO Annex 13, the NTSB accepted delegation of the investigation from the Afghanistan Civil Aviation Authority.

▶ **April 20 — About 0950 MDT, a Piper** PA-31T1 (N926K) was destroyed when it was involved in an accident about 1.5 mi. west of Billings Logan International Airport (BIL), Billings, Montana. The airline transport pilot was fatally injured. The airplane was operated as a Part 91 local flight. **BCA**

Alone at Night

This accident is a tough one to figure. It appears to me that the pilot could have handled the situation, but since we'll never know for sure, I offer some conjecture here for the purpose of discussion.

The single biggest difference is in the way that most professionals fly IFR as a crew whereas most private pilots do it alone.

When I flew military fighters, we often flew low ceiling and/or visibility approaches as single pilots. The approach controller came up on frequency when you were at 8,000-10,000 ft. and some 20 to 30 mi. from the airport. There were no changes in frequencies after that initial contact. Different controllers came up on the same frequency. Eventually, you were handed off to a final radar controller. Through that controller would come "3 mi. on final, on course, on glidepath, tower clears you to land," after which precision commands continued to be issued. On the rollout, you were advised to contact tower when able.

In short, during those single-pilot, low-visibility approaches, I was not much more than a voice-actuated autopilot. All I had to do was maintain orientation, have a backup approach tuned up if I lost communications and then fly as instructed.

Flying with a highly rated fellow crewmember is not much harder. The approach is put into the boxes well ahead of the terminal area and, in the vast number of cases, unfolds in a very systematic approach. The other pilot monitors every move you make and stands ready to add something if you've missed something. This gets the job done.

In my 40-year career, I missed an ILS approach only twice. I should add that there were numerous times I didn't even try the approach rather than trying and missing. Remembering that our job was convenience for the folks in the back of the plane, New Jersey's Teterboro Airport (KTEB) often had 700- to 800-ft. ceilings when nearby Westchester County Airport (KHPN) was reporting below minimums. The execs got to the office at the same time. No brainer.

For a missed approach in a crewed airplane, all the pilot flying (PF) generally needs to do is establish attitude, keep the wings level while adding power, call for approach flaps, gear up and clean up. Then it's keep the wings level, climb to a given altitude and follow guidance that, nowadays, comes up automatically. Usually a heading is assigned. While the PF's doing that, the pilot not flying (PNF) re-racks the navigation equipment and generally confirms the position with the PF. Again, not hard. At no time does the PF have to do anything but fly the airplane while the PNF sets up the next approach and monitors how well the pilot is flying. Then the PNF takes control and the PF briefs the next approach.

In reviewing the official report on the crash of N840V, you can almost feel the pilot's workload and pressure increase as the flight progresses. Picture that he probably got up early to get to a distant airport to pick up his plane, maybe flew a test flight, ferried to the departure location where he knew colleagues would be waiting, refueled and headed off into a very demanding situation.

I included all the related weather information in our review just because I always marvel at how much is available — so much that it's virtually impossible to not miss some of it. The pertinent weather information for the accident flight was low ceilings, tops to FL 190 and reported light to moderate icing. With those three tidbits, most of us would have assumed all the other information and PIREPs were out there, whether we received them or not. You're going to get into icing conditions and they're most likely going to be serious. There's no way out other than getting on the ground or going somewhere else.

Since the pilot had passed professional courses of instruction, it can be surmised that he was a capable instrument pilot. He got into the area. He made ATC wait while he figured out his course of action. (With an ILS to the other runway, it's a good bet he figured that would be the approach and one might argue he should have insisted on it with only a 3- to 4-kt. tailwind on a 6,000-ft. runway.) He successfully executed a missed approach and got himself back into position for another approach.

Obviously, this all had to weigh on his mind. Imagine his employees, friends probably, watching over his shoulder, maybe one of them in the front with him.

By all accounts, this pilot took his flying seriously. He averaged approximately 100 hr. a year although he seemed to have fallen off that pace before the accident. He had attended several professionally given refresher courses with simulators. Instead of trying to dump a misaligned airplane at the runway from low altitude, he showed good judgment by going missed. However, that increased the pressure since he had flown well below minimums. The missed approach and climb back to the second approach appeared normal. That speaks well for his ability, but be assured, pressure was building. Under such circumstances, it's possible to miss something.

Pressure kept increasing. The three passengers were probably peering forward at him, at the instruments and at the cold, blank scene beyond. There were probably indications of icing on the windshield. First approach missed. Nav equipment reset. Ice. Airspeed low. Power in to recover.

What would a copilot maybe have added to the scenario: "Anti-ice, boss." But N840V's pilot never got that cue.

Then . . . one engine doesn't spool . . . what's wrong?

Overload. Roll-off. Pull back.

Spin.

Obviously, the airplane was out of control just before the rate of descent exceeded 10,000 feet per minute and more than likely rolled under, rather than turned, to wind up impacting on a heading of 210 deg.

The situation deteriorated, and, as the pilot tried to cope, he eventually reached the limit of his ability when one of the engines didn't spool. The only chance he had at that point was to ease in power, level the wings, clean up the airplane and try to get it flying again. But he had missed one approach, was inside the initial approach fix, had another plane behind him and by then, just wanted to get on the ground. The loss of engine, yaw, slow speed and roll-off presented a situation outside his ability to cope. At the end, there were four passengers. **BCA**

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Smoke Signals

Every potential accident sends signals first — **can you spot them?**

The crash of the second XB-70 bomber

USAF

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

When I started U.S. Air Force pilot training in 1979, it wasn't uncommon for the service to lose an airplane every month. On average we lost five Cessna T-37s, our primary trainer, and seven Northrop T-38s, our advanced trainer, annually. Even the operational Air Force was accustomed to these kinds of losses. The primary fighter that year was the F-4 Phantom II and it averaged two losses a year. And the heavy aircraft world was not immune. We lost a KC-135A tanker and C-141 cargo transport every two years. As we used to say back then, "You have to expect a few losses in a big operation."

The most common refrain in class for us was, "You have to know this cold, or you will become a smoking hole in the desert." We were at the former Williams AFB, near Phoenix, and most of our flying was over the desert. To get an idea of the mindset of the service back then, a good case study would be the crash of a North American XB-70 Valkyrie on June 8, 1966.

The Valkyrie was designed to meet the requirements of a 1955 proposal for a bomber that would be fielded in 1963. The Soviets had just become nuclear capable and we wanted a long-range bomber to hit them in their territory before they had a chance to hit us. The biggest threats to our bombers at the time were their interceptors, so this airplane was supposed to fly very high, very fast. Nuclear bombs at the time were very large, so the airplane had to have a large payload. The XB-70 won the contract, with a promised top speed of Mach 3+ and altitude of 70,000 ft.

The airplane was both ahead of and behind the times. It took six engines using hybrid fuels to give it the required speed. While the engines burned twice as much gas as a conventional bomber, it flew at four times the speed. Its fuselage was designed to funnel the supersonic shock wave under the wings to provide compression lift, further improving its speed and fuel numbers. But by the time it started test flights, the mission had already changed. In 1960, the Soviets shot down a U-2 spy plane at around 70,000 ft., demonstrating the ability to use missiles to down aircraft at very high altitudes. The Air Force changed tactics to fly very low, beneath radar coverage, to penetrate enemy airspace. But once a weapon system's procurement has begun, the Defense Department is rarely willing to cancel.

But Secretary of Defense Robert McNamara, over the objections of the Air Force, was able to do just that, killing the program in 1962. Two XB-70s had been

XB-70 in flight

U.S. AIR FORCE PHOTO

built and were relegated to conducting advanced studies of aerodynamics and propulsion. On June 8, 1966, someone at General Electric thought it would be a great idea to have photos of the XB-70 flying formation with an F-4 Phantom, F-5, T-38 and an F-104 Starfighter. All five were powered by GE engines, after all. But then once the photoshoot was completed, the F-104 drifted too close to the XB-70 and was pulled in and over it, severing the XB-70's tail in the process. Both the F-104 and XB-70 crashed, killing the fighter pilot and the bomber's copilot. The XB-70 pilot was able to eject.

The photo of the XB-70's "smoking hole in the desert" haunts many of us veterans from that era. How is it we can lose sight of the mission and later of our safety procedures? It seems the original mission morphs, preempting the original, and then the new mission blinds us to our safety procedures. It is a problem that confronts every flying organization.

I think we can take the lessons from that smoking hole to look for signals from a flight operation in danger of similarly permitting disaster. Retired space shuttle commander Jim Wetherbee wrote about this in his excellent book, Controlling Risk in a Dangerous World. He writes that "every potential accident gives signals before it becomes an accident." He has a list of five common technical, systems and managerial conditions that existed in various organizations before they experienced major or minor accidents:

(1) Emphasized organizational results rather than the quality of individual activities.

(2) Stopped searching for vulnerabilities — didn't think a disaster would occur.

(3) Didn't create or use an effective assurance process.

(4) Allowed violations of rules, policies and procedures.

(5) Some leaders and operators were not sufficiently competent.

Organizational Results Over Individual Actions

U.S. Navy Capt. (ret.) Wetherbee says that individuals within an organization don't create results; they conduct activities. Results are important, of course, but it is the quality of activities that creates the quality of results. Most of us have examples in which organizations to which we belonged became so goal oriented as to become unsafe. Here is one of my earliest examples.

On Sept. 4, 1980, I flew a KC-135A tanker from Honolulu to Andersen AFB, Guam. It was a flight of 3,294 nm and took 8.4 hr. I was looking forward to meeting a friend of mine stationed at Grand Forks AFB, North Dakota, who was due to fly in the same day. He was flying a B-52 and I thought there might be a chance my airplane would refuel his. But fate had another scenario in mind.

In our tanker, Day One of the trip was to be from Loring AFB, Maine, to March AFB, California. After a night's rest, we flew on to Honolulu and got another night off. The third day of the trip was to Guam. I knew my friend, "2nd Lt. X," was scheduled to arrive in Guam about the same time. I didn't know he was doing the trip nonstop. It was 5,852 nm and would take around 20 hr. with three air refuelings and a practice low-level bomb run along the way. I also didn't know that the day before he left, President Jimmy Carter made a statement to the press that the B-52 could reach any target in the world in 24 hr. The Air Force higher ups decided they would prove that with this trip to Guam.

The view of a B-52H from a KC-135 Stratotanker

USAF PHOTO

The B-52 had a crew of six back then: two pilots, two navigators, an electronics warfare officer and a gunner. X's base decided they should have an extra pilot and navigator for the 24-hr. mission. The morning of the mission one of the pilots called in sick. The base decided they could go with just two pilots. Of course!

We arrived at Andersen AFB on schedule; it was a beautiful but humid day. The rest of my crew promptly went to bed while I checked out the command post to find out about X's bomber. I was told it was a little late but en route and would be landing the next morning. The next day I heard the bomber had landed, but the crew was restricted to quarters, pending an investigation and possible punitive actions. For the next week there was no news at all. My crew was sent to Diego Garcia and I forgot about it for a while.

When I came back to Guam, I was surprised to see a note on my door from X, inviting me to dinner at the Officer's Club. That night he let me know what had happened:

"We checked in with command post about 2 hr. out and gave them our ETA, which was to be right at 21 hr. They asked if we had enough gas to fly three more hours and we made the mistake of telling them yes. They told us to find a holding pattern and that under no circumstances were we to land with less than 24 hr. of flight time."

He further explained that they decided to pull the throttles back, fly their maximum loitering speed, and let the autopilot handle the flying chores. "I guess we all fell asleep — all seven of us," he said. "The base scrambled two fighters and they found us south of Guam a couple of hundred miles headed for the South Pole. None of us heard them on the radio. The command post told the fighters to get in front of us so their jet exhaust would shake our airplane, and it did. That's what woke us up."

By the time they got back on the ground they had their 24-hr. sortie and the base was contemplating throwing the book at the crew for falling asleep while flying, which was not allowed. In the end, saner heads prevailed, and the Strategic Air Command decided to look the other way.

This kind of mission myopia isn't limited to the military. We see examples of it on a regular basis: the crash of a prototype, for example. From the original G159 through the wildly successful G550, Gulfstream had long defined business travel on the high end. The Gulfstream G650 was something that pushed the envelope further with its wider cabin, longer range and higher speeds. But the company promised takeoff and landing field lengths more akin to those of its smaller aircraft. The test pilots were tasked with validating those numbers, not determining what the numbers would be.

Of course, they had computer models to go on and were confident the promised results could be achieved. This was a mistake. A crew of four gave their lives trying to achieve the promised results on April 2, 2011. Subsequently, Gulfstream raised the numbers and the airplane has gone on to be its most successful type ever. I believe the process has been fixed — at least I hope it has. The emphasis is now on the process (activity) of testing the aircraft, and not on achieving goals (results).

While results are a good way to measure success, they can blind everyone into overlooking the quality of the process leading to those results. Just because the results were good doesn't mean the process was optimal, safe, or advisable. That is especially true when the cost of the desired results is too high.

Not Searching for Flaws

Wetherbee found in his research of accidents that managers usually thought their teams were performing well before the disaster occurred. Those of us who have played a quality assurance role in our organizations owe upper management an accurate picture of that quality. There is pressure to say things are great, of course. But quite often we want the news to be good and so it is. (Until it isn't.)

In 2002, I fell for one of the oldest tricks in the book used against flight examiners. It goes like this: Please pass this pair of Pilot in Command (PIC) upgrade candidates. We know both have weaknesses, but we will only pair each with the strongest copilots to obtain the little seasoning needed. I did this once in the Air Force and regretted it — and did it again while flying the Challenger 604 and that didn't work out any better.

My Challenger flight department was collapsing upon itself after our company agreed to a buyout. We had racked up several years of high-tempo operations flying all over the world without so much as a scratch on any of our airplanes or people. But once it became known the flight department would be disbanded, we started losing experienced pilots and started hiring anyone with a pulse. One such pulsing pilot I'll call Peter.

Peter was a good guy and a fair stick and rudder pilot but a lousy decision maker. I gave him his pass to qualify as SIC while every other pilot then in our group was of the caliber to help with Peter's seasoning. However, a year later, after losing four experienced pilots and hiring four new ones, there was a push to make Peter a PIC. I initially resisted, but when you run out of bodies, what are you going to do? He would be a domestic-only PIC; what could go wrong?

In July of that year Peter and a contract pilot flew from Houston to Bedford, Massachusetts, landing around 9 p.m. My crew took over the airplane for the rest of the trip to Athens, Greece. The ramp was exceptionally dark and the only thing unusual about the crew swap was that their flight attendant, let's call her Patricia, had to be helped off the airplane. I asked Peter what happened to her and he said it was "nothing to worry about." When we landed in Ireland for fuel it was still dark. After the passengers awakened from their inflight naps they asked about Patricia's condition. They told us that it had been so turbulent descending into Boston that Patricia had been thrown about the cabin like a ping pong ball. Once we landed in Athens we saw that the nose of the aircraft showed evidence of hail damage.

Of course, Peter denied flying through a thunderstorm. But then I caught up with the contract pilot, who admitted that they had done just that, but he was a contract pilot and "what was I supposed to do?" Nobody looks good in any of this, me included. I should have shown more character and refused to upgrade Peter when I did. Our flight department pushed for upgrades and I didn't push back hard enough. This kind of push and failed pushback can have catastrophic results.


Breakup of the space shuttle Columbia

NASA

On Feb. 1, 2003, the space shuttle Columbia broke apart during atmospheric reentry, killing all seven crewmembers. A piece of foam insulation had separated from one of the two external fuel tanks during launch and struck the spacecraft's left wing. The damage was enough to breach the integrity of the heat tiles and hot atmospheric gases entered the wing during reentry. The damage destroyed the internal wing structure, causing the spacecraft to become unstable and fail catastrophically.

The accident was more tragic than just a retelling of the sequence of events because this kind of damage had been noticed several times before, causing anywhere from minor to near-disastrous results. The accident investigation focused on the foam and the organizational culture at NASA that caused its members to ignore the warning signs. But the culture at NASA goes deeper still since the three major accidents in its spaceflight history involve repetition.

The time leading up to the Jan. 27, 1967, Apollo 1 test explosion was one of urgency to meet President John F. Kennedy's deadline to place a man on the moon before the decade was out. The Mercury and Gemini programs had gone very well and they were ahead of the timeline. NASA believed shortcuts in the capsule's cabin environment (100% oxygen) and materials (non-flammability not required) were justified in that the mission was a national priority and it had taken adequate precautions. Nothing could go wrong.

The Jan. 28, 1986, launch of space shuttle Challenger was to begin the 25th orbital flight. NASA's stated objective for the mission was to make shuttle flights operational and routine. It had gradually lowered the lowest acceptable ambient air temperature for launch, overriding objections of engineers responsible for O-rings used to join segments of the solid rocket boosters. On this particular launch, the O-rings became brittle and failed. The shuttle exploded 73 sec. after launch. Nothing could go wrong.

In all three accidents there were engineers and managers who knew something was wrong, but there were higher level managers who refused to believe it.

There is a common thread between my upgrade of Peter and an injured flight attendant, the hail damage and NASA's Apollo and space shuttle accidents. In all, the organizations got comfortable and stopped thinking about what could go wrong. If you spot an organization with this level of complacency, watch out.

No Effective Assurance Process

Wetherbee also noted that prior to accidents, many of the managers involved did not understand how to create an effective process of assurance, nor did they understand its value. In an operational organization, providing assurance means a person is giving confidence about future performance to another person, or group, based on observations or assessments of past and current activities. That can't happen unless management is willing to listen to the operators as well as employ methods to ensure those same people are living up to the standards they have set.

Back in the 1980s, I was a member of an Air Force Boeing 707 (EC-135J) squadron in Hawaii whose mission was to support the U.S. Navy and its submarine fleet in the Pacific. In 1984, while I was at a three-month-long flight safety officer school, the Navy brought its submarines back from their former "westpac" orbits off the coasts of Korea and the USSR to "eastpac" missions right off the coast of California. As a result, our mission changed from Korea, Japan and the Philippines to California. The squadron set up a staging operation at March AFB, Riverside, California. It all seemed pretty straightforward.

Well, it would have been except the squadron had a change in leadership about a year prior and the new squadron commander set about replacing every subordinate officer who wasn't spring-loaded to a "yes, sir" response. Non-sycophants were shown the door. The commander kept the new mission to himself along with a chosen few until it became operational. Details were restricted on a "need to know" basis, so line pilots were denied a look at the mission until they actually flew it. Two months after returning from safety school and four months after the change in mission, I found myself at March in an airplane too heavy to safely take off if an engine failed at V1.

"What do you mean you can't go?" the commander asked over the phone. "My staff has gone through this backward and forward. You either fly it or you can consider your flying days with my squadron over."


N121JM wreckage, aerial photograph, from NTSB Accident Docket

COURTESY OF MASS STATE POLICE

As it turned out, the new staff didn't have a lot of experience considering obstacle performance with an engine failed and did not factor the mountains just north of the airport along with higher temperatures. The previous aircraft commanders made sure they had the performance for their particular departure days and didn't mention the plan was flawed, since the emperor didn't like bad news. I had the first departure on a hot day since the plan had changed. But the squadron commander had signed off on the plan for year-round operations. Now he had to go back to the Navy and say he couldn't do it. He was obviously furious.

But he was lucky since all he had to contend with was a little embarrassment and not notifying the next of kin that one of his crews had splattered themselves in the California mountains. Not everyone gets this lucky.

During the night of May 31, 2014, the pilots of Gulfstream IV N121JM failed to rotate and ended up in a fireball at the end of Runway 11 at Hanscom Field, Bedford, Massachusetts (KBED). Tower reported that the nose failed to lift off and the braking didn't start until very late in the takeoff roll. As most of us with GIV experience suspected, the pilots forgot to release their gust lock prior to engine start and then tried to disengage it during the takeoff roll rather than abort and have to admit their mistake.

The NTSB described the actions of the two pilots as "habitual intentional noncompliance." Many of us speculated that they trained with "Brand X," but that wasn't true. They trained with the same training provider that we use. We also hypothesized that these pilots never heard of a safety management system (SMS). Again, not true. They had been awarded their Stage II SMS rating. If only they had a flight operations quality assurance (FOQA) system. But they did.

When the details of the crash finally emerged, it came to light that these pilots put on an act when training, just to pass the check ride. But in daily operations they flew by their own rules, not using checklists, callouts or common sense. They had SMS certification, but it was a "pay your fee, get your certificate" operation. As for FOQA, it appears the data existed, but the program was not used. These were two pilots who were comfortable operating their very expensive jet as you would a beat-up pickup truck. And now they are dead. It is a tragedy compounded since they took innocent lives with them.

Many small organizations, like my squadron in Hawaii, are parts of a larger whole that has existing, and mandatory, robust safety assurance systems. Others, like N121JM's flight department, are enrolled in assurance systems that are simply purchased. While most SMS auditors do a good job and try to get it right, some are out there to sell you the certificates and are unwilling to criticize the people signing their paychecks. Any organization willing to pencil-whip these assurance programs is courting the next accident.

Flaunting Rules, SOPs

According to Wetherbee's study, accident investigators usually determine that some organizational rules, policies and procedures were violated before an accident. Often, the workforce reported unofficially that some managers were cognizant of these violations. I've noticed that the more senior and "special" an organization regards itself, the more likely this kind of negligence is to happen.

When I showed up as a copilot in our Hawaii Boeing 707 squadron, the biggest challenge for me was going to be learning how to air refuel as a receiver.

Unlike the tanker that normally flew as a stable platform with the autopilot engaged, the receiver had to fly formation using old-fashioned stick and rudder skills. Just as I was getting the hang of it, one of the pilots talked the tanker into allowing him to fly fingertip formation, something reserved for smaller aircraft.

Air refueling formation is what is called "trail formation," in that one airplane flies behind the other, albeit close enough to make physical contact. It requires a high level of training (and skill) but offers the advantage of an easily effected abort: The receiver pulls power the tanker adds. There is more to it than that, but you get the idea.

However, fingertip formation introduces a lot of variables from the high- and low-pressure zones of overlapping wings. There have been more than a few midair collisions with one airplane quite literally sucked into another. That was what I was thinking about when I was a passenger in the copilot's seat watching the guy in the left seat fly fingertip formation with a tanker. One 200,000-lb. aircraft flying so close to another weighing almost as much, so closely that our left wing was underneath and just behind the tanker's right wing. I asked our squadron commander about this and was told it was perfectly safe and we did it to keep our flying skills sharp.

A few months later there was a midair between a tanker and an AWACS airplane and the Air Force made it clear in no uncertain terms that anyone caught flying unauthorized formations in any aircraft would be getting a one-way ticket to Leavenworth, the military's most infamous prison. All of a sudden, the fingertip formation program in our squadron went away.

A few years later, I joined the Air Force's only Boeing 747 squadron (at the time) and shortly after I arrived I was medically grounded with cancer. I spent two months in a hospital and shortly after I returned the squadron commander was fired. There were videotapes circulating showing him flying fingertip formation with another of our 747s. In this case, there were two 600,000-lb. airplanes doing what I had seen in the smaller 707. I overheard him talking about it, acknowledging that he was fired and forced to retire. I think he got off easy.

The most unkind, and valid, insult ever given to an airline came from Robert Gandt in his excellent book Skygods: The Fall of Pan Am, when he wrote, "Pan Am was littering the islands of the Pacific with the hulks of Boeing jetliners." By the close of 1973, Pan American World Airways had lost 10 Boeing 707s, not including one lost in a hijacking. At least seven of the 10 crashes were due to pilot error. Pan Am initiated a study to find out what was wrong. As the study was being conducted, its pilots crashed two more airplanes.

To get a feel for the carrier's culture at the time, Gandt tells the story of a captain flying a visual approach into Honolulu International Airport in the days they shunned checklists or callouts. The captain simply flew the airplane as he thought best while the first officer did his best not to offend the "skygod." Descending through 600 ft., the first officer asked the captain if he was ready for the landing gear. The captain exploded with rage, saying, "I'll tell you when I want the landing gear." Two and a half seconds later, with a great deal of authority, he said, "Gear down!"

PUBLIC DOMAIN

The first three Pan Am Boeing 707s (N709PA, N710PA, N711PA), Seattle, 1958

USAF

RC-135S 61-2664 at Shemya AFB

The story doesn't end the way you would expect. The captain reported the first officer's temerity to the chief pilot, whose response was to tell the first officer that if he ever challenged another captain's authority, he would be fired.

It is true that was a different time, but the culture at Pan Am was firmly established in the flying boat era: The captain was imperial. That vaunted status became a true danger with the arrival of jet-powered airliners. In fact, things got so bad, the FAA threatened to ground the airline. Subsequently, the company got rid of all those "skygods" and turned into one of the safest airlines in the world. But until then, it provided case study after case study on how not to run a crew.

In both my Boeing 707 and 747 squadrons, its members were considered performing what the Air Force called "special duty" assignments. We were outside the normal assignment process and getting hired required an interview with the squadron's command staff, whose leadership felt above the normal rules of the Air Force. In both squadrons various Air Force rules were formally waived and both squadrons tended to bend those bent rules further. But in both cases, we were spared midair collisions because external forces managed to rein us back in. Pan American World Airways was not so lucky, but it managed to return to the fold after finally learning hard lessons.

Incompetent Leaders

Deficiencies in knowledge, skills or attitudes at any level in the organization, notes Wetherbee, can result in accidents. Qualified assessors should have been assigned to test knowledge and skills and evaluate attitudes of all people who were contributing to hazardous missions. One of my sister squadrons from my Boeing 707 days experienced this with tragic results.

The RC-135S was a Boeing 707 variant assigned a spying mission (the "R" stands for reconnaissance). In the late 1970s and early 1980s, an RC-135S could usually be found sitting in Shemya AFB, on Shemya Island, Alaska. The weather on this Aleutian Island was usually poor, but the location was key for monitoring a Soviet Union ballistic missile test area.

On March 15, 1981, an RC-135S landed short of the runway at Shemya, destroying the airplane and killing six of the 24 crew on board. The copilot had ducked under a precision approach radar (PAR) glidepath and the poor visibility at minimums fooled both pilots into thinking the landing could have been salvaged.

As with most aircraft accidents, there are many related causes, but the striking fact in this tragedy is that the squadron appeared to have very good pilots who flew into this hazardous airport routinely with great success. This particular copilot, however, had a history of flying below glidepath and his behavior appeared to be overlooked. Compounding the problem was that the squadron's other pilots also may have tended to fly below glidepath but were able to get away with it due to a higher experience level. The copilot survived and was asked about the prohibition against ducking under in the Air Force instrument flying manual, called Air Force Manual 51-37. He said he thought that manual only applied to the T-37, the airplane he flew in pilot training.

I had undergone Air Force pilot training at about the same time as this copilot and also flew the T-37. I knew full well that AFM 51-37 applied to all Air Force airplanes. It seems to me someone along the way should have realized that this pilot, and possibly others in the squadron, did not have the competence to correctly fly a PAR approach. I was flying an EC-135J when the accident report was released. The EC- and RC- are both derivatives of the C-135, a Boeing 707. Unlike the KC-135A, however, these airplanes were much heavier and had higher approach speeds. Flying a PAR was a challenge. Many in our squadron knew some of those who had died in the RC-135 and our nonpilots wondered if our pilots were competent enough to have prevented the crash. We pilots, however, had no doubts.

Reading the Signals

Of course, there are countless textbooks, web posts, magazine articles and seminars out there that tell you what not to do so you can avoid the next aircraft accident. The problem is that most operators in organizations that will have that next aircraft accident are blind to those and the danger signs within their own department or group. To them, as to most of us, they are doing everything just right and the next accident will happen to the "other guy." What worries me, and should worry you, is that other guy could be me or you. Wetherbee's list of warning signals gives us something to look for:

(1) Does your organization place more importance on the desired results of your mission (getting from Point A to Point B) than on the activity required to do that (flying safely within all known procedures and regulations)?

(2) Does your organization spend time looking for weaknesses and other ways it may be vulnerable to missing something important?

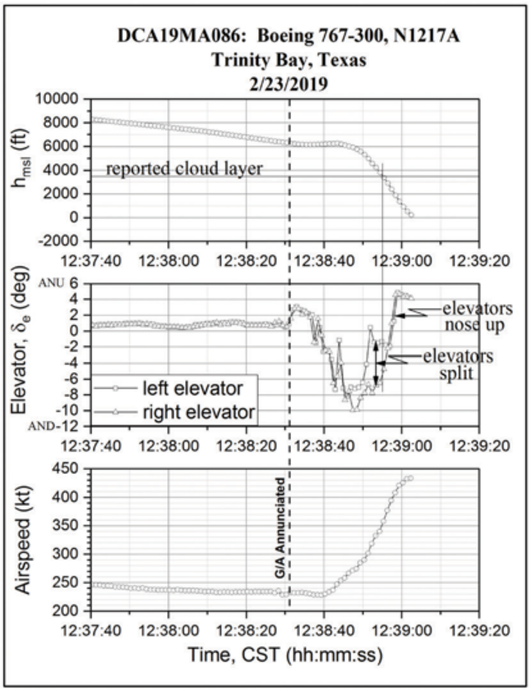
(3) Does your organization earnestly and honestly use assurance programs, such as SMS and FOQA?

(4) Does your organization look the other way at violations of any rules, policies or procedures?

(5) Are your operators competent at what they do?

A Case Study in Progress

In February 2019, an Atlas Air Boeing 767 plunged into a muddy swamp near Houston-George Bush Intercontinental Airport (KIAH), doing over 400 kt. with the autothrust engaged. While the NTSB has not finished its investigation, it has released its airplane performance study.



NTSB AIRPLANE PERFORMANCE STUDY

Atlas Air Flight 3591 elevator split

It appears that during their descent the takeoff/go-around function of the autopilot was activated, confusing the first officer, who was the pilot flying. He made a comment about airspeed and about the airplane stalling, though all indications were otherwise. Looking at a plot of the airplane's altitude versus airspeed and elevator position, it appears the first officer pushed the nose down aggressively while the captain pulled back. Once they popped out of the weather the first officer joined in pulling back the elevator but it was too late.

The first officer had a history of failed check rides at Atlas and previous employers. The captain's record was only slightly better. According to the director of human resources at Atlas Air, the carrier had seen a "tough pilot market." After looking at these two pilots and their training at Atlas, it's my opinion that the operator's hiring standards were low and it trained as best it could with the talent available. I think the culture emphasized filling cockpit seats over producing safe pilots, failed to look for weaknesses in its hiring and training processes, failed to implement or use an effective pilot evaluation system, and failed to ensure the competency of its pilots. In other words, the organization exhibited four of the five warning signals.

Other than landing at the wrong airports a few times and sliding off the end of a runway once, Atlas Air's safety record was generally good. But no operator can rest on its laurels and consider safety something that is addressed only once.

Years ago, while flying for TAG Aviation, we had a pilot retire who gave us a well-intentioned compliment during his exit interview that hit my flight department two different ways. TAG had well over 200 pilots at the time and double that number of personnel. The retiring pilot had been with TAG almost from the beginning and had been a member of several flight departments. He said at his exit interview that we were the best flight department in which he had been a member in terms of adhering to standard operating procedures. He said that we were "as close to being by-the-book" as he had ever seen.

Half of our pilots were pleased with the statement, but the other half asked, "What do you mean 'close?'" He was referring to our disregard for 14 CFR 91.211, which requires oxygen use above FL 350 when one pilot leaves the cockpit. Our chief pilot would not budge on the subject. He was fired about a year later and we immediately started flying by the book, even when it came to 14 CFR 91.211.

That was 18 years ago. I am now starting my 12th year leading my current flight department. I worry about whether our organization is placing more importance on the desired results of the mission than the activity required to do that. That is the nature of our business and if it doesn't worry you, it should. **BCA**

Bombardier Global 7500

Fifty-seven-ton flagship **shows off unsurpassed low-speed agility**

Duck into that small mountain airport and you'll find the big bird feels as agile as a light jet.

BOMBARDIER

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

Walk around the Global 7500 and each time the sheer size and girth of this capacious Canadian cruiser always impresses. This flying Feadship is all about air supremacy, being the largest, heaviest and roomiest purpose-built business jet yet to enter production. It measures 111 ft. from nose to tail, spans 104 ft. and reaches 27 ft. in height, with a maximum ramp weight of more than 115,000 lb. That's more girth than a Boeing 717 or BAC 1-11.

Unlike those liners, the Global 7500's main mission is obviously not shuttling 130 to 150 commuters between Dallas and Denver or Seattle and San Francisco. Rather, the Bombardier flagship is designed to carry up to eight or nine people in unparalleled comfort on 16+ hr. transoceanic flights. Leave Tokyo at 5:00 p.m. and arrive in New York at 6:00 p.m. — on the same day. Three meals, two movies and one long, comfortable nap and you're home from the Western Pacific in time for dinner.

The cabin is 12 ft. longer than the interior of a Global 6500, providing space for four cabin sections plus a full-size crew rest compartment up front. And it's not just about what this luxury aircraft can do in the air, but how well it cossets passengers in the process.

This begins with offering them more cabin window area than any other large-cabin aircraft. The transparencies are substantially larger than the Airbus-size windows on other Globals, so the interior is flooded with bright ambient light. Bombardier's Soleil cabin lighting system automatically adjusts the intensity and color of the interior lights throughout the flight to help passengers adjust to time zone changes by simulating day, dusk, night and dawn ambient light conditions.

The aircraft we flew for this report is no stripped-down, baseline model. It's loaded with luxury options, including wine refrigerator, chiller and freezer, plus warming drawer, coffee and espresso makers and a full complement of top-end crystal, china and flatware. The galley has wood-veneer flooring and there's stone-veneer flooring in the aft lavatory. The forward, or Zone 1, club suite has four oversized, plush, ergonomically shaped Nuage chairs. The Zone 2 six-seat conference suite area has a table that can be extended the full width of the cabin and chairs that move sideways for ample elbowroom at mealtime.

Zone 3 is the entertainment suite, complete with Bombardier's signature 1,275-watt, multi-speaker l'Opera audio system, media center storage unit and 32-in. HD monitor plus three-place divan. The master suite in Zone 4 has a twin-size bed and single-chair executive workstation. The aft "en suite" lavatory may be equipped with optional shower.

Others may choose a different cabin configuration. In fact, this ultimate Global has a modular cabin design that enables buyers to pick and choose different layouts for each of the four 9-ft.

ASK FRED

Send your questions about this article to:
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seating areas, providing a choice of 10,000 distinctive floor plans. A corporate flight department, for instance, might choose back-to-back, four-chair club sections in Zone 1 and 2, swap out the entertainment suite for a conference grouping and install a three-place divan plus single chair for Zone 4.

Standard equipment includes a Honeywell JetWave 15-Mbps Ka-band satcom, voice and FANS over Iridium satcom, Lufthansa Technik Nice cabin management and IFE system, six external videocams, plus two media centers with hard disc AVOD storage and Blu-ray Disc players, 24-in. HD screen in the club suite, along with HDMI ports in the club and entertainment suites, and front and rear wireless access points. Pick up your mobile phone, enable Wi-Fi calling and the Ka-band satcom will connect you with anybody on the ground virtually any place you're likely to fly.

With all this luxury kit, basic operating weight balloons to 61,700 lb. Yet, generous weight allowances still enable the aircraft to carry 1,890 lb. with full fuel. As a result, the fully equipped demonstrator aircraft has been able to rack up its share of range and speed records, including an 8,225-nm run from Sydney to Detroit.

The aircraft typically cruises at Mach 0.85 or 488 KTAS in the mid- to high forties, essentially the same speed as the latest long-range jetliners from Airbus and Boeing, but at considerably higher altitudes. It also can dash between Tokyo and New York at Mach 0.90.

However, our goal in flying the Global 7500 earlier this year wasn't to press its speed, altitude or range limits. Rather, it was to probe its low-speed capabilities, its maneuverability, its handling characteristics, its advanced high angle of attack (AOA) protections. We soon learned there's a world of difference between the Global 7500 and most competitors.

15,000 Ft. and Below

We belted in the left seat of serial number 70006 at California's Norman Y. Mineta San Jose International Airport (KSJC) with Bruce Duggan in the right seat as instructor pilot and Michael Goggins on the jump seat as safety pilot. Zero fuel weight with three of us aboard and 100 lb. of supplies was 61,830 lb. Ramp weight was 80,080 lb. with 18,250 lb. of fuel, sufficient to fly from the Bay Area to Stephenville, Newfoundland.

Computed takeoff weight was 79,600 lb. Using Flaps 2 and de-rated thrust on that 14C day with a 6-kt. tailwind, takeoff field length was 4,066 ft. The V1 takeoff decision speed was 108 KIAS, rotation was 109 KIAS and the V2 one-engine-inoperative takeoff safety speed was 124 KIAS. Vfto final segment "clean wing" speed was 170 KIAS. We set the pitch trim at 5.5-deg. nose up as computed by the FMS for our weight and CG.

However, we could have shortened TOFL to 3,500 ft. by using Flaps 3, full-rated thrust and correspondingly lower V speeds, assuming we departed Runway 12R. The 1,254-sq.-ft. wing is smaller in area than that of the Gulfstream G700, but the Global 7500's high-lift system, including leading-edge slats and double-slotted inboard Fowler flaps, gives the aircraft the best sea-level, standard-day runway performance of any aircraft in its class.

EFIS color conventions and clear, simple symbology also are best in class, in *BCA*'s opinion. Cyan signifies pilot input, magenta is for computer-generated targets, green shows active and short-range navigation modes, and white indicates standby or armed modes. The FMS is quite versatile and capable, but as with most modern avionics suites, mastering it is the most challenging aspect of learning the aircraft.

Once we nudged the thrust levers to move us out of the chocks, the lightly loaded aircraft only required idle thrust to keep moving at a brisk taxi speed. We found it helpful to deploy one thrust reverser to control taxi speed without having to ride the brakes. The

Conference suite offers a wall-to-wall dining table, comfortably seating three people on each side.

BOMBARDIER

Entertainment suite features a reclining sleeper sofa, surround sound and large HDTV providing a home theater experience.

BOMBARDIER

nosewheel steering tiller provides 82.5 deg. of authority while +/-9 deg. is available through the rudder pedals.

When we were cleared for takeoff on Runway 30L, I armed the autothrottles, advanced the thrust levers and they engaged at about 60% N1 (fan speed) rpm. Pitch response, using the sidestick, was crisp but well damped, as one might expect from a well-sorted digital flight control system. The Global 7500 uses the fly-by-wire (FBW) system developed for the Airbus A220 (nee Bombardier CSeries), incorporating C*U speed stable control law. A trim switch atop the sidestick sets the neutral trim speed on normal law and it's depicted on the airspeed tape as a cyan arrow. On the ground, the trim switch directly adjusts horizontal stabilizer trim position.

The biggest difference in control response between the Airbus A220 and Global 7500 is the sportier thrust-to-weight ratio of the business jet. Duggan advised me to stay on top of the need to trim the aircraft by anticipating rapid acceleration.

The FBW system eliminates pitch aberrations induced by configuration change. As Duggan retracted the landing gear, then selected Flaps 1, followed by Flaps 0, there was virtually no change in pitch attitude.


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The Global 7500's capacious forward galley supports multiple meal services during 16+ hour flights.

We flew the TECKY3 departure to TECKY intersection then eastbound to Friant VOR in the Sierra Nevada foothills via NTELL intersection. The autothrottles handled the thrust setting chores. Duggan requested a 14,000- to 16,000-ft. altitude block for airwork.

Warm-ups started with some garden variety, hand-flown/hand-throttle 45-deg. bank turns at 200 KIAS. Gentle lateral pressure on the sidestick rolls the aircraft at the comfortable, stately rate desired by carriage-class customers. The flight path vector on the PFD makes it easy to hold altitude during such conventional maneuvers. The sidestick controller has soft stops that assure the aircraft remains inside the published flight envelope.

Later, we slammed the sidestick to the hard stop to push the big bird close to the stall limit and it instantly seemed to shed its bulk and respond as though it were a lightly loaded Learjet. Had we paying passengers in the cabin, we would have been updating our resumés shortly after landing.

Then, we slowed the aircraft, extended gear and Slats/Flaps 4 (landing


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Forward club suite features Bombardier's signature Nuage chairs. The Global 7500 has the largest cabin window area in class, providing bright daylight illumination.

BOMBARDIER

BOMBARDIER

configuration) and bugged landing speed at 125 KIAS, about 6 to 7 kt. above VREF for the actual aircraft weight of 78,400 lb. We rapidly rolled into left and right 45-deg. bank angles, pulling 1.7 Gs to maintain aircraft altitude. The aircraft remained fully controllable with no hint of stall warning buffet.

Next, we returned to wings level, disconnected the autothrottles and slowed to Vate, the lowest allowable trim speed, at a weight of 78,300 lb., for an envelope protection demonstration. At 116 KIAS, stabilizer trim was disabled, the autothrottle system automatically re-engaged and added full thrust to prevent the aircraft from decelerating.

We manually disengaged the autothrottles and pulled back the sidestick to the first, or soft, stop, the point at which the edge of the normal flight envelope is reached. The FBW system reined in allowable roll rate in response to the increased AOA to assure the aircraft didn't depart controlled flight. We continued to pull back the sidestick to the hard stop, causing the stick shaker to activate and an aural "STALL, STALL" warning to be triggered. The FBW system nudged over the nose to prevent reaching aerodynamic stall and also restricted the bank angle to a few degrees left or right of wings level.

Our last maneuver was a demonstration of maximum bank angle available at low speed. With gear and Slats/Flaps 4 extended, we slowed to a VREF speed of 124 KIAS. We started a series of progressively tighter wind-up turns. As the aircraft approached 60-deg. angle of bank, the avionics system automatically bumped up VREF by 6 kt., to 130 KIAS. We weren't quite able to maintain aircraft altitude at 2 G at that speed with the stick pulled back to the soft stop. But the aircraft remained fully controllable, giving complete confidence that it could be maneuvered in such an extreme way if the situation warranted it.

Reserve crew chair (left) in cabin faces sideways, forward or backward to seat either a third pilot or flight attendant. Aft private suite is available with double bed. A single executive work chair, not shown, also is available for the opposite side of the compartment.

Following the airwork maneuvers, we returned to San Jose for landing. VREF at 76,400 lb. was 116 KIAS and landing distance was 2,443 ft. Total flight time was 0:53 min.

Benefits of Low-Speed Agility

The Global 7500 responds more like a Ferretti sport yacht than a stately Feadship in terms of agility. Most crews never will need to press the aircraft to its limits. But flying the aircraft to the low-speed edges of the flight envelope instills plenty of confidence in its capabilities, should the need arise.

Weather conditions at destination airports can change radically during the course of a 16-hr. flight. At times, the weather at divert airports seems to deteriorate in keeping with Murphy's law. When clouds darken, turbulence kicks up and low-altitude wind shear arises, flight crews can feel confident in this aircraft's crisp control response and flight envelope protections. The jet seems capable of handling just about anything Mother Nature can throw at it, short of a black swan microburst or Texas tornado.

Few business aircraft we've flown in this class, indeed in any class, handle better at low speed than the Global 7500. However, size and stoutness still matter regarding permission to land and take off. There are many landing facilities that don't have pavement that's strong or wide enough to accommodate such large aircraft. The Global 7500 may be sufficiently nimble to navigate around storms and peaks in the Rockies, but it's not welcome at Aspen-Pitkin County Airport/Sardy Field (KASE) due to its 104-ft. wingspan. And it can circle to land tight-in at New Jersey's Teterboro Airport (KTEB) in stiff crosswinds, but it's prohibited from landing there because of its weight.

Bombardier has redefined expectations for large-cabin aircraft with this Global, spurring strong competition from Savannah and St. Cloud. Development of Gulfstream's four-section-cabin G700 is proceeding amain. Its net cabin size, speed and range will offer the Global 7500 hot competition. Lacking leading-edge slats, though, its low-speed performance won't be in the same league.

Later this year or in early 2021, Dassault is expected to launch the Falcon 9X, its largest, fastest, longest-flying business jet. It's expected to have the lightest weight airframe in class, along with full-span slats and digital flight controls. Thus, its low-speed handling should be unsurpassed. Meeting or beating best-in-class range and speed numbers will be its biggest challenge.

For now, however, the Global 7500 offers an unmatched blend of cabin comfort and convenience, speed and range, low-speed agility and handling ease. It's in the lead and others are running hard to catch it. BCA

Under Pressure

If you blow a cabin at mid-ocean, **can you make your alternate?**


JAMES ALBRIGHT

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

In the unlikely event of a cabin depressurization, supplemental oxygen is your best friend. Here, *BCA* contributor James Albright models a quick-don oxygen mask.

Oh, we humans, never content to remain on the earth that holds us down with its gravity and sustains us with oxygen-laden atmosphere to breathe.

No, as soon as we figured out how to ascend into that atmosphere, cheating gravity with hydrogen-filled balloons or artificial wings, we were compelled to claw our way ever higher into the thin, cold air of the stratosphere. But alas, fragile mammals that we are, we could not survive for long – let alone maintain consciousness to control our fabricated aerial conveyances. So we learned to take containers of our precious gravity-thickened atmosphere aloft with us to inhale through rubber hoses or to encase our bodies in suits and helmets pumped full of that life-fortifying gas.

In the early 1930s, record-setting aviator Wiley Post and Russell Colley of B.F. Goodrich Co. developed some of the first pressure suits — looking more like deep-sea diving rigs — for long-distance, high-altitude flights. Wearing one of these in 1934, Post achieved an altitude of 40,000 ft. over Chicago, piloting his famous Lockheed Vega *Winnie Mae*. Swaddled in his pressure suit on a subsequent flight, he climbed the Vega to 50,000 ft. and inadvertently discovered the jet stream.

Later in the decade, military aircraft were introduced that were powered by supercharged engines capable of routine flight into the mid-30,000s, where crewmembers breathed bottled oxygen and endured sub-zero temperatures wearing insulated flight suits. But for commercial transportation at high altitudes, to avoid weather and attain higher speeds, oxygen masks or pressure suits would be impractical for passengers, so an appropriate, comfortable cabin environment would be needed.

Perfecting the Pressurized Cabin

Boeing took on this challenge later in the decade and, with a pressurized cabin mated to the flying surfaces and engines of its B-17 Flying Fortress heavy bomber, produced the Model 307 Stratoliner, the world's first pressurized airliner. During World War II, the small number of 307s that had been produced for Pan American World Airways and Trans World Airlines was drafted into the Army Air Force as C-75 transports (sans the pressurization equipment to save weight). Meanwhile, Boeing lofted what it had learned in the program into the B-29 Superfortress, the world's first pressurized bomber, a quantum leap forward in aircraft design.

At war's end, Boeing once again leveraged a military design into a commercial airliner, using the B-29 airframe to create the double-decked KC-97 military transport/tanker and Model 377 Stratocruiser civil counterpart. Douglas and Lockheed quickly followed with, respectively, the DC-6 and -7 and Constellation pressurized piston-powered airliners, setting the stage for the emergence of the first-generation jetliners.

The British led the way with the de Havilland Comet, an aesthetic tour de force but initially plagued with a design flaw that led to metal fatigue in the upper fuselage from repeated pressurization and decompression cycles each time the plane flew. However, that aircraft initially had a design flaw causing metal fatigue in the upper fuselage from repeated pressurization and decompression cycles, which resulted in catastrophic decompression and inflight breakup of two Comets and loss of all on board. (A third crash occurred when a Comet was overstressed in violent weather and also broke apart in the air.) The ensuing investigations led to a fleet grounding and redesign of the type. Significantly, the effort also resulted in a major revision of the British Civil Aviation Authority certification rules, recasting the CAA as the most stringent aircraft approval agency in the world.

Meanwhile, Boeing spawned the iconic Model 707 from the KC-135 jet transport/tanker it had developed for the U.S. Air Force. And Douglas and Convair followed, certificating their contributions to the civil jet age, respectively, the DC-8 and 880/990. These transports were designed to cruise at altitudes up to 41,000 ft. for best efficiency of their turbojet engines, requiring robust and reliable cabin pressurization systems with differentials as high as 8.5 psi. In the early 1960s, the Lockheed JetStar, North American Sabreliner, Learjet 20/25, Beech King Air and Grumman Gulfstream debuted, bringing turbine-powered, high-altitude speed and pressurized comfort to business aviation.

Without cabin pressurization or supplemental oxygen to breathe at such altitudes, flight crews and passengers would quickly be overcome by hypoxia — oxygen starvation — followed rapidly by unconsciousness. Death would occur soon afterward. It is a tribute to designers and manufacturers of pressurization equipment (or "packs," when installed in airframes) that humans can routinely venture into the stratosphere, traveling in comfort at average 7,000-ft. cabin altitudes, while the outside air is unbreathable and ambient temperatures hover in the -60s F (-50s C).

Get Down — Fast!

While sudden cabin depressurizations in flight are rare, they can occur, and all pilots of aircraft built to climb and cruise above 12,500 ft. are trained to cope with them. The standard procedure for an unexpected loss of pressurization is an immediate and rapid descent to a lower altitude where aircraft occupants can breathe without emergency or supplemental oxygen, generally around 15,000 ft. However, some operators of turbine-powered equipment may choose a recovery altitude as high as 25,000 ft. for more favorable fuel burn on the way to an alternate.

In two-crew cockpits, one pilot will execute the descent while the other communicates with air traffic control to clear any aircraft flying below away from the descent area. With loss of cabin pressure below a predetermined value, emergency oxygen masks should drop from ceiling compartments above every seat in the cabin. Note that loss of cabin pressure and donning of emergency masks should be part of passenger briefings.

On March 9 of this year, a Southwest Airlines Boeing 737-300 on a fight from Las Vegas to Boise, Idaho, experienced a gradual loss of cabin pressure while cruising at 39,000 ft. Noting the pressure drop on cockpit instrumentation, the crew initiated a 6-min. descent to 22,000 ft. and continued uneventfully to the destination. Because the pressure loss was gradual and not catastrophic, the emergency oxygen masks did not deploy. A post-flight inspection of the aircraft revealed a 12-in. crack in the crown of the fuselage just aft of the cockpit. Southwest claimed the airframe had been inspected for skin cracks during the previous FAA-required 1,500-hr. airframe inspection interval. (Apparently, the fuselage crown — which experiences heavy slipstream pressure in flight — is a somewhat common area for fatigue cracks.)

The carrier, whose all-737 fleet logs high cycles (as many as five takeoffs and landings a day), is no stranger to cabin depressurization incidents. It experienced three rapid depressurizations in a 30-day period in 2018. The first occurred on April 17 when the left engine of a 737-700 threw a fan blade into the fuselage, killing a passenger in a window seat and depressurizing the cabin; the aircraft executed an emergency descent and landed at Philadelphia. On May 2, a 737 en route to Newark from Chicago was forced to make an unscheduled landing at Cleveland after the outer pane of a window cracked. And on May 12, a flight from Denver to Dallas experienced what the airline termed "a pressurization issue" with emergency oxygen masks dropping from ceiling compartments 30 min. before the flight landed at Dallas; some passengers experienced pain in their ears, and the crew radioed ahead for medical personnel to meet the flight.

In 2009, a Southwest 737 cruising at 35,000 ft. over West Virginia lost cabin pressure when the bond between two aluminum skin plates separated on the top of the fuselage; an emergency descent and unscheduled landing ensued. And in April 2011, an explosive decompression blew a 5-ft.-long hole in the roof of one of the airline's 737s flying from Phoenix to Sacramento, California. Passengers reported a loud bang and being able to see the sky through the oblong opening. Oxygen masks dropped as pilots initiated a rapid, controlled descent for an emergency landing at an Arizona military base. Fatigue cracks in the plane's skin were blamed for the failure.

Two of the most spectacular and horrifying airline depressurizations occurred in the late 1980s, both involving older Boeing airframes.

On April 28, 1988, Aloha Airlines Flight 243, a B737-200, was en route from Hilo to Honolulu, Hawaii, at 24,000 ft. when an explosive decompression caused an 18.5-ft. section of the top half of the fuselage from behind the cockpit to just forward of the wing to depart the aircraft. A flight attendant standing in the aisle was sucked from the aircraft. Looking over their shoulders to where the cockpit door had been, the flight crew could see blue sky. Controls were responsive, and the pilots immediately began a descent, steering the stricken aircraft to the nearest alternate, Kahului Airport on the island of Maui, performing a successful landing 13 min. after the fatal incident.

Emergency evacuation slides were deployed and the passengers and crew quickly evacuated the aircraft. Of the 94 survivors on the airplane, 65 were injured, eight of them seriously. The decompression occurred over open ocean, and the ill-fated flight attendant's body was never found; she had served for 37 years with Aloha.

> The Boeing's cargo door **blew out so explosively that it opened a gaping hole** in the cabin.

The 737-297 had been delivered to Aloha off the Boeing Renton, Washington, production line in 1969 and had logged 35,496 hr. However, due to the short-segment, high-cycle nature of Aloha's intra-island service, the B737 had experienced 89,680 cycles at the time of the decompression, more than twice the number of flights for which the aircraft was designed. It was considered to be irreparable and was dismantled on site.

The NTSB determined the cause of the explosive decompression was metal fatigue exacerbated by corrosion in a bonded lap joint in the upper fuselage skin. It is notable that the entire 19-year operational life of the aircraft had occurred in a high salt and humidity marine environment, rife for corrosion. The Safety Board also cited the fabrication process Boeing was employing at the time to bond 737 upper-fuselage sections, leading to a revision of the process whereby a doubler was applied over the lap joint that had failed in the subject aircraft. Aloha management was also cited for failure to properly supervise its maintenance department and correctly carry out required airframe inspections. The FAA also caught some blame for not requiring Airworthiness Directive 87-21-08, which directed inspection of 737 lap joints as per a Boeing Service Bulletin and a complete terminating action "after discovery of early production difficulties in the B737 cold-bond lap joint, which resulted in low bond durability, corrosion and premature fatigue cracking."

The second incident occurred 11 months later and involved a United Airlines Boeing 747-122 on a flight from Honolulu to Sydney with 337 passengers and 18 crewmembers aboard. As the aircraft was climbing out of PHNL and passing through 22,000 ft., the forward baggage door overcame its latching system and blew out so explosively that it slammed back against the fuselage on its hinges, opening a gaping hole and decompressing the cabin. The cabin floor caved in from the pressure differential, and 10 seats occupied by eight passengers were ejected from the hole; a ninth was sucked out from a seat still in the cabin. Engines three and four on the right wing suffered debris damage and eventually both had to be shut down. A flight attendant was nearly sucked out, too, but saved herself by hanging onto the aircraft's upper deck stairs until she could be pulled to safety.

The cockpit crew, assuming that a bomb had gone off in the hold, immediately began a descending left turn back to Honolulu. Because the right-wing flaps had been damaged and could only partially be deployed, the crew calculated a landing speed of between 190 and 200 kt. The landing was successful, and Capt. David Cronin was able to bring the big Boeing to a stop on the runway. All of the victims pulled out of the aircraft were lost at sea.

The 747 was manufactured in 1970, and at the time of the cargo door blow-out had accumulated 58,814 hr. and 15,028 cycles. The cargo door was eventually recovered by a robot submarine under 14,100 ft. of Pacific Ocean. An extensive two-part NTSB investigation (the second part was a reopening of the original investigation after the cargo door had been recovered) determined that the cause of the accident was "the sudden opening of the cargo door, which was attributed to improper wiring and deficiencies in the door's design. It appeared in this case that a short circuit caused an uncommanded rotation of the latch cams, which forced the weak locking sectors to distort and allow the rotation, thus enabling the pressure differential and aerodynamic forces to blow the door off the fuselage; ripping away the hinge fixing structure, the cabin floor and the side fuselage skin; and causing the decompression." The Safety Board recommended that locking systems for outward-opening cargo doors on this variant of the 747 be replaced and redesigned.

Notable Business Jet Failure

Business jets and pressurized turboprops have cabin pressurization lapses, but rarely. Probably the most tragic and arresting was the 1999 case involving a Learjet 35 chartered by professional golfer Payne Stewart and three colleagues for a flight from Orlando to Dallas. Climbing out on a northwesterly course with 4 hr. of fuel on board and a clearance to FL 390, Jacksonville Center lost radio contact with the aircraft as it passed through 23,000 ft. Then the Learjet failed to make a planned turn toward Dallas, climbing through its assigned altitude and ultimately reaching 48,900 ft. on its original course.

When repeated attempts to contact the flight crew went unacknowledged, controllers requested an Air Force F-16 pilot out of Eglin AFB who was flying nearby to intercept the Learjet and make a visual inspection. After also failing to receive a radioed response, the fighter pilot closed in on the Learjet and reported no visual anomalies with the aircraft; both engines were running, and the rotating beacon was activated. However, moving closer, the pilot noted that, while the cabin windows were dark, most of the cockpit panes were frosted over and he could see no movement inside the aircraft. Then he had to break away because of low fuel.

As the Learjet continued north, two more intercepts by Air

Guard F-16s from different states were carried out with no reported changes to the business jet or its behavior. By then, it was assumed that the Learjet's crew, and probably its passengers, had become incapacitated, probably from a cabin depressurization, that the aircraft was operating on autopilot, and that it would probably fly until its fuel ran out — or it was shot down so it wouldn't threaten a populated area like a city.

(During the aftermath of the event, Pentagon sources strongly denied that shooting down the errant Learjet was ever an option. However, the prime minister of Canada did authorize the Royal Canadian Air Force to destroy the Lear if it entered Canadian airspace, as its unwavering course would have taken it directly to Winnipeg.)

In the end, the Lear exhausted its fuel over South Dakota. When the autopilot began pulling the aircraft's nose up, attempting to maintain altitude, the stick shaker, sensing an incipient stall, disconnected it, sending the Learjet out of control and nearly reaching supersonic speed as it spiraled down into an open field. The two pilots and four passengers aboard either succumbed early in the flight or died in the crash. The Lear had traversed 1,500 sm in just under 4 hr.

The subsequent NTSB investigation assumed that the Lear 35 had suffered a cabin depressurization and that occupants had died from hypoxia. But a definitive cause of the decompression was elusive. Impacting the ground at a steep angle, little was left of the aircraft that could determine exactly what had caused the cabin depressurization or the nature of it — a rapid decompression or a very subtle leak-out of the pressure vessel. As there was no evidence of a breach, based on the visual inspections of the F-16 pilots, logic tended to support the latter possibility, a gradual loss of pressure and stabilization of the cabin altitude to that outside the airplane.

Why No Supplemental OX

A blown seal somewhere or a faulty flow control valve could have caused a subtle drop-off. Considerable testing by the NTSB supported the premise that a closed flow control valve could cause complete depressurization over a period of several minutes. Then, consider the Learjet 35's location of the cabin pressure gauge and associated controls at the bottom left-hand corner of the first officer's panel — *i.e.,* hidden behind an average human's knee and not within the usual scan pattern. The crew could have missed the gauge's unwinding until the falling oxygen levels had impaired their cognitive abilities to the point where they couldn't respond to the cabin altitude alert or don their supplemental oxygen masks.

Tests showed it would take only a few minutes for cognitive abilities to be compromised. From the NTSB accident report: "If there had been a breach in the fuselage (even a small one that could not be visually detected by the inflight observers) or a seal failure, the cabin could have depressurized gradually, rapidly, or even explosively. Research has shown that a period of as little as 8 sec. without supplemental oxygen following rapid depressurization to about 30,000 ft. may cause a drop in oxygen saturation that can significantly impair cognitive functioning and increase the amount of time required to complete complex tasks."

Finally, it is noteworthy that the Learjet 35's operator had documented several instances of maintenance on the aircraft's pressurization system leading up to the accident. The NTSB, however, was never able to substantially verify that any act of maintenance or specific component in the pressurization system was responsible for the loss of cabin pressure, *i.e.,* that "nothing stemmed from a common problem." Its stated probable cause of the mishap was "incapacitation of the flight crewmembers as a result of their failure to receive supplemental oxygen following a loss of cabin pressurization, for undetermined reasons."


CIT

In as little as eight seconds after a cabin depressurization at jet cruising altitudes, cognitive functions can be impaired. The drill — always — is first, don supplemental oxygen masks.

Another depressurization incident involving a Learjet 35 about a decade earlier had a much happier outcome for Joe Hotkewicz, who currently captains an intercontinental business jet for a corporate flight department. His tale began with a takeoff from a New Jersey airport in the Learjet 35, filed for Charlotte, North Carolina. "We were climbing to the southeast for our assigned cruising altitude of 39,000 ft. when I felt something in my ears — a clicking — as we passed through FL 330."

Simultaneously, Hotkewicz and his copilot noted the cabin altitude was rising at 2,000 fpm and knew immediately what was happening. "In rapid succession, we donned our oxygen masks, radioed ATC, and I initiated a descent to 10,000 ft., which took about 2.5 min.," he said. "This happened about halfway through the trip, and we continued on to Charlotte for a routine landing."

Hotkewicz had six passengers aboard the Lear that day. "We were lucky. This was my first flight in a Learjet. I had just completed type training, and our chief pilot was riding the jump seat as check airman, and he handled the people in the back. The emergency oxygen masks correctly deployed in the cabin."

Later, Hotkewicz learned that the depressurization had been caused when ducting for the bleed air from the engines had come apart, and the hot air was blowing into the "hellhole," the aft services compartment between the engines. Further, the point where the break occurred was in contact with a wiring bundle, and the hot air was melting the insulation on the wires.

A Happier Ending . . .

Another business jet depressurization, this one affecting a Dassault Falcon 2000 in 2018, was the progeny of a collection of multiple incidents that began with a ferry of the airplane from a southern city to Teterboro, New Jersey. Our narrator, who asked for anonymity, accepted the airplane for a trip to Europe with planned multiple stops. "On the ferry," he said, "the crew had a pressurization problem that they isolated to the auto controller." They transferred the system to manual mode, and that kept the cabin where it should have been.

"Then I picked the trip up," the narrator continued, "and we headed for Biggin Hill outside of London, and everything went fine. We made several stops in Europe without incident, and then, going from Avion to Bordeaux with three passengers aboard, the same problem with the pressurization system auto controller came up again during the climb out. We went through the checklist, isolated the auto controller, and adjusted the cabin with the manual controller. We landed at Bordeaux — site of the Falcon factory — but there was no one there to work on it, so we then headed to our next destination, Oslo, and everything worked great including the auto controller."

The final destination of the Falcon 2000 was back in the U.S. in Colorado, "so just to be safe and ensure we would have alternates we could make if we had to do a rapid descent to a low altitude," the narrator explained, "we took a northerly route over Iceland, Greenland and Frobisher Bay. It was a great circle route that was better anyway, and presented lots of alternates in case we would have needed any." (Note the selection of the route for access to good alternates in the event of a depressurization.)

For Further Reading . . .

"Captain Eddie," proprietor of the "Code 7700" website and *BCA* contributor James Albright's nom de cyber, offers two commentaries on rapid cabin depressurization well worth the reading.

The first is a detailed primer on the structure of the atmosphere, flight physiology after loss of pressurization, tips on oxygen masks, timing the descent, and more. It can be found at **http://code7700.com/rapid_depressurization.htm**

The second is a fable on cockpit leadership and the wages of fooling around with pressurization controls when you don't know what you're doing: **http://code7700.com/1984_rapid_depressurization.htm** **BCA**

Supplemental Oxygen: It Can Save Your Life

The FARs and ICAO generally align regarding supplemental oxygen, and once inside of ICAO Annex 6, there is a virtual reprint from the commercial side (Part 1) to the general aviation side (Part 2) which specifies that life-sustaining oxygen for a rapid descent is as critical as the fuel to get to a runway.

Part 91.211 discusses the same thing: supplemental oxygen for a general aviation operation. (The FAA published a change to Part 121.329 specifying that now, if one pilot leaves his or her station above FL 410, as opposed to FL 250 (the previous limit), the other has to put on a quick donning mask [which may seem counterintuitive].)

Just remember that the cumbersome quick-don supplemental oxygen mask is your best friend if you're unfortunate enough to blow a cabin. **BCA**

Still another pilot *BCA* interviewed experienced a catastrophic depressurization on a ferry flight in the Southwest U.S. during the last century when a baggage door blew out on a first-generation business jet at cruising altitude. "The first thing I remember," he said, "was how cold it got in the airplane." The crew and a third pilot riding in the jump seat immediately donned emergency (supplemental) oxygen masks, alerted ATC, descended to an altitude with breathable air and then executed a safe emergency landing.

Every cockpit crew of an aircraft that operates into the stratospheric altitudes must take the possibility of a cabin depressurization into consideration in their flight planning, *i.e.,* where will you go if you have to descend into lower altitudes with consequent fuel consumption issues. This consideration is paramount in long-range flights across remote regions of the planet.

Can You Make the Alternate?

Here is the premise of this discussion: How do you plan "suitable" alternates to accommodate loss of cabin pressure on very-long-range flights over remote areas, such as the North Pacific? Loss of cabin pressure is insidious: For the survival of all on board, you have no choice but to go down — and as we've seen, the faster the better. The drill: Don supplemental oxygen masks, 45-deg. turn off course, inform ATC, and descend like a stone to get down to an altitude where you can breathe without the aid of bottled oxygen.

"It is easy to see where vast expanses of ocean like the Pacific can be problematic in alternate selection," Guy Gribble, president, International Flight Resources, a training consultancy, observed. "Then, too, there are continental regions that can be thought of as 'dry oceans,' — for example, Western China, Eastern Russia, the Amazon Basin, the Australian Outback and the trans-polar routes that were opened up only a couple decades ago." These unique regional conditions must be evaluated for hazards demanding conscious risk-mitigation measures for acceptable remote alternate airport selection. "It goes without saying that over open ocean like the South Atlantic and Pacific," Gribble pointed out, provocatively, "your aircraft simply has to have the range to get to a runway in the event of a contingency."

Added Mitch Launius, of 30 West International Procedures Training, "The Pacific is challenging, but so is northern Russia, and particularly so are polar operations. There are places to land but the options are poor. People with medical problems can die on the ground because medical facilities are so far away." All this has to be considered in the selection of alternates.

So, when it comes to alternates and long-range flights, the more planning the better, Gribble, a retired American Airlines widebody captain, insists. "The PIC must be involved early in the process by engaging the flight planning service's experience and forecasting ability. Operating pilots need to set the priorities and define the acceptable conditions for alternate selection from the start. This can be refined closer to departure time. This is not as simple as having an airfield nominated by a handling service and an equal time point [ETP] calculated for you."

Launius agreed. "Equal time points are what this is all about. Planning should be done under the advisement of the crew — it's only a math problem for the flight planning agencies. It should involve more than just the minimums that are required to make this work. Select an altitude for what would be safe

Auto Emergency Descents: Watch Out Below

Auto emergency descent is a standard function on newer jets that have the ability to cruise in the high flight levels.

Research has shown that 80% of pilots with no experience of rapid/explosive decompression wait as long as 15 sec. to respond correctly to a loss of cabin pressure. Thus, auto emergency descent is a feature intended to help solve the physiological and response problem in the event of a rapid or explosive cabin depressurization. But auto emergency descent does not solve the procedural problems and can actually create traffic avoidance challenges.

In the automatic mode, the plane senses that the cabin altitude is out of control (from a cabin breach, a pressurization controller that has failed, dual pack failure, etc.), and executes a turn off course of 45 deg. with a 30-deg. bank and 25-deg. pitch-down. "This does not take into account the actual traffic or terrain situation in the operating environment," Guy Gribble, president of International Flight Resources, warned. "Nothing in the software will separate you from another aircraft except a TCAS/ACAS resolution advisory [RA] and a pilot responding to the alert," he said. "There needs to be an awareness item in the operator's operations manual or safety management system [SMS] that the pilot has to make the decision in place of automation.

"Displacement from other aircraft is the key factor in ensuring the greatest level of safety within the functionality of auto emergency descent," Gribble continued. "If you are operating on a random route, the threat level is somewhat reduced on the assumption that a random route is displaced widely from other aircraft operating in the region."

But this may not always be the case; for example, a mirror image of an organized track system (OTS) route on a non-published altitude in the track message. Obviously, cruising on such a route would require heightened awareness among the cockpit crew. When operating in (or over) an organized track system, the safety analysis assumptions are that cognizant pilots are physically alert and situationally aware enough to intervene to avoid midair collision hazards during the descent. This is especially important when in a reduced-lateral-separation situation. "Pilots simply do not have the same amount of time to decide and react to traffic while descending at an emergency rate," Gribble observed.

"Procedurally, auto emergency descent may not always be the most compliant course of action," he pointed out. "In NAT HLA [North Atlantic High-Level Airspace] and Western New York OCA [Obstacle Clearance Altitude], modified ICAO contingency procedures have been implemented as published in Document No. 7030. The turn off the track is now 30 deg., and the lateral offset is 5 nm in place of the standard 45 deg./15 nm that is programmed into the auto emergency descent functions." **BCA**

for your passengers, plan diversions to fields with appropriate medical capabilities. It's our business to know what the best choices are and not just accept what the planners give you."

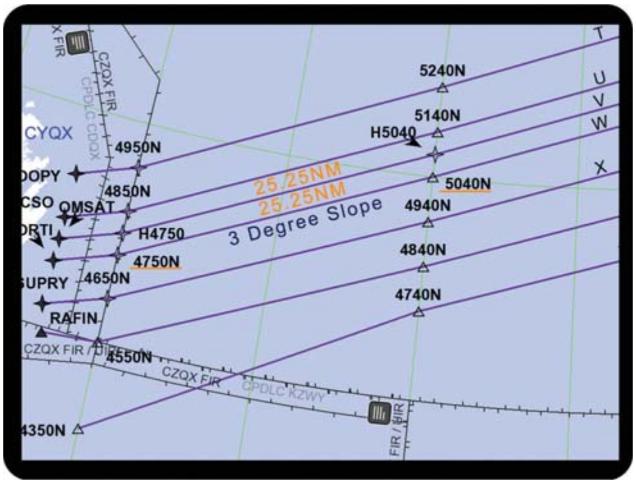
Questions on the runway condition, length and airport services should play a role when selecting an alternate. What is the runway condition? Is it long enough? What are the surface conditions? ("The really important piece," to Gribble.) Is there a displaced threshold? Is runway maintenance in progress? "Be aware that a Landing Runway Condition Assessment [LRCA] prior to approach, originally a commercial ops requirement, is now a requirement under Part 91, as per SAFO 19001," Gribble reminded operators. "EASA has the same thing via ICAO, effective November 2020. If you slide off the runway some place, the regulating authorities will want documentation that you had done the assessment [e.g., field condition reports via the FICOM NOTAMs — see AC 25-32 for details]."

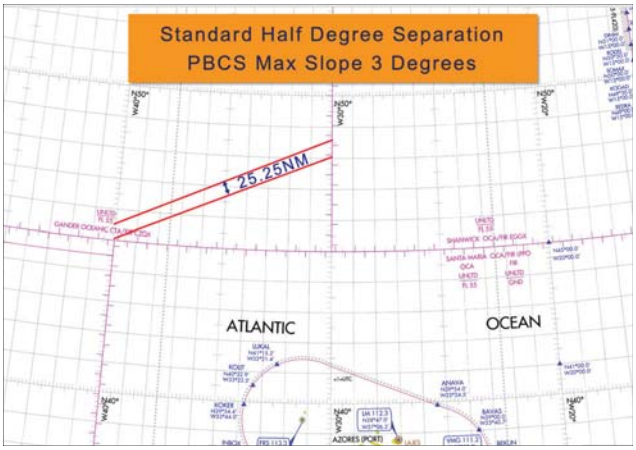
Know Your Runway

And once you get to that runway, you have to know whether you can you stop the airplane. "Consider, for example," Gribble pointed out, "that in the Amazon Basin, some runways can be covered with a green fungus activated after the frequent rainfalls that characterize this tropical region. This makes for a temporarily super-slick runway surface." Another consideration: Once safely stopped on the runway, what is your next move? Is there a parallel taxiway to the ramp or is a back taxi on the runway required? On the ramp, is there parking available and is the surface sufficiently "hard," *i.e.,* what is the Pavement Classification Number (PCN)? Is it enough to support your aircraft weight and wheel configuration, the Aircraft Classification Number (ACN)?

There may not be ramp service, fuel available or a hotel on or near the field. Most en route diverts are driven by medical concerns for the crew or passengers. So what kind of medical services are available on or near the airfield? Consider the fact that first aid or emergency medical service (EMS) at a commercially served airport is only on duty for the commercial flight service. And once that last commercial flight has landed safely, those services are closed, and the personnel manning them go home. In most austere regions, the availability of a fully staffed trauma center will be non-existent or a long drive or ambulance ride away in the closest city. Now, compare this to a hypothetical onboard medical response you may have and the transit time to a full-service trauma center at a different alternate airport option.

"It is equally important to consider cultural issues," Gribble reminded operators. "Many remote regions are especially





An example of "sloped tracks" in an Organized Track System (in this example, an inset of the NATs just east of Gander), showing how as tracks are angled in relation to meridians of longitude, the distance between them decreases from the standard lateral separation of 30 nm. Imagine threading the needle in a rapid emergency descent between a stack of tracks like this populated by aircraft ten minutes in trail at 1,000 ft. vertical separation between FL 280 and FL 410.

sensitive to religious and political orientations. Ongoing armed conflicts can impede expedited travel to a safe harbor of an en route divert airfield. These issues rarely offer any latitude for exceptions and are ever-changing with the local political system. This makes for a dynamic and ongoing security evaluation across planning and en route phases of the trip."

Consider the Descent

The emergency descent demands consideration, also. "The underlying issues concerning rapid emergency descents are oxygen, or the lack of it, and terrain, too much of it," Gribble cautioned. "While a reasonably healthy person may be able to endure a cabin depressurization and the subsequent rapid descent, the experience may not be the same for someone who is 'pneumatically challenged' with a condition like COPD, asthma or the effects of heavy smoking." Other factors can include obesity, advanced age and lack of fitness.

According to Launius, "Depressurization, if it's bad, can lead to situations that require medical attention — anything above 15,000 ft. exasperates that, and some operators use 25,000 ft. as their descent altitude for better fuel burn.

"Medical problems can appear in more ways than you can imagine," he continued, "gastronomic, dental, anxiety, the bends. Most people don't know the effects of flying a non-pressurized airplane at those lower altitudes. I've seen companies that plan for depressurization ETPs at 25,000 ft. for extended periods of time in an effort to meet fuel requirements."

Scuba diving and recent blood donations exacerbate the physiological problems of cabin depressurization. A 24-hr. waiting period is generally accepted as the limitation for scuba diving; for blood donations, it's up to three days. Of course, this will vary with individual health and fitness conditions. Following a scuba dive without at least a 24-hr. pause, in the event of a depressurization incident and subsequent rapid descent, there is a significant risk of encountering the bends, a condition known to divers where the dissolved nitrogen in the blood begins bubbling out of the circulatory system. And at the higher altitudes that some airplanes can fly today, without cabin pressurization, the diver's blood can actually boil.

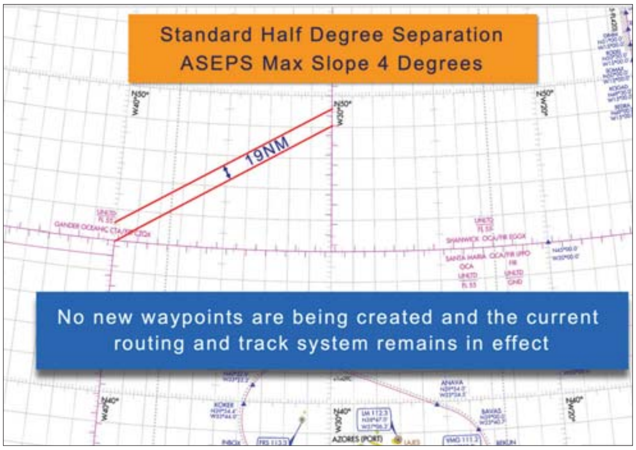
Exactly how you conduct the descent depends on the airspace in which you are flying. Take, for example, operating in an organized track system, such as the North Atlantic Track System (NATS) or Pacific Organized Track System (PACOTS). This is high-density airspace, and depending on your assigned flight level, there will generally be aircraft flying below you at 1,000-ft. vertical separations and to either side (if you are on an inside track), now at reduced lateral separation.

When lateral separation was 60 nm (or 1 deg.), the procedure for initiating a rapid descent was to turn either left or right from the assigned track 45 deg. and then begin the descent while informing the relevant air traffic manager of your intentions. But now that lateral separation has been halved to 30 nm (0.5 deg.), the cut from the assigned heading has been correspondingly reduced to 30 deg. Note that this does not leave a lot of room for maneuvering. Launius points out that "if a track has a 'slope' [*i.e.,* angled in relation to the meridians of longitude], separation can be as close as 19 nm in some instances!"

The tracks are stacked as high as FL 410, but many business jets are certificated to fly well above that, and operators often elect to overfly the tracks, cutting across them at an angle — or will even "shadow" individual tracks. The lesson here is to always know what is below you, so make sure your planning chart shows the track array for the 12-hr. period in which you are operating and that you know your position relative to the tracks. This way, if you have to go down in a hurry, you'll be able to make the descent between the tracks.

Terrain is a constant threat in executing a rapid descent to breathable air. "This requires pilots to be familiar with the definitions of MOCAs, MORAs and MEAs and their location relative to the aircraft's position," Gribble said. "How do I get to a safe altitude along this route to an alternate? This is as basic a requirement as looking for forced landing spots during primary flight training."

A direct route from your present location to a diversion airport is not always possible due to terrain limitations. In such cases, a series of intermediate waypoints needs to be included in flight planning to delineate a suggested safe routing from a planned position to a diversion airport. "Keep in mind that it does little to plan a perfect terrain avoidance model at a higher-than-normal emergency descent altitude only to run out of



supplemental oxygen for the passengers and possibly the crew part way to the alternate," Gribble chided. "The same can be said of fuel consumption."

Extended Range Ops and Alternates

Business aviation pilots operating under FAR Part 91 could learn a lot from the commercial world's ETOPS, or Extended-Range Twin-Engine Operational Performance Standards. "There is a direct correlation with overwater and remote continental alternate selection for all operators, commercial or private," Gribble asserted. "In either case, the concept of 'suitable' versus 'adequate' airports applies. An adequate airport is one that has a runway; a suitable airport is one where you can approach, land and stop and which has services available. An adequate airport may not have approach and runway lights or crash-fire rescue, but a suitable one would have these items. Suitable airports also have passenger facilities with enough room and temperature control to accommodate everyone on your aircraft." In some cases, a passenger recovery plan needs to be planned and supported before operating with a particular airport listed as an alternate.

Another ETOPS concept applicable here is the "validity period," the time window during which a designated alternate should be evaluated for landing purposes. This means that the earliest to latest arrival times are defined by the descent/diversion flight profile. The applicable time window should consider the earliest to latest expected arrival times for each en route alternate aerodrome based on the planned departure time. The validity period for a given alternate is typically determined based on a diversion from the first and last ETPs for the alternate.

And of course, weather at the alternate and on the flight there has to be planned for. "Weather planning factors help to define the suitable airfield from the adequate airfield," Gribble said. "This is to allow for the potential of deteriorating weather conditions after the flight has commenced. Conditional forecast elements may also be defined — for example, a PROB 40 or TEMPO condition below the lowest applicable operating minima is normally taken into account."

Once the operator diverts from the planned destination and heads to the alternate, the operator's planning minimums dissolve, the alternate then becomes the new destination, and the published minimums of the alternate become the controlling factor. "There are planning factors based on how many runways and nav facilities are available; extended-range ops addresses this," Gribble explained.

Inside the criteria for extended-range ops, "one piece of landing surface concrete with one navigation facility would require published minimums plus 400-ft. ceiling and published visibility plus 1 mi. to list this as a 'suitable' alternate," he continued. "With no other guidance or insight, this would be a good place to start from as a reference point for Part 91 ops. Runway count points up another age-old question: With just one landing surface, is this one runway or two? Compare FAA OpsSpec C055 to ICAO Doc 9976 Flight Planning and Fuel Management (FPFM) manual." When it comes to destination alternates, it's easy to see that the basic idea from the standpoint of the FAA is that one landing surface is defined as two runways. But from the standpoint of ICAO, destination alternates will need two separate landing surfaces.

With two navigation facilities, the operator can reduce the weather planning fudge factor to published minimums plus 200-ft. ceiling and visibility plus 0.5 mi. "From this point, operating pilots need to loop back and consider the runway involved and tailwind/crosswind limitations," Gribble said. "The lowest minimums published may not be for the runway you want to land on based on local wind conditions. This will drive you from a precision approach at 200 and a half to a non-precision approach at 600 and two."

What about emergencies other than depressurizations? What happens if your airplane is on fire? "And that's a whole other conversation," Launius said. "Nothing else matters but getting on the ground. If you are on a long-range flight, some choices for a fire or an engine inop are more acceptable than those for a medical diversion in which you are looking for something more. The flight planners are not going to give you a tier of alternates; it's up to you to go beyond what they give you for the situations that you might encounter. When you're putting together your flight, you need to make your own tier of alternates, some for medical diverts and others for pure emergencies like engine loss, smoke and fumes, or an outright fire."

The alternate becomes the new destination, and its published minimums become the operation's controlling factor.

There comes a time in long-range flight planning where, no matter the range capability of your aircraft, the austerity of your route will not support the necessity for accessible alternates in the event of a cabin depressurization — or other contingency. "The solution is often available," Launius offered: "Plan an additional stop for fuel or a route that is not as direct. Using the polar example, you could take a more southerly route with lots of good alternates, but it will add 1:30 to the duration of the trip. We are pushing business jets with 6,500-nm range on routes with very limited options, like the polar routes. The airlines have longer-range aircraft and are not as concerned about it. An effective medical divert is what we're talking about." **BCA**

Mountain Wave Monsters

The **most intense turbulence** produced by Mother Nature

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

With a wingspan of nearly 200 ft. and max takeoff weight in excess of 700,000 lb., a Boeing 747-100 is not easily disturbed by turbulence. Imagine then being at the controls of a heavily loaded one during departure from Anchorage International Airport (PANC) on March 31, 1993, when extreme turbulence abruptly rolled the aircraft 50 deg. to the left, followed by a significant yaw. Several pitch and roll oscillations followed as the pilots struggled to maintain control of the lumbering giant.

The severe turbulence induced dynamic lateral load that so exceeded the load-carrying capability of the No. 2 engine pylon that it ripped completely from the jumbo. The flight crew declared an emergency, dumped a lot of fuel and returned to PANC for an emergency landing.

The NTSB's investigation determined that the strong rolling motions induced by the atmospheric turbulence produced "multi-axial" loading that caused structural failure of the pylon.

That wasn't the first time that a rugged commercial airliner experienced severe structural failure due to atmospheric turbulence. On March 5, 1966, British Overseas Airways Corporation Flight 911, a Boeing 707, departed Tokyo's International Airport destined for Hong Kong. The flight crew requested a visual meteorological conditions (VMC) climb westbound via the Fuji-Rebel-Kushimoto waypoints, which would take the Boeing nearer to Mount Fuji, possibly to give the passengers a better view of the landmark. The request was granted.

After takeoff, the aircraft made a continuous climbing right turn over Tokyo Bay, and rolled out on a southwest heading, passing north of Odawara. It then turned right again toward the mountain, flying over Gotenba, at an indicated airspeed of 320 to 370 kt., and an altitude of approximately 4,900 meters (16,000 ft.), well above the 3,776-meter (12,388 ft.) mountain peak.

Winds at the summit of Mount Fuji were measured at 60 to 70 kt. from the northwest. While flying into the wind, approaching Mount Fuji from the downwind side, the aircraft encountered severe clear air turbulence (CAT) associated with lee waves. Subsequent investigation determined that the vertical stabilizer failed first, which then broke the left-side horizontal stabilizer as it departed in a left and down motion. Shortly thereafter the right wing failed upward and completely separated from the aircraft. The four engine pylons, ventral fin and forward fuselage also failed from a leftward over-stress, and each eventually departed the aircraft during the inflight break-up.

All 113 passengers and 11 crewmembers were killed in the disaster. The official investigation determined the probable cause as, "The aircraft suddenly encountered abnormally severe turbulence which imposed a gust load considerably in excess of the design limit."

A U.S. Navy A-4 Skyhawk was sent up shortly after the accident to search for the wreckage and encountered extreme turbulence in the accident area. The cockpit accelerometer display registered peak values of +9 and -4 Gs, causing temporary loss of control, and leading the Navy pilot to believe his fighter would also break up in the turbulence. He regained control and landed safely, but the aircraft was grounded for post-flight inspection. Many other aircraft that passed near Mount Fuji that day also reported moderate to severe turbulence.

Atmospheric rotors pose a great hazard to aviation. The World Meteorological Organization's "Aviation Aspects of Mountain Waves" states the turbulence contained within mountain wave rotors is worse than that experienced by atmospheric research pilots in thunderstorms!

COMET PROGRAM/NOAA (2)

Clouds associated with mountain waves.

NTSB records from 1990 to 2017 contain 42 accidents in which mountain wave turbulence was a primary contributing factor. Rotor turbulence was so severe in numerous accidents that it caused the inflight break-up of the aircraft. (See "Turbulence Tragedies" sidebar.) Additionally, the extreme rotor

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turbulence can make aircraft control impossible. A search of the NTSB database found 16 fatal "Loss of Control" accidents attributed to the turbulence during mountain wave encounters.

The FAA's Airplane Upset Recovery Training Aid states, "Turbulence, when extreme, can lead to airplane upsets, and/or structural damage. These incidents of turbulence can cause large airspeed, altitude or attitude deviations. The aircraft may be momentarily out of control. Severe or extreme turbulence can be associated with clear air turbulence and mountain waves." It also states, "Moderate turbulence will be experienced 150-300 miles downwind on the leeward side when the wind component of 25-50 knots at ridge level. Severe turbulence can be expected in mountainous areas where wind components exceeding 50 knots are perpendicular to and near ridge level."

Extreme turbulence is defined as the "aircraft is violently tossed about and is practically impossible to control. Structural damage may occur. Rapid fluctuations of 25 knots or greater will be experienced. Vertical gusts equal to 50 fps or greater will be encountered. The most frequent locations of extreme turbulence are found in mountain wave rotors and severe thunderstorms."

And according to the "Aviation Aspects of Mountain Waves," "rotor turbulence is much more intense in waves generated by larger mountains. Violent sharp-edged gusts exceeding 12 m/s (approximately 2,362 fpm) have been measured in some Sierra waves, and experienced pilots have reported complete loss of control of their aircraft for short periods of time while flying in the rotor areas."

Some of the earliest scientific data on rotor turbulence came from the Jet Stream Project, overseen by Dr. Joachim P. Kuettner, an avid soaring enthusiast who was a scientist at the U.S. Air Force Cambridge Research Center in 1955. The project used B-29 and B-47 aircraft as well as specially designed Pratt-Read gliders built to tolerate 8 to 10 Gs to study the atmospheric motions within mountain waves. One flight assignment had project pilot Larry Edgar tasked with descending through a "roll cloud" in a spectacular mountain wave near Bishop, California.

As Edgar's glider descended through 14,000 ft., it encountered a very severe and turbulent gust, extreme yawing and rolling forces. Positive Gs were so extreme as to cause failure of the left wing at the mid-aileron point, producing a high rate of roll to the left. The high negative Gs built up to the point that they caused damage to Edgar's eyes. Then the left wing failed completely, causing even more rapid rolling. The load factors created were so adverse that the glider's nose section broke free from the rest of the structure. It is estimated the glider encountered approximately 16 Gs! Despite all that, Edgar managed to bail out of his disintegrating craft and float safely to the ground, having suffered only bruises.

This and other early research projects helped with understanding "classic" mountain waves in which the rotor is present underneath each wave crest. Most of our modern aviation

Turbulence Tragedies

Dec. 10, 2015, Hurricane, Utah
Aircraft: RV-7
Injuries: 2 Fatal

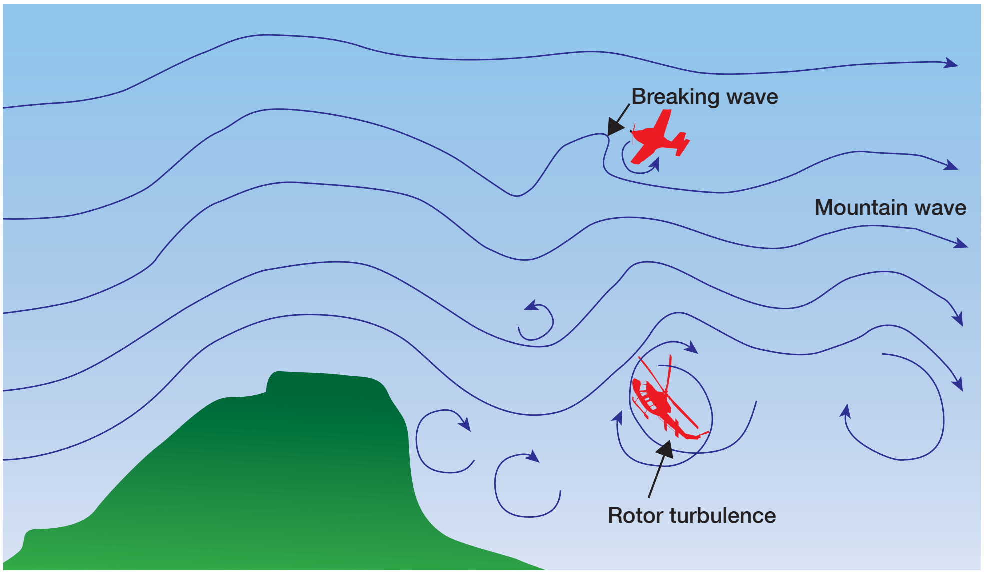
The ATP was conducting a local personal flight. Witnesses observed airplane debris floating in the air. Post-accident examination revealed extensive damage to the horizontal stabilizers, elevators and wings consistent with overloading. A review of the weather information indicates that there were likely low-level winds gusting from 26 to 46 kt. at the time of the accident and that moderate to severe turbulence likely existed at the accident site. The NTSB determined the pilot's abrupt flight control inputs in severe winds and turbulence resulted in an inflight breakup.

May 11, 2005, Ouray, Colorado
Aircraft: Cessna T210
Injuries: 4 Fatal

The airplane was reported missing and the Civil Air Patrol located the wreckage near Mount Whitehouse. National track analysis program radar data depicted the accident flight's altitude varied from 17,500 ft. MSL to 19,200 ft. MSL. The aircraft ground speed during this time was measured to vary between 124 kt. and 314 kt. An airman's meteorological information (AIRMET) for occasional moderate turbulence below FL 180 was valid. In addition, an AIRMET for occasional moderate turbulence between FL 180 and FL 410 and possible mountain wave action had been issued. The NTSB determined the probable causes of this accident were the pilot's inadvertent flight into adverse weather conditions, loss of control and resulting exceedence of the design stress limits of the aircraft, which led to an inflight structural failure. Factors in the accident included the severe turbulence and the mountain wave.

Aug. 19, 2001, near Mount Archer, Queensland, Australia
Aircraft: Agusta 47G
Injuries: 1 Fatal

According to the Australian Transport Safety Bureau, the pilot of an Agusta 47G was fatally injured when he lost control of the helicopter after encountering severe mountain turbulence on the northeast slope of Mount Archer. "The extensive damage to the helicopter, severed tailboom and the location of parts on the ground led transport safety investigators to conclude that the main rotor blade may have contacted the tailboom in flight. This type of damage was consistent with flying into mountain wave turbulence, and may have occurred from one of two events: blade flapping (divergence of the main rotor blade from its normal plane of rotation encountered during severe turbulence) or the pilot's instinctive reaction to pull up after a sudden nose-down pitch. . . .Weather conditions at the time were conducive to mountain waves." BCA training texts contain pictures of this configuration. These "classic" waves contain what some researchers categorize as Type 1 rotors. Such rotors are frequently recognizable by rough appearing fracto-cumulus cloud lines that form parallel to a mountain range when sufficient moisture exists in the atmosphere. Rotor clouds are constantly forming on the upwind side and dissipating on the leeward side. The transition from the smooth air in the updrafts and downdrafts to the extreme turbulence of the rotor section is often very rapid.



SOURCE: FLIGHT SAFETY AUSTRALIA

Hypothetical air flow pattern associated with a mountain wave.

More recent research aided with advanced instrumentation has helped us understand rotors that rise to much higher altitudes. Research pilots with the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, have studied mountainous airflows for several decades with specially instrumented aircraft to measure the turbulence. In a 1992 experiment, the NCAR Sabreliner experienced severe turbulence at 20,000 ft., 30,000 ft. and 39,000 ft. The unit's Queen Air along with the Sabreliner encountered severe turbulence at all levels below 15,000 ft. They encountered frequent 2- to 4-G gusts, both horizontal and vertical, in rotors. On one occasion a gust produced a 7-G load factor on the aircraft. Surface winds in Boulder exceeded 100 kt. in some locations and the NCAR hangar at nearby Rocky Mountain Metropolitan Airport (KBJC) was severely damaged in an infamous Front Range windstorm. The conditions airborne were even more extreme. Two DC-8s flying over the Front Range experienced temporary losses of control due to the turbulence, and one of them suffered structural damage.

A collaborative group of scientists and organizations has sought to better forecast conditions that create this extreme turbulence. The Sierra Rotors Project was the first phase of a coordinated multi-year effort to study atmospheric rotors and related phenomena in complex terrain. It was a joint National Science Foundation funded project involving the Desert Research Institute, Naval Research Laboratory, Universities of Washington, Utah, Wyoming and Arizona State, the British Met Office, the Army Research Laboratory, the Air Force Research Laboratory, along with the NCAR. The second phase of the project was the recently completed Terrain-Induced Rotor Experiment — nicknamed "T-Rex," which seems fitting given the ferocity of the subject matter being studied.

The team of some 60 scientists hoped to improve the understanding and predictability of CAT caused by complex terrain. The knowledge gained should help forecasters predict when and where rotors are most likely to occur and their intensity, as well as the nature of the mountain waves that crest high above the rotors and cause strong turbulence.

The field activities focused on the Owens Valley to the east of the southern Sierra Nevada, which is the tallest and steepest topographic barrier in the contiguous U.S. The ridgeline of the Sierra Nevada reaches an average elevation of 11,500 ft. MSL, and the tallest peaks exceed 13,100 ft. MSL, including the tallest mountain in the contiguous U.S., 14,505-ft. MSL Mount Whitney. In contrast to the tallest peaks, the valley floor lies at an average elevation of approximately 3,770 ft. MSL. This elevation change occurs in less than 5.5 nm of distance, resulting in 30% eastern facing slopes. Soaring enthusiasts and atmospheric researchers have long known that the mountain waves and attendant rotors can reach particularly striking amplitude and strength there.

The researchers took advantage of the newest advances in remote sensing and numerical modeling. On the ground, they probed the atmosphere with radars, lidars (laser-based radars), automated weather stations, wind profilers and balloons. Those aboard special aircraft including a modified Gulfstream V observed the rotors from above and released dropsondes (instruments that contain temperature, wind and other sensors) into the most turbulent areas. Two other aircraft, the University of Wyoming's King Air 200T and the U.K. Environmental Research Council's BAe146, flew at lower elevations, gathering data by aiming special radars into the rotors.

The $81.5 million Gulfstream, owned by the National Science Foundation and operated by the NCAR, is nicknamed HIAPER, for High-performance Instrumented Airborne Platform for Environmental Research. During the T-Rex project it departed from its base at KBJC to California's Owens Valley for 10-hr. flights during the project's observation periods.

What follows are some of the project's more notable findings: The strongest wave events were found to be associated with (1) an upper-level pressure trough along the Pacific Coast with strong westerly flow across the Sierras and (2) a cold or occluded front approaching California from the northwest, in particular in the pre-frontal stage over the Owens Valley. In addition, the jet stream was typically found to cross Oregon or Northern California during strong wave events. The strongest waves were also correlated with strong winds at the mountain crest level, a pronounced inversion layer and large vertical shear in the lower troposphere.

James Doyle, of the Naval Research Laboratory, and Dale Durran, of the University of Washington, in a paper titled

"Rotor and Sub-Rotor Dynamics in the Lee of Three-Dimensional Terrain" (*Journal of Atmospheric Sciences,* December 2007), found that irregularities along the ridgeline of a mountain chain create "sub-rotors" within the airflow that are intensified well in excess of those in the parent rotor. Because of their intensity, Doyle and Durran opine, such sub-rotors likely pose the greatest hazard to aviation.

The Desert Research Institute's analysis of the data found considerable variation in the behavior of the waves, for reasons that are not yet completely understood. The teams observed a pronounced diurnal variation of the wave and rotor activity, with the maximum wave and rotor strength occurring in the early evening hours. They also noticed lee wave and rotor response is strongly controlled by changes in the upstream ambient wind and stability profiles.

Two types of rotors were observed during the projects. The first was found to be located under the crest of a lee wave, paralleling the topography and its curvature — the classic Type 1.

The second type was signified by a roll cloud that looked like an almost vertical wall. Researchers currently refer to these as Type 2 rotors. These sometimes have a massive roll cloud with a nearly vertical leading edge and tend to form a straight barrier extending the full length of the mountain range. Type 2 rotors may reach heights of 25,000 to 30,000 ft.

In the words of Drs. Kuettner and Rolf F. Hertenstein, associated with the NCAR and Colorado Research Associates, respectively, in their research report titled "Observations of Mountain-Induced Rotors and Related Hypotheses: A Review," "It is unlikely that aircraft can be designed strong enough to withstand the excessive loads of a fully developed Type 2 rotor."

At the International Civil Aviation Organization's Second High-Level Safety Conference in Montreal in February 2015, information from accident and incident investigations revealed that present day encounters with this atmospheric phenomenon may infringe on current aircraft certification envelopes. The subcommittee overlooking certification issues recommended the follow-up include the need for improved ICAO airworthiness, operations and detection equipment provisions in order to further mitigate changing meteorological risks.

The FAA's Airplane Upset Recovery Training Aid states, "Avoidance of environmentally induced upsets is the best course of action. Pilots should monitor the environmental conditions and avoid high risk situations." This is mirrored by *Flight Safety Australia,* a publication of the Australian Transport Safety Bureau, which cautioned, "It is absolutely essential that aviators are aware of the wind and its potential effects on aircraft." As pointed out in the fatal accident of an Agusta 47G on Aug. 19, 2001, near Mount Archer, Queensland, Australia, such warnings pertain to rotorcraft as well.

What are the early warning indications that pilots should look for in weather reports so they can anticipate and try to avoid rotor encounters? Any NOTAM containing "ACSL" (altocumulus standing lenticular) should be taken seriously as an indication of mountain wave activity, as well as PIREPs observations. Reports of pressure falling rapidly at stations on the lee side of a mountain are also indicative of mountain wave activity. Reports of strong surface gusts, blowing dust and windsocks at opposite ends of the runway showing greatly varying winds are classic signs of mountain wave turbulence that extends to the surface.

Furthermore, avoid flight in or near rotor clouds as you would a mature thunderstorm. And avoid flight in the vicinity of ragged or frayed lenticular clouds, as these are prime indicators of severe turbulence. Whenever near a rotor, observe the turbulence penetration speeds published in your aircraft's AFM.

When those of us who enjoy wave soaring see those "lennies" in the air, we dream of the silky smooth updrafts that can lift us to high altitudes, but we also know that extreme turbulence in the rotor and the downdrafts are very severe hazards to all aircraft. Like any significant weather threat, this one demands respect and a knowledge of how to safely operate around it. This is a threat that can't be shrugged off with a "we fly jets so the weather doesn't affect us" attitude. There is only one method for dealing with this atmospheric threat, and that is "avoid . . . avoid . . . avoid." **BCA**

Rotor Streaming

If in your aviation career you spent much time along Colorado's Front Range or similar locations downwind from mountains, you likely encountered days in which the windsocks on the airport were pointing in completely different directions. That results from an atmospheric condition called "rotor streaming" and it brings a hazardous mixture of strong turbulence and a high degree of wind variability.

In simplified terms, rotors — think of "vortices" or "recirculation zones" — flow from the mountain crest along the lower layer of air close to the ground. Atmospheric scientists describe the complex flows with statements like "this layer of high vorticity air is separated from the surface in a region of adverse pressure gradient." A good indication of rotor streaming can be seen by surface observations downwind of the mountain range showing a light or even a strong wind, often from the opposite direction.

Conditions that typically produce rotor streaming include: strong winds (more than 20-25 kt.) at the top of the boundary layer, typically just below a sharp inversion; the wind blowing within 30 deg. of perpendicular to the ridge axis; a low-level neutral layer capped by a marked inversion 1.5 to 2 times the height of the hills; a marked decrease in wind speed, accompanied by a significant change in direction, at a height 1.5 to 2 times the height of the hills; a stable air mass above the well-mixed lowest layer.

According to the World Meteorological Organization's Aviation Meteorology, rotor streaming and surface rotors are extremely hazardous to aircraft. Due to the constant shifts in wind a landing aircraft may be unable to fly a stabilized approach. Wind direction changes abruptly, causing marked changes in lateral drift, as well as significant glide-path deviations caused by strong updrafts and downdrafts. The crosswinds from rotors may well be outside the limits of the aircraft. It is possible for windsocks at different locations within the perimeter of an airfield to all indicate markedly different wind directions and strengths. **BCA**

2020 Avionics Update

The coronavirus pandemic all but grounded aviation, but when the skies clear, there will be **no shortage of great new avionics and ideas** for flying blind

UNIVERSAL AVIONICS

Universal Avionics ClearVision

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

As we were finalizing this year's review of all things avionic, the coronavirus pandemic was rapidly expanding. In response, airframers, avionics makers, MROs and FBOs were squinting to see any positive news and with many also hitting the Pause button.

Almost all the big air shows and industry gatherings were postponed or canceled, including EBACE, Sun 'n Fun and Farnborough's huge biennial event. Business aviation activity was down by 30% or more, and descending further.

Many avionics makers were issuing statements expressing their confidence that despite temporary layoffs or reduced production, things would return to normal when the worst had passed — even if nobody could say when that would be. Universal Avionics was providing a non-profit group with assembly line space at its headquarters in Tucson, Arizona, to manufacture medical face masks and shields. Other aviation manufacturers — Piper, Textron Aviation, Honeywell, CAE and General Electric among the many — were ramping up production of specialized gear to help protect medical personnel and aid those infected with the virus.

So, we decided the only logical response to those circumstances was to punt with a snapshot summary of the avionics sector just before all hell broke loose in the U.S. in early April. That said, we hold firm to the expectation that eventually goodly numbers of new aircraft will begin rolling off production lines again, all fitted with new avionics, and that operators of existing aircraft will continue to upgrade their flight decks.

Call for Backup

In the opinion of many — including the Aviation Week & Space Technology editorial team that recently awarded it a Laureate — the most consequential event in general aviation avionics in a very long time occurred in October 2019 when Garmin International introduced its Autoland system.

An emergency landing system for light business aircraft, it can be activated by the pilot or passengers by simply pushing a guarded red button. It can also self-activate automatically in extreme circumstances. The system takes full control of the aircraft, notifies ATC and then flies to and lands at the most appropriate airport — all automatically.

The system's FAA approval and entry into service seems imminent on several aircraft. It's part of Garmin's newly branded Autonomi package, which includes electronic stability and protection and emergency descent mode. (For more, see "Flying Garmin's New Emergency Autoland," *BCA,* October 2019.)

Now, there may be another auto concept to consider. Skyryse, a Los Angeles-based transportation startup, has unveiled a new "universal flight automation system." The technology, it claims, can be retrofitted into any aircraft to enable virtually anyone to fly as safely as a crew of professional pilots using the system's intuitive controls — and an iPad.

The aircraft-agnostic system, known as Skyryse FlightOS, introduces a new paradigm in flight safety and capabilities through simplified flight controls. It's quite a claim, and it would be easy

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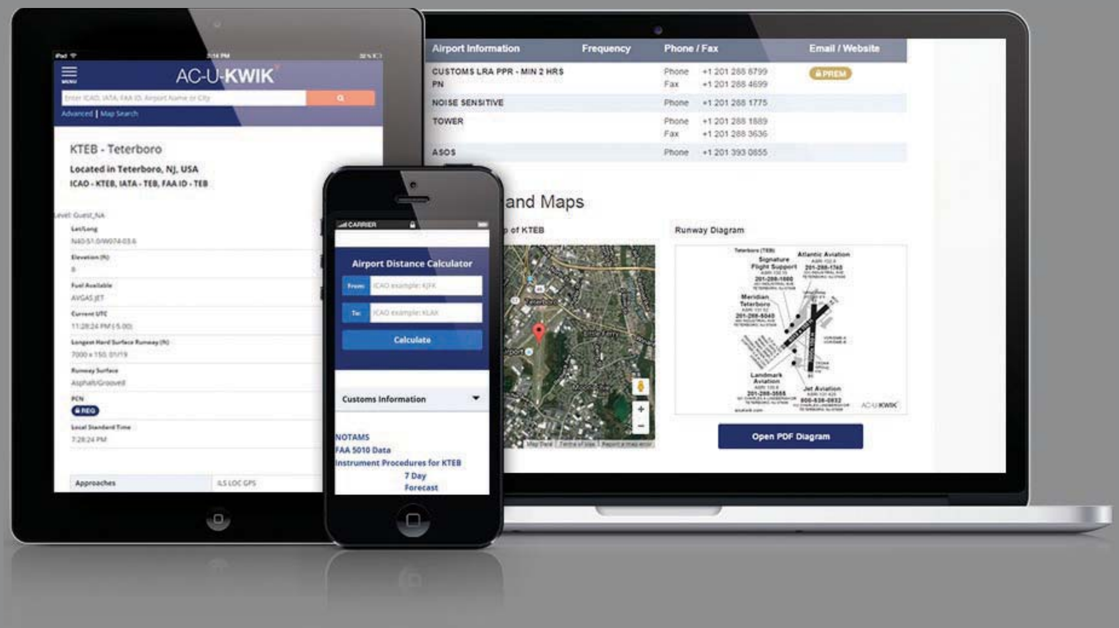

KTEB - Teterboro

Located in Teterboro, NJ, USA

ICAO - KTEB, IATA - TEB, FAA ID - TEB

Level: Guest_NA

Lat/Long: N40-51.0/W074-03.6

Elevation (ft): 8

Fuel Available: AVGAS JET

Current UTC: 11:28:24 PM (-5.00)

Longest Hard Surface Runway (ft): 7000 x 150, 01/19

Runway Surface: Asphalt/Grooved

PCN: REQ

Local Standard Time: 7:28:24 PM

Approaches: ILS LOC GPS

From: ICAO example: KJFK

To: ICAO example: KLAX

NOTAMS

FAA 5010 Data

Instrument Procedures for KTEB

7 Day Forecast

Airport Information	Frequency	Phone / Fax		Email / Website
CUSTOMS LRA PPR - MIN 2 HRS PN		Phone Fax	+1 201 288 8799 +1 201 288 4699	PREM
NOISE SENSITIVE		Phone	+1 201 288 1775	
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SKYRYSE

Skyryse FlightOS

to dismiss as vaporware designed by a kid in their basement. The company's video pitch, however, is compelling; the Skyryse folks may indeed be on to something. The company has raised $38 million from world-class investors, including Bill Ford, CEO of Ford Motor Co., as well as Stanford University and Venrock.

Unlike other companies building autonomous vertical takeoff and landing (VTOL) aircraft from scratch or only for the military, Skyryse refits existing certified aircraft and technologies with as-yet undescribed software and hardware innovations. The Skyryse FlightOS was initially designed for and demonstrated on a Robinson R44 helicopter. Each component of the system works in triplicate with fail-operational technology to ensure that automation functions remain operational at all times, even in the presence of equipment failures.

Skyryse claims it's a year away from FAA certification. Founder/engineer Vance Creighton told *BCA* that Skyryse doesn't see itself as competitive with Garmin's Autoland. "It's important to be distinct as to the different parts of the company and technology. Skyryse as a company has a mission to provide the safest, fastest and most uplifting transportation. Our goal is to democratize the air, by making air transportation accessible for everyone and having a positive impact on the communities we serve.

"To help create this future," Creighton continues, "we've created the Skyryse FlightOS and are now offering FlightOS as the first product from [a] suite of technologies we are selling. FlightOS is always on and continuously keeps the pilot within the flight envelope and will manage emergencies. FlightOS also differs in that it works with all aircraft while Garmin's technology works with only two types of aircraft. We created FlightOS as an entire industry solution for everything from eVTOLs to a Sikorsky S-80 to unlock the future of urban air mobility." Watch this space for updates.

Got ROAAS?

Meanwhile, runway overruns are a leading cause of incidents and accidents. In response to customer input, optional avionics upgrades for Embraer's new Phenom 300E now include predictive wind-shear awareness and an Embraer-developed runway overrun awareness and alerting system (ROASS) to warn pilots if the aircraft's approach is too steep or too fast.

The alerting system, which engages at 1,000 ft. AGL, warns the crew through primary flight display messages, aural alerts and data recorder, prompting a go-around. The upgrade also includes a standard new weather radar, ADS-B In, an emergency descent mode, graphical weight and balance, VFR approach, coupled go-around and other items.

Helo TAWS

Over the past two decades, the U.S. helicopter fatal accident rate has been halved, from 1.27 per 100,000 flights to 0.63, according to the U.S. Helicopter Safety Initiative's figures. However, the crash that killed Kobe Bryant and eight other people in late January has put a new focus on rotary-wing safety. Accordingly, U.S. Rep. Brad Sherman (D-Calif.) has introduced legislation to require terrain awareness and warning systems (TAWS) on all helicopters.

In a press release accompanying the announcement of the "Kobe Bryant and Gianna Bryant Helicopter Safety Act," Sherman declared, "Had this [TAWS] system been on the [accident] helicopter, it is likely the tragic crash could have been avoided."

The press release didn't provide any evidence for the claim. In February, Vanessa Bryant filed a wrongful death lawsuit against Express Helicopters and Island Express Holding Corp. for dispatching the Sikorsky S-76 helicopter in which her husband and 13-year-old daughter and seven others were killed. The suit alleges that Ara Zobayan, the lone pilot, failed "to use ordinary care in piloting the subject aircraft" and was "negligent" when taking off Jan. 26 for the fatal flight.


LUNA COPTER


HENSOLDT

Hensolt drone detection

Talk to Me

Switzerland's RUAG has developed a Controller-Pilot Data Link Communications (CPDLC) upgrade kit for Embraer Legacy 600/650 aircraft. Operators are free to decide if they prefer to opt for CPDLC as outlined by Mandate 2020 from both the European Union Aviation Safety Agency (EASA) and the FAA.

HENSOLDT

Hensolt detect-and-avoid radar

The upgrade requires five days' downtime for the implementation.

Meanwhile, German sensor and avionics tech companies Hensoldt and Diehl are developing a radar and camera system that can reliably detect objects in the flight path of UAVs. The recognition of such obstacles is one of the essential requirements for deploying the unmanned aircraft in controlled airspace.

The Manufacturers

What follows is a summary of significant product and service developments since last June.

Aspen Avionics

Albuquerque, New Mexico-based Aspen Avionics has added new features and functions for its Evolution E5 Electronic Flight Instrument (EFI). New features include traditional horizontal situation indicator (HSI), outside air temperature (OAT), true airspeed (TAS), wind direction and speed, and WAAS GPS mode annunciations. Starting at $4,995, the E5 EFI is approved for both IFR and VFR flight.

When introduced in 2018, the Evolution E5 EFI combined an attitude indicator plus DG/CDI into a single display. After receiving feedback from operators and installers, Aspen responded with a new software release for those who prefer a more traditional HSI. Aircraft owners who already own the Evolution E5 can update their current display through an Aspen authorized dealer who will note the change with a logbook entry. New E5 displays are now shipping with the HSI feature.

The Evolution E5 EFI is approved for IFR flight when installed with a panel-mounted IFR GPS. When installed without a panel-mounted GPS, the E5 EFI is approved for VFR flight only. The new optional software features including TAS, OAT, wind direction and speed, and WAAS GPS mode annunciations are available for $495.

Astronautics

Astronautics Corp. of Anaheim, California, is readying its wireless Airborne Communication System (wACS) for various Airbus Helicopter models, beginning with the H145. The wACS will enable operators to connect their aircraft to the Airbus Helicopters data link via the Airbus Helionix avionics suite to use the Airbus HCare analytics services.

Benefits include increasing operational safety and faster performance computation when preparing for a flight. In addition, the system helps ease maintenance decision-making for future flights, facilitates flight debriefings, speeds defect location and helps to prioritize troubleshooting.

And wACS enables secure transfer of operational and maintenance data to onboard repository, over Wi-Fi or cellular connection, with cybersecurity ensured via encryption, among other features.

Astronics Max-Viz

Sikorsky and Astronics have worked together to install and certify the Max-Viz 2300 enhanced vision system (EVS) on a new Sikorsky S-76D helicopter; the system is now certified and being delivered with new production aircraft or can be upgraded on existing helicopters.

The 2300 also had received an amended FAA and Transport Canada Supplemental Type Certificate (STC) approvals for multiple Textron and Leonardo helicopter models, including the AW109 and AW119.

Offered by the Buffalo, New York, avionics maker's Max-Viz subsidiary, the 2300 can now present images on multifunction displays (MFDs), primary flight displays (PFDs) and standalone displays. Approximately 40% of the over 3,000 installed Max-Vis EVS systems are in helicopters.

Avidyne

The new Atlas "multifunction" FMS by Avidyne is designed for installation on fixed-wing turbine aircraft. The touchscreen displays present moving maps, weather, traffic, geo-referenced approach charts, airport diagrams, radar and video, as well as integrated Wi-Fi connectivity and extensive I/O resources including the company's unique GPS Legacy Avionics Support (GLAS) technology.

Dzus-mounted, Atlas includes a satellite-based augmentation system (SBAS) GPS navigator with required navigation performance (RNP) and area navigation (RNAV) capability. This includes

AVIDYNE

Avidyne Helios TerrainAlert

Avidyne Atlas Hawker panel

AVIDYNE

localizer performance with vertical guidance (LPV), lateral navigation/vertical navigation (LNAV/VNAV), LNAV-only and approach procedures with vertical (APV) information.

The system also features a QWERTY keyboard, with Avidyne's "Page & Tab" and hybrid touchscreen user interface, allowing crews to get to any function with only one or two button pushes. This would be a great upgrade for operators who previously chose to do a compliance-only ADS-B Out upgrade, as Atlas will provide them with the full benefits that SBAS has to offer.

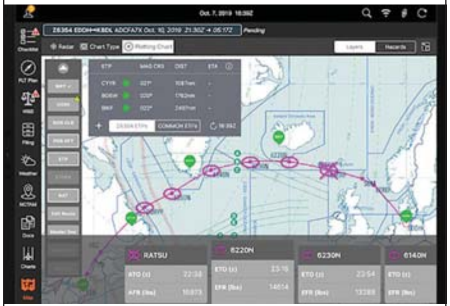
The Melbourne, Florida, manufacturer's GLAS provides a direct interface to legacy Collins Pro Line 21 and Honeywell Primus EFIS systems for vertical guidance during approach operations. This integration enables an EFIS certified before the availability of LPV approaches to have coupled guidance on these and other SBAS approaches.

Atlas boasts a variety of features. These include traffic display from TCAS or ADS-B, display of Jeppesen approach plates and airport diagrams with aircraft position shown on the charts, Wi-Fi and Bluetooth connectivity, integration with ForeFlight and other EFBs, and built-in USB charger. An integrated 16-watt VHF COM, VOR, localizer and glideslope radio is also available.

Avidyne's multifunction Helios provides many of those same features for rotary-wing operators. Its options include 16-watt VHF NAV/COM with ILS, HTAWS, GLAS, radar control/display capability, NVIS (near vertical incidence skywave) compatibility and an RS-170 video input. The system features a built-in moving map with 3 arc-second terrain and powerline data, plus charts, and VHF NAV/COM, video, NVIS and radar options.

Collins

Collins is redefining flight operations for business aviation with a new digital Oceanic Plotting Chart for pilots. Available on the company's ARINCDirect iPad app, it eliminates the paper plotting charts and manual processes commonly used today for navigating oceanic airspace.



Collins plotting chart

Free to ARINCDirect flight-planning subscribers, the chart plotter includes Live ETPs (equal time points), a feature that updates bearing, distance and arrival time constantly throughout the flight. Live ETPs are computed and updated for any scenario addressed with the flight plan including engine failure, depressurization and a medical emergency, thereby completely eliminating the need for manual computations.

Esterline CMC Electronics

DAC International and CMC Electronics have obtained FAA approval of their latest ADS-B Out STC for aircraft equipped with Honeywell Primus II avionics, thus providing an alternative to upgrading existing onboard Honeywell equipment.

The STC meets the DO-260B ADS-B Out worldwide mandate by replacing the existing non-compliant Primus II transponder with the Becker BXT6553 Diversity Transponder, paired with CMC Electronics' CMA-3024 GPS/SBAS (GNSSU) receiver.

Further, it extends the operating life of a broad range of aircraft such as Bombardier's Challenger 600 series, Hawker 800/800XP, Learjet 45, Gulfstream GIV/G450, Textron Cessna Citation II and V, and many more. The CMA-3024 sensor provides ADS-B-compliant SBAS/GPS primary means navigation and is fully compatible with all SBAS signals worldwide. With SBAS coverage, differential corrections are incorporated to provide RNP 0.1. Full installation kits, including the CMA-3024 and STC package, are provided by DAC.

In March, TransDigm Group of Ohio acquired Montreal-based CMC Electronics Esterline Technologies for approximately $4 billion.

FreeFlight Systems

Mexico's Civil Aviation Federal Agency has validated FreeFlight Systems' AML STC for the company's Avail ADS-B. The package is intended to help turboprop and light jet owners in Mexico and Central America comply with ADS-B requirements.

Next, the Irving, Texas, company's RA-4500 plug-and-play radar altimeter now comes with digital-to-analog converter capabilities, making the system a replacement for legacy altimeters like the KRA-405/405B. According to the manufacturer, the RA-4500 is ideal for TCAS I, single-install aircraft, like Citations and Learjets.

Also, FreeFlight recently joined the ACR Group's portfolio of aviation companies, which includes ARTEX, Flight Data Systems, Latitude Technologies and SKYTRAC Systems, but it will continue to operate as an independent subsidiary.

Garmin International

In addition to the unveiling of its Autoland system, Garmin has received FAA approval for the installation of the GTN 650Xi and GTN 750Xi for select helicopter models. Designed as a direct slide-in upgrade to the previous generation GTN 650/750, the all-in-one GPS/NAV/COMM multifunction display can integrate with new or existing remote-mount equipment such as a transponder or audio panel.

Preserving the same form factor as its predecessor models, the 6-in.-tall GTN 750Xi and the 2.65-in.-tall GTN 650Xi offer an intuitive touchscreen design with a dedicated direct-to button and dual concentric knob that ease interfacing with the display.

Helicopters currently approved for installation of the GTN Xi series include: Airbus AS350B2, AS350B3, EC120B, EC130B3 and EC130T2; Bell 206B, 206L, 206L-1, 206L-3, 206L-4 and 407; Enstrom F-28F, 280FX and 480B; and MD Helicopters 369E, 369F and 369FF.

Meanwhile, Garmin's new G1000 NXi integrated flight deck upgrade for the King Air C90 offers a new capabilities and, when moving from the G1000, requires minimal aircraft downtime.

Flight Stream 510 and Connext technology within the G1000 NXi integrated flight deck enables the wireless transfer of aviation databases from the Garmin Pilot app on a mobile device to the G1000 NXi. Additional features include two-way flight plan transfer, and the sharing of traffic, weather, GPS information, back-up attitude information and more, between the NXi and Garmin Pilot, FltPlan Go and ForeFlight Mobile apps.

Visual approach guidance and map overlay within the HSI further enhance the NXi feature set. Within the HSI map, pilots can overlay NEXRAD, Flight Information Service-Broadcast (FIS-B) weather, weather radar, SafeTaxi airport diagrams, traffic, terrain and more. A split-screen view is also available on the MFD, offering a simultaneous view of maps, sectional and IFR low/high en route charts, checklists, flight plans and more on a single screen.

The G1000 NXi also supports the display of ADS-B In traffic and FIS-B weather. The addition of SurfaceWatch runway monitoring provides visual and aural cues to help prevent pilots from taking off or landing on a taxiway, on a runway that is too short or on the wrong runway based on performance data entered during preflight. Visual and audible runway distance remaining annunciations are also available.

This upgrade adds to the growing portfolio of aircraft eligible for the G1000 NXi integrated flight deck upgrade, including the King Air 200/300/350, Daher TBM 850/900, Cessna Citation Mustang, Piper PA-46 and soon, the Embraer Phenom 100. Upgrades to the G1000 NXi require little aircraft downtime or panel disruption because the displays preserve the same footprint and connectors.

Genesys Aerosystems

Remote-mounted and software-definable, Genesys Digital Radio (GDR) products feature combined VOR/localizer/glideslope and marker beacon nav and VHF comm with a frequency range of 118-136 MHz or 118-156 MHz and 25 or 8.33 kHz channelization with transmit power of 16 or 25 watts. Embedded UHF 225-400 MHz comm is optionally available. The radio is designed to interface to a host controller/displays.

The Mineral Wells, Texas, manufacturer specializes in cockpit integration. As an example, its IDU-680 EFIS display now integrates with the PAC45G digital audio controller from PS Engineering. The PAC45G is a TSOed audio management system that offers MultiTalker, a patented technology providing up to nine unique positions so that each radio has its own location within a stereo headset.

The Genesys IDU-680 EFIS displays feature a variety of PFD and MFD formats that can be configured to show flight instruments, moving map, HSI, flight planner, traffic, terrain, weather radar, data link, video, radio/audio management and engine displays. The IDU-680s also feature a built-in FMS and integrated Class-A TAWS.

Meanwhile, the company's unique OASIS (Open Architecture System Integration Symbology) platform allows flexibility to display engine information, CAS messages and special-mission equipment. Its GPS and ADAHRS round out the offering.

Honeywell Aerospace

PJ18 4D Trajectory Management, a Honeywell project that's part of the SESAR 2020 initiative, is intended to modernize air traffic management in the EU. SESAR (Single European Sky ATM Research) is now in its second phase.

The company says the system will enhance safety, efficiency and situational awareness for flight crews and passengers. It analyzes available weather and aeronautical data, sends updates to the aircraft via data link and displays the information graphically using the pilot's EFB app.

PJ18 is one of several dozen SESAR projects in which Honeywell is involved and 4D Trajectory Management will help ATM authorities and operators handle greater volumes of future air traffic.

Meanwhile, with the introduction of Honeywell's new Forge data-driven analytics platform, business aviation customers can have an ostensibly easy-to-use, integrated dashboard that sends real-time alerts on connectivity issues and flight plan changes. With full visibility into their services, customers can use the platform to tap into data that helps flight departments troubleshoot and fix issues as soon as they arise.

The next evolution of what was formerly known as Honeywell's GoDirect portfolio, Forge is designed to improve passenger connectivity, help manage costs and give flight departments a better understanding of their fleet's status in real time. It provides a full suite of mission-management capabilities in the areas of flight operations, nav databases and maintenance.

And for operators looking to access more airports, increase safety, reduce crew workload or meet the changing regulatory and airspace requirements, the Honeywell FMZ-2000 FMS version 6.1 upgrade contains significant improvements. The upgrade is required for the 2020 Future Air Navigation System (FANS) 1/A mandate on the Embraer Legacy 600/650, Dassault Falcon 900A/B/C/EX (non-EASy), Embraer Legacy 600/650, Gulfstream IV/IV-SP/V and Cessna Citation X.

Also, BendixKing's AeroVue Touch PFD is now available for 353 aircraft types on the Approved Model List STC. The display has the highest-resolution EFIS on the general aviation market and features Honeywell's SmartView SVS, terrain awareness, a moving map, a vertical situation display, aeronautical charts, and traffic and weather information. These are consolidated within a near-4K high-resolution, 10.1-in. touchscreen display. Every safety-critical function is accessible within two pilot touches on the display and all functions are available within four touches or less.

For owners upgrading to a digital cockpit, AeroVue Touch offers a modular and compact unit that comes with Wi-Fi and Bluetooth connectivity as standard.


UNIVERSAL AVIONICS

Universal Avionics is assisting the local Tucson community in protecting healthcare workers and first responders.

It allows pilots to seamlessly upload flight information in under 4 min. and software updates in less than 10 min. and also has self-contained architecture, which allows the system to be easily expanded to two or three displays.

BendixKing has obtained an STC for the AeroFlight KA 310 autopilot adapter, enabling the KI 300 to be used as a sole-source, three-axis attitude reference and flight director for BendixKing KAP 100, 150 and 200 and KFC 150, 200 and 225 autopilots. The company says that with the upgrade, owners save the typical $4,000 to overhaul mechanical gyros every 800 hr., while also having much of the same information available in a PFD at a much lower cost.

And the BendixKing AeroCruze 230 touchscreen autopilot is also now available for certified aircraft. A slide-in replacement for the KFC 150, the AeroCruze 230 reuses the servos already in the aircraft, dramatically cutting down on installation cost. Purchase of the AeroCruze comes with a new two-year warranty on those servos.

IS&S

The FAA has awarded a first-of-its-kind STC to Innovative Solutions & Support for technology to protect against one-engine-inoperative (OEI) loss-of-control accidents. Authorities suggest such mishaps are responsible for as many as 90 fatalities annually.

The IS&S autothrottle upset protection system automatically adjusts power in the operating engine to provide the maximum safe thrust, preventing severe yaw that can catastrophically upset the aircraft. The system is available for rapid retrofits.

Meanwhile, the Exton, Pennsylvania, manufacturer has received the first FAA STC for its patented ThrustSense autothrottle for retrofit in King Airs. The system provides FADEC-like engine protection and is a full regime autothrottle, from takeoff to landing phases of flight, including go-around. Accordingly, it allows the pilot to automatically control the power setting of the engine. ThrustSense computes and controls appropriate power levels, reducing pilot workload while providing a new level of convenience and safety.

L3Harris Technologies

Express Readout, L3Harris Technologies' new automated aircraft recorder validation service, provides detailed reports about recorder functionality. Global aviation authorities require aircraft operators to provide annual compliance for FDRs and CVRs, including those with data link capabilities, to prove they are functioning correctly. Express Readout allows operators to upload the recorder files to a secure server for validation, without manually removing the device.

According to the Melbourne, Florida, manufacturer, Express Readout's patented algorithms also identify unusual parameter patterns and highlight these to the user for inspection. Interactive charts allow users to inspect every parameter in detail and assess up to 50 flight hours of data, across multiple flights, within the same readout. Users can download the report files in various formats and the results are stored indefinitely on the secure platform, exceeding regulatory requirements.

Express Readout is available as an automated self-service solution or as a full-service validation, which includes an expert assessment on the recorded data.

Universal Avionics

Universal Avionics has obtained EASA certification for its ClearVision enhanced flight vision system (EFVS) with SkyLens head-wearable display (HWD).

ClearVision provides head-up operations combined with enhanced vision (EVS), synthetic 3-D terrain display (SVS), and a unique and optimized combined vision system (CVS). For greater flexibility, it interfaces with a variety of display options: traditional fixed head-up display (HUD) systems, head-down flight display systems or wearable devices like the "near-to-eye" SkyLens HWD. All these options offer pilots unprecedented situational awareness, enhancing what they can see with "natural vision" in degraded visual environments and adverse weather conditions, day or night.


UNIVERSAL AVIONICS

Universal says ClearVision can provide relief to approach bans under FAR Part 121 operations and allows operators to use its enhanced flight visibility to meet the flight visibility required to depart to a destination or begin an instrument approach.

To Our Health

How well business aviation weathers the coronavirus crisis is anybody's guess at this point. But while we're all while practicing personal distancing, and complying with stay-at-home requests, catching up on sleep, enjoying our families and exercising more, we suggest checking your aircraft's avionics maker's website for some terrific online webinars and training programs. BCA

Congratulations to Our Very Own William Garvey!

On his induction into the “Living Legends of Aviation”

BCA

Business & Commercial Aviation

***BCA* Editor-In-Chief William Garvey** has been inducted into the Living Legends of Aviation.

Garvey is part of the Class of 2020 inductees, which includes Apollo 13 Commander Jim Lovell, Gulfstream’s Larry Flynn and Sergei Sikorsky. Past inductee recipients include more than 100 men and women from every corner of aerospace.

During a career that has already spanned 50 years, Garvey has established himself as a well-known, highly respected ambassador for aviation and shaped ***BCA*** into the leading, essential “how-to” business aviation publication within the industry.

> “For the past five years, I have been honored to work alongside Bill. His writing never fails to amaze me, and his knowledge and innate understanding of our industry is unparalleled. He is simply the best story teller I know. Congratulations to Bill on this outstanding recognition.”
>
> *— Frank Craven,*
> *Managing Director*
> *Business Aviation*

Photo: *Business & Commercial Aviation (BCA)* Editor-In-Chief William Garvey is introduced by Living Legends of Aviation host, actor/pilot John Travolta. ©2020 Larry Grace Photography / Living Legends of Aviation (LLoA)

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Pandemic Nose Dive

How long to **recovery?**


DASSAULT AVIATION

Dassault Falcon 8X

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

The first half of 2020 was an economic catastrophe for the business aviation sector, for air transport in general and for most of the world economies as well. April 2020 business jet flights declined more than 75% year over year. FBO fuel sales were off as much as 95%. Deliveries of some new general aviation aircraft were cut in half, pilots were furloughed, MRO staff was cut. Manufacturers' supply chains have been disrupted and some firms may not survive. Some facilities at general aviation airports were shuttered with no hope of reopening. The FAA is reducing operating hours at 100 control towers, mostly at smaller airports.

Recovery from the COVID-19 pandemic indeed could be more difficult than pulling out of the 2008 Great Recession because of the depth and breadth of the economic damage throughout the economy. Business aviation "got sucker punched," was the view of Michael Bruno, *Aviation Week & Space Technology*'s senior business editor, during "Business Aviation, Post-Pandemic: Will This Crisis Reshape the Industry?" part of a COVID-19 webinar series hosted by the Aviation Week Network, of which *BCA* is a member.

Gulfstream's customers deferred deliveries of 11 aircraft in the first quarter and the firm announced the layoffs of 700 employees in early May. In late April, Superior Air Charter, parent company of JetSuite, filed for bankruptcy. And NetJets announced a 25% cut in staff at two business units and deferral of some new aircraft deliveries.

Adding to the pain is the "complete collapse of oil prices," according to Richard Aboulafia, Teal Group's vice president of analysis, during the webinar. "In 2008, the top end of the market did fine, but the bottom end got crunched and never fully recovered. Small general aviation companies never got back to the frothiness they saw back in 2007 and 2008.

"So much of the top end of the market

is linked to resource rich economies, their companies and high-net-worth individuals. There's no way [this time] the top end doesn't take an extremely serious hit," says Aboulafia.

"Pain will be felt across all sectors, 40% in light jet, 30% in midsize and 30% in large cabin," says Rolland Vincent, head of the Plano, Texas, consultancy bearing his name. Aboulafia believes that "safe havens" are the first things business aircraft makers will seek in order to survive. "And the only thing I can see that even vaguely resembles a safe haven in this crazy world is defense spending."

General Dynamics, the parent company of Gulfstream Aerospace, is the U.S.'s fifth-largest defense contractor, earning more than half its revenue in that sector. Long term, that bodes well for Gulfstream as it proceeds amain with development of its 7,500-nm-range, four-section-cabin G700, as well as future projects, such as the P-32 joint venture with Israel Aerospace Industries (IAI) described below.

Dassault can fall back on sales of its Mach 2-class Rafale fighter and refurbished Atlantique 2 patrol aircraft. That will allow the French firm to push forward with both the Falcon 6X and upcoming Falcon 9X ultra-long-range executive jet.

But Bombardier has no such defense sector backstop to shore up its finances as it rides out the storm and attempts to service $9.3 billion in debt. "That puts [Bombardier] in a fairly vulnerable place. So, I think it faces a unique set of challenges," says Aboulafia. Embraer, in spite of its defense business, also is in financial peril after the collapse of its $4.2 billion joint venture with Boeing.

"Ironically enough, if you could somehow find a way to put ownership issues, ego issues, whatever else aside, it's hard to imagine a better combination than Embraer and Bombardier. That would actually go pretty well as retrenchment in this business," says Aboulafia.

"Not in my lifetime, no way," counters Vincent. He believes there are too many cultural differences between the two firms. There is also bad blood over old government subsidy feuds. But there are undeniable synergies, if such an agreement could be reached. Embraer's Phenom 300 has been the best-selling light jet for more than a decade, while Bombardier Learjet 75 sales have flagged. The Embraer Legacy 500 never has sold well and the Bombardier Challenger 350 continues to dominate the super-midsize class. Bombardier's Global 5500, 6500 and 7500 models are well positioned against large-cabin competitors, leaving only the long-in-the-tooth Challenger 650 in need of faster cruising, higher flying, longer range replacement.

Textron, in contrast, may rekindle merger talks with Bombardier, now that Alstom's proposed $6.7 billion acquisition of Bombardier's rail business is on hold. Meanwhile, Mitsubishi's $550 million offer to buy the Bombardier CRJ line seems to be proceeding. Regardless, there's pressure on cash-strapped Bombardier to unload its debt burden, adding urgency to a possible sale. Vincent notes that a sale of Bombardier Business Aircraft to a third party likely would leave the founding Boudoin family with a hefty portion of shares in any third-party acquisition as part of the deal.

"There are opportunities here. It's just that, as we all know, the history of business jet consolidation is largely unblemished by success," says Aboulafia. In summary, he quips, "We're all reminded of Warren Buffett: 'When the tide goes out, you see who's swimming naked.'"

Bruno notes that Textron doesn't have "mounds of cash" for research and development. The firm also may be too cash-strapped to pursue acquisitions, considering that its 1Q20 revenues declined 10.7% from 2019 mainly because of the impact of COVID-19. Notably, Textron Aviation's 1Q20 revenues also were down 23% year over year. Vincent believes it would be more likely that a private equity firm, such as Bain Capital or Carlyle, would make a bid for Bombardier sooner than another business aircraft manufacturer.

More importantly, Vincent says consolidation of overlapping models will happen before companies consider mergers. Prime examples include Bombardier's Global 5000 and 5500, and Global 6000 and 6500, along with the Embraer Legacy 450 and Praetor 500, and Legacy 500 and Praetor 600, plus Textron Aviation's Sovereign and Longitude. Newer designs offering more range, more payload or more spacious cabins will survive. Market demand for older models will wane, leading to end of production.

TEXTRON AVIATION

Textron Aviation Citation M2

Uncertainty dominates the market. ". . . [F]rankly we don't know the magnitude of this recession. We don't know how long equities markets will keep falling, or indeed, if they will keep falling. Maybe there'll be some stability. We don't know about the length and depth of the recession that's coming," says Aboulafia.

Vincent says that customer sentiment, their intentions to purchase are the lowest he's seen in nine years. "It'll be a very strange market for the next few months."

The beginnings of a business aviation turnaround will be shown by an uptick in aircraft utilization and a firming of prices in the pre-owned market.

TEXTRON AVIATION/PAUL BOWEN

Citation Latitude

Aboulafia says that a recovery in crude oil markets and recoveries in the equities markets will be key, coupled with a surge in business earnings. "The corporate profit index comes back and business jets come back."

Vincent says GDP growth, bulls running in stock markets and more favorable U.S. dollar to foreign currency exchange rates, along with higher oil prices, will be the main drivers. He disagrees with Aboulafia's prediction that higher corporate earnings will drive business aircraft purchases, pointing out that companies have not chosen to buy aircraft with profits that have surged since 2008. They've made considerably larger capital expenditures for other equipment. And the trend is unlikely to change as the world's economies begin to recover.

Business aviation should recover before the airline industry because it's much less dependent on discretionary travel. Face-to-face deal-making is one of the benefits of business aviation. You can't Skype or Zoom your way through business negotiations. You have to be on site to inspect a plant, talk with employees, see processes in progress, examine products, hear what customers, financiers and suppliers have to say.

"It's a competitive world. If I have a slight advantage of unseating a competitor, whether I'm trying to buy a company or consulting. It's a competitive world and travel helps you. Nobody competes on safety. But it's kind of implicit before people feel comfortable getting back in airports and airlines, they're going to feel better about private aviation," says Aboulafia.

This is particularly true for international air travel. Private aviation won't leave you stranded a long, long way from home because of an Icelandic volcano eruption, second wave of virus, travel bans or other roadblocks to commercial air travel.

And while private and public aviation sectors have been loath to point fingers at each other concerning safety, there's a strong undercurrent of discussion about business aviation being the preferred mode of air travel in the new non-normal era of COVID-19.

Bruno says that coronavirus has been added to the risk management matrix and "executives don't want to risk exposure on commercial flights." Companies operating business aircraft have door-to-door control over the risk of exposure to disease, including assurance about the sanitation of ground support facilities, vehicles and aircraft, plus screening personnel, pilots and passengers for signs of infection. They'll know that a person on board is coughing due to a seasonal allergy, not the onset of COVID-19. One industry observer says that companies are seeking to create a "health corridor" that will provide travel with near virus-free-exposure from origin to destination. Vincent believes that load factors aboard corporate aircraft may increase as CEOs strive to keep more key employees off the airlines.

Companies may view their aircraft as essential business tools, but they're also keenly aware of the vilification of business aviation by Washington politicos and the media during the 2008 economic meltdown.

Aboulafia says that operators will have to manage the "optics" carefully to avoid a repeat of the "One Percenter" class warfare that dominated the news a decade ago, especially regarding use of private aircraft. "Otherwise, there's going to be a certain degree of tension over the optics of that," says Aboulafia.

Carbon impact is another part of managing "optics." Europe is taking aim at business aviation because carbon emissions per passenger are considerably higher for an eight-passenger business jet than for a 400-passenger jumbo twin. Environmentalists note that the skies have been noticeably cleaner and quieter since the COVID-19 pandemic virtually shut down air travel. Even before that, "flight shaming" became common practice in some parts of Europe. Business aircraft are an especially easy target for eco activists.

As shown on the accompanying chart, though, all of aviation in the U.S. accounts for a scant 2.6% of greenhouse gas emissions, according to the Environmental Protection Agency. U.S. business aviation comprises 2% of aviation emissions or 0.052% of the total U.S. carbon footprint, according to the General Aviation Manufacturers Association (GAMA) and the International Business Aviation Council (IBAC). In contrast, more than 60% of human-generated greenhouse gases in the U.S. are emitted by power plants, factories and light cars and trucks.

Nonetheless, the business aviation community has been quite proactive in pushing for development and use of sustainable aviation fuels (SAFs), which are refined from plant-based feedstocks that absorb carbon dioxide during their growth cycles. GAMA and IBAC predict that more fuel-efficient business aircraft, coupled with widespread use of SAF, will eventually reduce business aircraft carbon emissions to 50% of what they were in 2005.

"It's a matter of when, not if, to curb aviation carbon emissions. The idea of carbon offsetting is widely shared across both political parties," says Bruno.

Long term, the outlook for private aviation is bright, especially with people being increasingly concerned about the risks of exposure to disease associated with traveling on commercial airlines. "Taking the long view, yes, we'll get back on that growth trajectory. We're still a really solid business that employs a lot of people. There's a lot of money to be made by a lot of different types of companies," says Aboulafia.

Short term, however, "we're going to have a really difficult couple or three years" because of the fallout of COVID-19. One broker tells BCA that he recently had four transactions blow up because buyers were so concerned about the economy.

Bruno counters, "Billionaires and multi-billionaires don't let little things like economic recessions stop them. They continue to march forward in all of their deal making and all of their business activity." Ultra-high-net-worth individuals "are the stalwarts of this market," says Aboulafia. "And one of the things we know about them is they like to get there faster," adds Bruno.

This may bode well for the future of the Aerion and Boom supersonic aircraft projects, assuming the regulatory, technical and environmental hurdles can be overcome.

While the business aviation community awaits such quantum leaps in cruise performance and price tags, this year's Purchase Planning Handbook provides performance numbers, size measurements and operational specifications for an impressive array of more conventional aircraft. They range from four-seat singles that can hop between tiny towns in Texas up to 12-passenger uber jets that can fly from Teterboro to Taipei.

The COVID-19 pandemic is creating acute downward price pressure in some sectors. Manufacture of some models has ceased. For instance, we no longer list Mooney Ovation and Acclaim single-engine aircraft. The Embraer Legacy 650E, the business jet variant of its EMB-135 regional jet, and the Bombardier Learjet 70 are gone from the Handbook. Production lines for the Nextant G90XT and 400XTi, Piaggio Avanti Evo and Syberjet SJ30i may not be dead, but they're in persistent vegetative states. Most manufacturers have nudged up asking prices ever so slightly. Bombardier and Dassault held over 2019 prices for 2020, as did Embraer for its super-midsize models. Textron even trimmed a little from Caravan and Grand Caravan EX prices.

Textron, however, hiked the retail price of the Citation Longitude by nearly $1.4 million, making it the most-expensive super-midsize jet and only $1.6 million less than the large-cabin Dassault Falcon 2000S. The Longitude was also the last aircraft to enter the fiercely competitive segment dominated by the Bombardier Challenger 350, the Embraer Praetors and the Gulfstream G280.

In December 2018, IAI and Gulfstream started planning for a successor to the G280, each agreeing to invest $80 million in the new aircraft, code-named P-32, according to Globes, Israel, business news. If the project comes to fruition, it will make the super-midsize segment even more competitive.

Textron also raised the price of the CJ4 by $450,000, upped the list of the Latitude by $700,000 and ballooned the price of the Sovereign+ by $1 million.

Pilatus, benefiting from unsurpassed customer loyalty and strong market demand, raised the price of the PC-12 by more than $350,000, bringing it to within $1 million of the Beech King Air 250. Pilatus continues to own the passenger/freight combi niche of the pressurized single-engine turboprop market because of protracted delays in development of Textron's Denali utility turboprop.

The Pilatus PC-24's price has gone up 10%, to more than $11 million as demand builds for the Swiss manufacturer's first twin-turbofan light utility aircraft. Arguably, though, the PC-24 is a midsize jet because of its cabin cross-section. It's the only midsize aircraft with a cargo door and capable of operating from unimproved runways.

This year, Bombardier's Global 5500 and 6500 make their debuts in the *Handbook*. They're considerably more capable than the Global 5000 and 6000, plus they're aggressively priced to make them competitive with the Gulfstream G500 and G600. Meanwhile, the Bombardier Global 7500 now has direct competition as the Gulfstream G700 makes its first appearance in the *Handbook*.

We've retained the Airbus ACJ and Boeing BBJ jetliner derivatives as business aircraft because of their appeal to head-of-state and government special-mission organizations. A few of these large aircraft still are purchased by ultra-high-net-worth individuals, but their appeal to corporate operators seems to have all but dried up.

With the bears clearly beating the bulls so far this year, 2020 should be a bonanza for buyers across a wide range of models. Many aircraft manufacturers are itching for new business, in spite of their raising asking prices. They'll be willing to take a fine pencil to sales contracts to ink deals and keep production lines open — at least for the near future.

While demand for business aircraft likely will be lackluster until 2022, or later, the intrinsic value of these business tools is becoming even clearer in the new non-normal era of disease pandemics. Demand will rebound, slowly at first, but steadily with time. As the market recovers, prices will get firmer and bargains will be fewer. This year should be the best year for buyers in more than a decade. **BCA**

TEXTRON AVIATION

Textron Aviation Hemisphere

How to Use the Airplane Charts

TEXTRON AVIATION/DENALI

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

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

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

Manufacturer, Model and Type Designation

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

BCA Equipped Price

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

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

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

Characteristics

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

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

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

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

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

Dimensions

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

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

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

BOEING

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; Hon — 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.


CESSNA AIRCRAFT

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 weight, 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.


TEXTRON AVIATION

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

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

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

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

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

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

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

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

Limits

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

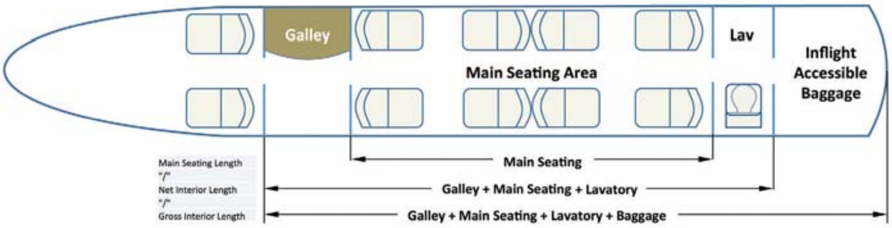
▶ **VREF** — Reference landing approach speed (large turboprops and turbofan airplanes, four passengers, NBAA IFR reserves; eight passengers for ultra-long-range aircraft).

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

Airport Performance

Airplane Flight Manual takeoff runway performance is shown for sea level, standard day and for 5,000-ft. elevation/25C day density altitude. All-engine takeoff distance (TO) is shown for single-engine and multiengine piston, and turboprop airplanes with an MTOW of less than 2,500 lb. Takeoff distances and speeds assume MTOW, unless otherwise noted.

Cabin Length



▶**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 airports 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.

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.

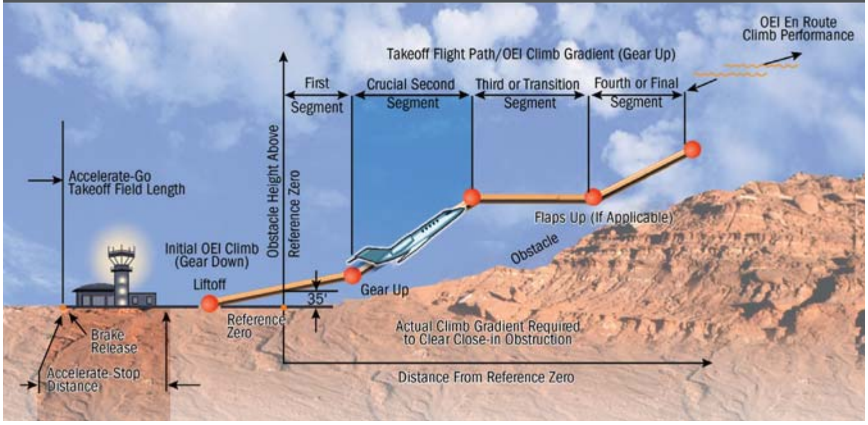
The OEI climb gradient is computed at the same flap configuration used to calculate the takeoff field length.

Ceilings (ft.)

▶**Maximum Certificated Altitude** — Maximum allowable operating altitude determined by airworthiness authorities.

▶**All-Engine Service Ceiling** — For

FAR Part 25 and Part 23 Commuter Category OEI Climb Performance



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.

▶ **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 airspeed (TAS), fuel flow in pounds/hour, flight level (FL) cruise altitude and specific range for long-range cruise specified 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 trade-offs, 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.


TEXTRON AVIATION

▶ **Seats-Full Range (Single-Engine Piston Airplanes)** — Based on typical executive configuration with all seats filled with 170-lb. occupants, with maximum available fuel less 45-min. IFR fuel reserves. We use the lower of seats full or maximum payload.

▶ **Tanks-Full Range (Single-Engine Piston Airplanes)** — Based on one 170-lb. pilot, full fuel less 45-min. IFR fuel reserves.

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

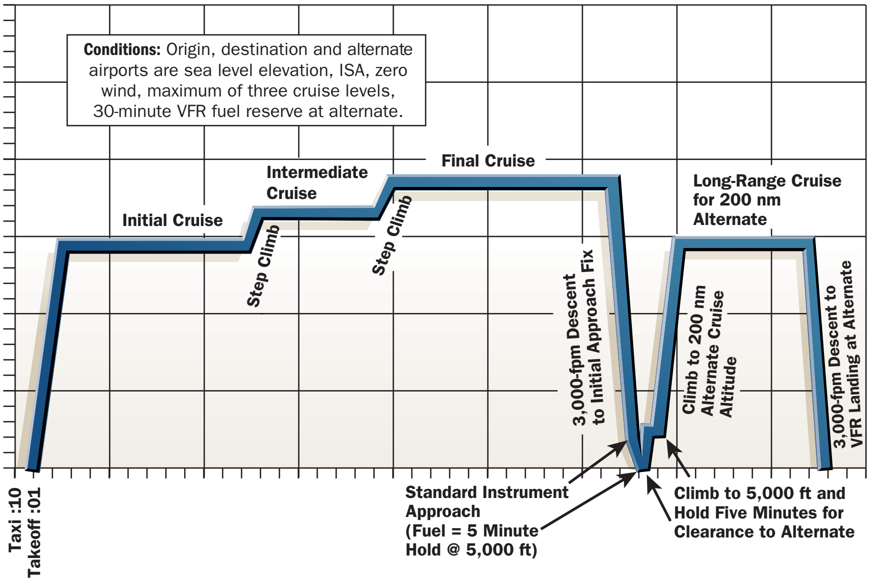
▶ **Ferry (Multiengine Piston Airplanes and Single-Engine Turboprops)** — Based on one 170-lb. pilot, maximum fuel less 45-min. IFR fuel reserves.

Please note: None of the missions for piston-engine aircraft includes fuel for diverting to an alternate. However, single-engine turboprops are required to have NBAA IFR fuel reserves, but only a 100-mi. alternate is required.

NBAA IFR range format cruise profiles, having a 200-mi. alternate, are used for turbine-powered aircraft with MTOWs equal to, or greater than, 22,000 lb. Turbine aircraft having MTOWs less than 22,000 lb. only need a 100-mi. NBAA alternate. The difference in alternate requirements should be kept in mind when comparing range performance of various classes of aircraft.

▶ **Available Fuel With Max Payload (Multiengine Turbine Airplanes)** — Based on aircraft loaded to maximum zero fuel weight with maximum available fuel up to maximum ramp weight, less NBAA

NBAA IFR RANGE PROFILE



PILATUS AIRCRAFT

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 presented 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.

BCA Required Equipment List

	Single-Engine Pistons	Single-Engine Pistons, Turbocharged	Single-Engine Pistons, Pressurized	Multiengine Pistons	Multiengine Pistons, Turbocharged	Single-Engine Turboprops	Turboprops ≤12,500 lb.	Turboprops >12,500 lb.	Jets <20,000 lb.	Jets ≥20,000 lb.
POWERPLANT SYSTEMS										
Batt temp indicator (nicad only, for each battery)						●	●	●	●	●
Engine synchronization									🔵	🔵
Fire detection, each engine						●	●	●	●	●
Fire extinguishing, each engine						●	●	●	●	●
Propeller, reversible pitch						●	●	●		
Propellers, synchronization							●	●		
Thrust reversers									🔵	🔵
AVIONICS										
ADF receiver (non U.S. deliveries)						●	●	●	●	●
Altitude alerter						●	●	●	●	●
Altitude encoder	●	●	●	●	●	●	●	🔵	🔵	🔵
Audio control panel	●	●	●	●	●	●	●	🔵	🔵	🔵
Automatic flight guidance, 2-axis, alt hold	●	●	●	●						
Automatic flight guidance, 3-axis, alt hold					●	●	●	●	●	🔵
Digital air data computer							●	🔵	🔵	🔵
DME or approved GPS distance indication	●	●	●	●	●	●	●	●	●	🔵
EFIS/large-format flat-panel displays	●	●	●	●	●	●	●	●	●	●
ELT	●	●	●	●	●	●	●	●	●	●
FMS (TSO C115) or GPS (TSO C129/145/146)	●	●	●	●	●	●	●	●	●	🔵
Marker beacon receiver	●	●	●	●	●	●	●	●	🔵	🔵
Radio altimeter						●	●	●	●	🔵
RVSM certification						●	●	🔵	🔵	🔵
Satcom, Iridium, or Inmarsat									●	●
TAS or TCAS I						●	●	●		
TAWS						●	●	●	●	●
TCAS I/II									●	●
Transponder, Mode S 1090ES	●	●	●	●	●	●	●	🔵	🔵	🔵
VHF comm transceiver, 25-KHz spacing	●	●	●	●	●	●	●	●		
VHF comm tranceiver, 8.33-kHz spacing									🔵	🔵
VOR/ILS	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵
Weather data link										
Weather radar						●	●	●	●	●
GENERAL										
Air conditioning, vapor cycle (not required with APU)				●		●	●	●	●	●
Anti-skid brakes (not required MTOW <10,000 lb.)								●	●	●
APU (required for air-start engines, ACM air conditioning)										●
Cabin/cockpit bulkhead divider								●	●	●
Corrosion-proofing	●	●	●	●	●	●	●	●	●	●
Exterior paint, tinted windows	●	●	●	●	●	●	●	●	●	●
Fire extinguisher, cabin						●	●	●	●	●
Fire extinguisher, cockpit	●	●	●	●	●	●	●	●	●	●
Fuel tanks, long-range	●	●	●	●	●					
Ground power jack	●	●	●	●	●	●	●	●	●	●
Headrests, air vents at all seats	●	●	●	●	●	●	●	●	●	●
Lavatory								●	●	●
Lights, external — nav/beacon/strobe/landing/taxi	●	●	●	●	●	●	●	●	●	●
Lights, internally illuminated instrument/cockpit flood	●	●	●	●	●	●	●	●	●	●
Oxygen, supplemental — all seats		●			●	●	●	●	●	●
Refreshment center							●	●	●	●
Seats, crew, articulating	●	●	●	●	●	●	●	●	●	●
Seats, passenger, reclining	●	●	●	●	●	●	●	●	●	●
Shoulder harness, all seats/crew with inertial reel	●	●	●	●	●	●	●	●	●	●
Tables, cabin work						●	●	●	●	●
ICE AND RAIN PROTECTION										
Alternate static pressure source (not required with dual DADC)	●	●	●	●	●	●	●			
Flight Into Known Icing (FIKI) approval			●	●	●	●	●	●	●	●
Ice protection plates							●	●		
Pitot heat	●	●	●	●	●	●	●	🔵	🔵	🔵
Windshield rain removal, mechanical/pneumatic/hygroscopic							●	●	●	●
INSTRUMENTATION										
Angle-of-attack stall margin indicator									●	●
EGT	●	●	●	●	●					
IVSI (or equivalent DADC function)	●	●	●	●	●	●	●	●	●	●
OAT	●	●	●	●	●	●	●	●	●	●
Primary flight instruments	●	●	●	●	●	●	🔵	🔵	🔵	🔵

● Required
🔵 Dual Required

Runway performance is obtained from the Approved Airplane Flight Manual. Takeoff distance is listed for single-engine airplanes; accelerate/stop distance is listed for piston twins and light turboprops; and takeoff field length, which often corresponds to balanced field length, is used for FAR Part 23 Commuter Category and FAR Part 25 large Transport Category airplanes.

Flight Time (takeoff to touchdown, or weight-off-wheels, time) is shown for turbine airplanes. Some piston-engine manufacturers also include taxi time, resulting in a chock-to-chock, Block Time measurement. Fuel Used, though, is the actual block fuel burn for each type of aircraft, but it does not include fuel reserves. The cruise altitude shown is that which is specified by the manufacturer for fixed-distance missions.

▶ **200 nm –** (Piston-engine airplanes).
▶ **500 nm –** (Piston-engine airplanes).
▶ **300 nm –** (Turbine-engine airplanes, except ultra-long-range).
▶ **600 nm –** (Turbine-engine airplanes, except ultra-long-range).
▶ **1,000 nm –** (All turbine-engine airplanes).
▶ **3,000 nm –** (Ultra-long-range turbine-engine airplanes).
▶ **6,000 nm –** (Ultra-long-range turbine-engine airplanes).

Remarks

In this section, *BCA* generally includes the base price, if it is available or applicable; the certification basis and year; and any notes about estimations, limitations or qualifications regarding specifications, performance or price. All prices are in 2017 dollars, FOB at a U.S. delivery point, unless otherwise noted. The certification basis includes the regulation under which the airplane was originally type certified, the year in which it was originally certified and, if applicable, subsequent years during which the airplane was re-certified. "*BCA* Estimated Data" indicates that we made adjustments to data provided by manufacturers.

General

The following abbreviations are used throughout the tables: **"NA"** means not available; "—" indicates the information is not applicable; and **"NP"** signifies that specific performance is not possible. **BCA**

SINGLE-ENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Cirrus Design	Piper Aircraft	Textron Aviation
Model			**SR20**	**Arrow PA-28R-201**	**Cessna Skylane CE-182T**
BCA Equipped Price			$474,900	$515,087	$530,000
Characteristics		Seating	1+3/4	1+3/3	1+3/3
		Wing Loading	21.7	16.2	17.8
		Power Loading	14.65	13.75	13.48
		Noise (dBA)	83.4	77.7	77.7
External Dimensions (ft.)		Length	26.0	24.7	29.0
		Height	8.9	7.9	9.3
		Span	38.3	35.4	36.0
Internal Dimensions (ft.)		Length	8.0	7.7	7.2
		Height	4.1	3.7	4.0
		Width	4.1	3.5	3.5
Power		Engine	Lyc IO-390-C3B6	Lyc IO-360-C1C6	Lyc IO-540-AB1A5
		Output (hp)	215	200	230
		Inspection Interval	2,000t	2,000t	2,000t
Weights (lb.)		Max Ramp	3,160	2,758	3,110
		Max Takeoff	3,150	2,750	3,100
		Max Landing	3,150	2,750	2,950
		Zero Fuel	3,043b	2,636b	2,986b
		EOW	2,120	1,798	2,000
		Max Payload	923	838	986
		Useful Load	1,040	960	1,110
		Max Baggage	130	200	200
		Max Fuel	336	432	522
		Available Payload w/Max Fuel	704	528	588
		Available Fuel w/Max Payload	117	122	124
Limits		V_{NE}	201	183	175
		V_{NO}	164	146	140
		V_{A}	133	118	110
Airport Performance		TO (SL elev./ISA temp.)	2,530	1,600	1,514
		TO (5,000-ft. elev.@25C)	4,305	3,250	2,708
		V_{SO}	62	55	49
		V_{X}	81	78	65
		V_{Y}	88	90	80
Climb		Time to Climb (min.)/Altitude	20/FL 100	16/FL 100	15/FL 100
		Initial Gradient (ft./nm)	540	560	694
Ceiling (ft.)		Service	17,500	16,200	18,100
Cruise	Long Range	TAS	135	124	125
		Fuel Flow	53	51	61
		Altitude	FL 080	FL 100	FL 100
		Specific Range	2.547	2.431	2.049
	Recommended	TAS	145	130	135
		Fuel Flow	61	68	69
		Altitude	FL 080	FL 090	FL 100
		Specific Range	2.377	1.912	1.957
	High Speed	TAS	152	137	144
		Fuel Flow	71	76	76
		Altitude	FL 080	FL 060	FL 060
		Specific Range	2.141	1.803	1.895
Ranges	Seats Full	Nautical Miles	672	537	723
		Average Speed	135	121	130
		Fuel Used	275	256	379
		Specific Range/Altitude	2.444/FL 080	2.098/FL 070	1.908/FL 120
	Tanks Full	Nautical Miles	672	926	912
		Average Speed	135	121	131
		Fuel Used	275	408	471
		Specific Range/Altitude	2.444/FL 080	2.270/FL 070	1.936/FL 120
Missions (4 occupants)	200 nm	Runway	1,685	1,600	1,249
		Block Time	1+26	1+29	1+37
		Fuel Used	112	125	123
		Specific Range/Altitude	1.786/FL 080	1.600/FL 070	1.626/FL 120
	500 nm	Runway	1,685	1,600	1,402
		Block Time	3+30	3+50	3+52
		Fuel Used	245	278	269
		Specific Range/Altitude	2.041/FL 080	1.799/FL 090	1.859/FL 0120
		Suggested Base Price	$474,900	$490,298	$515,000
Remarks		Certification Basis	FAR 23, 2000 Includes Garmin Perspective+ avionics.	CAR 3, 1976/2001 Garmin G500 TXi standard.	FAR 23, 1996/2001 A 23-6 Garmin G1000 NXi with GFC 700 autopilot.

SINGLE-ENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Cirrus Design	Textron Aviation	*GippsAero*
Model			**SR22**	**Beechcraft Bonanza G36 G36**	***Airvan GA-8***
BCA Equipped Price			$654,900	$919,000	$939,632
Character-istics		Seating	1+3/4	1+4/5	1+6/7
		Wing Loading	23.5	20.2	20.7
		Power Loading	11.61	12.17	13.33
		Noise (dBA)	83.7	76.7	84.9
External Dimensions (ft.)		Length	26.0	27.5	29.3
		Height	8.9	8.6	12.8
		Span	38.3	33.5	40.7
Internal Dimensions (ft.)		Length	8.0	12.6	11.6
		Height	4.1	4.2	3.7
		Width	4.1	3.5	4.2
Power		Engine	Cont IO-550-N	Cont IO-550-B	Lyc IO-540-K1A5
		Output (hp)	310	300	300
		Inspection Interval	2,000t	1,900t	2,000t
Weights (lb.)		Max Ramp	3,610	3,663	4,014
		Max Takeoff	3,600	3,650	4,000
		Max Landing	3,600	3,650	4,000
		Zero Fuel	3,400c	3,510b	3,849b
		EOW	2,260	2,590	2,241
		Max Payload	1,140	920	1,608
		Useful Load	1,350	1,073	1,773
		Max Baggage	130	670	180
		Max Fuel	552	444	540
		Available Payload w/Max Fuel	798	629	1,233
		Available Fuel w/Max Payload	210	153	166
Limits		V_{NE}	205	203	185
		V_{NO}	176	165	143
		V_A	140	139	121
Airport Perfor-mance		TO (SL elev./ISA temp.)	1,756	1,913	1,860
		TO (5,000-ft. elev.@25C)	3,016	3,450	3,670
		V_{SO}	64	59	57
		V_X	88	84	70
		V_Y	108	100	86
Climb		Time to Climb (min.)/Altitude	11/FL 100	14/FL 100	15/FL 100
		Initial Gradient (ft./nm)	775	730	787
Ceiling (ft.)		Service	17,500	18,500	20,000
Cruise	**Long Range**	TAS	160	160	127
		Fuel Flow	68	71	78
		Altitude	FL 080	FL 080	FL 120
		Specific Range	2.353	2.254	1.628
	Recommended	TAS	171	167	135
		Fuel Flow	92	86	88
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.859	1.942	1.534
	High Speed	TAS	180	174	142
		Fuel Flow	107	93	101
		Altitude	FL 080	FL 080	FL 060
		Specific Range	1.682	1.865	1.406
Ranges	**Seats Full**	Nautical Miles	1,118	217	487
		Average Speed	162	153	124
		Fuel Used	492	115	339
		Specific Range/Altitude	2.272/FL 080	1.887/FL 040	1.437/FL 120
	Tanks Full	Nautical Miles	1,118	860	690
		Average Speed	162	159	125
		Fuel Used	492	403	464
		Specific Range/Altitude	2.272/FL 080	2.134/FL 080	1.487/FL 120
Missions (4 occupants)	**200 nm**	Runway	1,303	1,665	1,860
		Block Time	1+09	1+11	1+38
		Fuel Used	127	130	157
		Specific Range/Altitude	1.575/FL 080	1.538/FL 060	1.274/FL 120
	500 nm	Runway	1,519	1,858	1,860
		Block Time	2+49	2+54	3+55
		Fuel Used	305	304	339
		Specific Range/Altitude	1.639/FL 080	1.645/FL 060	1.475/FL 120
		Suggested Base Price	$654,900	$914,000	$798,256
Remarks		Certification Basis	FAR 23, 2000 Includes Garmin Perspective+ avionics.	CAR 3, 1956/69/83/2005 A/C system standard; Garmin G1000 NXi.	FAR 23 A 54 Includes Garmin G500. All data preliminary.

SINGLE-ENGINE PISTONS TURBOCHARGED

Manufacturer			Textron Aviation	Cirrus Design	GippsAero
Model			Cessna Turbo Stationair HD CE-T206H	SR22T	*GA8 Airvan TC GA8-TC320*
BCA **Equipped Price**			$735,000	$754,900	*$977,856*
Character-istics		Seating	1+5/5	1+3/4	*1+6/7*
		Wing Loading	21.8	23.5	*20.7*
		Power Loading	12.22	11.43	*13.13*
		Noise (dBA)	82.6	80.3	*85.4*
External Dimensions (ft.)		Length	28.3	26.0	*28.3*
		Height	9.3	8.9	*9.3*
		Span	36.0	38.3	*36.0*
Internal Dimensions (ft.)		Length	9.3	8.0	*11.6*
		Height	4.1	4.1	*3.7*
		Width	3.7	4.1	*4.2*
Power		Engine	Lyc TIO-540-AJ1A	Cont TSIO-550-K	*Lyc TIO-540-AH1A*
		Output (hp)	310	315	*320*
		Inspection Interval	2,000t	2,000t	*1,800t*
Weights (lb.)		Max Ramp	3,806	3,610	*4,214*
		Max Takeoff	3,789	3,600	*4,200*
		Max Landing	3,600	3,600	*4,000*
		Zero Fuel	3,615b	3,400c	*4,053b*
		EOW	2,365	2,342	*2,349*
		Max Payload	1,250	1,058	*1,704*
		Useful Load	1,441	1,268	*1,865*
		Max Baggage	180	130	*180*
		Max Fuel	522	552	*540*
		Available Payload w/Max Fuel	919	716	*1,325*
		Available Fuel w/Max Payload	191	210	*161*
Limits		V_{NE}	182	205	*185*
		V_{NO}	149	176	*143*
		V_{A}	125	140	*121*
Airport Perfor-mance		TO (SL elev./ISA Temp.)	1,970	1,517	*1,840*
		TO (5,000-ft. elev.@25C)	2,845	2,268	*2,788*
		V_{SO}	59	64	*61*
		V_{X}	70	88	*71*
		V_{Y}	88	103	*81*
Climb		Time to Climb (min.)/Altitude	12/FL 100	7/FL 100	*13/FL 100*
		Initial Gradient (ft./nm)	724	782	*825*
Ceilings (ft.)		Certificated	26,000	25,000	*20,000*
		Service	26,000	25,000	*20,000*
Cruise	**Long Range**	TAS	137	171	*125*
		Fuel Flow	85	76	*68*
		Altitude	FL 240	FL 250	*FL 200*
		Specific Range	1.612	2.250	*1.838*
	Recommended	TAS	155	201	*130*
		Fuel Flow	99	98	*78*
		Altitude	FL 240	FL 250	*FL 200*
		Specific Range	1.574	2.051	*1.667*
	High Speed	TAS	164	213	*135*
		Fuel Flow	116	110	*98*
		Altitude	FL 200	FL 250	*FL 200*
		Specific Range	1.410	1.936	*1.378*
Ranges	**Seats Full**	Nautical Miles	465	1,021	*233*
		Average Speed	137	171	*125*
		Fuel Used	358	486	*220*
		Specific Range/Altitude	1.299/FL 200	2.101/FL 250	*1.059/FL 200*
	Tanks Full	Nautical Miles	608	1,021	*618*
		Average Speed	138	171	*125*
		Fuel Used	430	486	*459*
		Specific Range/Altitude	1.414/FL 240	2.101/FL 250	*1.346/FL 200*
Missions (4 occupants)	**200 nm**	Runway	1,420	1,405	*1,743*
		Block Time	1+23	1+08	*1+35*
		Fuel Used	163	197	*125*
		Specific Range/Altitude	1.227/FL 150	1.015/FL 100	*1.600/FL 120*
	500 nm	Runway	1,626	1,699	*1,743*
		Block Time	3+22	2+28	*3+30*
		Fuel Used	386	360	*373*
		Specific Range/Altitude	1.295/FL 240	1.389/FL 180	*1.340/FL 200*
Remarks		Suggested Base Price	$714,000	$754,900	*$837,133*
		Certification Basis	FAR 23, 1998 Utility version with 2,212-lb. EOW available for $707,650.	FAR 23, 2010 Includes Garmin Perspective+ avionics.	*FAR 23, 1998 Garmin G500; KC 225. All data preliminary.*

SINGLE-ENGINE PISTONS PRESSURIZED

Manufacturer			Piper Aircraft
Model			M350 PA-46-350P
BCA Equipped Price			$1,478,000
Characteristics		Seating	1+4/5
		Wing Loading	24.8
		Power Loading	12.40
		Noise (dBA)	81.0
External Dimensions (ft.)		Length	28.9
		Height	11.3
		Span	43.0
Internal Dimensions (ft.)		Length	12.4
		Height	3.9
		Width	4.2
Power		Engine	Lyc TIO-540-AE2A
		Output (hp)	350
		Inspection Interval	2,000t
Weights (lb.)		Max Ramp	4,358
		Max Takeoff	4,340
		Max Landing	4,123
		Zero Fuel	4,123c
		EOW	3,146
		Max Payload	977
		Useful Load	1,212
		Max Baggage	200
		Max Fuel	720
		Available Payload w/Max Fuel	492
		Available Fuel w/Max Payload	235
Limits		V_{NE}	198
		V_{NO}	168
		V_A	133
		PSI	5.5
Airport Performance		TO (SL elev./ISA temp.)	2,090
		TO (5,000-ft. elev.@25C)	2,977
		V_{SO}	58
		V_X	81
		V_Y	110
Climb		Time to Climb (min.)/Altitude	8/FL 100
		Initial Gradient (ft./nm)	703
Ceilings (ft.)		Certificated	25,000
		Service	25,000
		Sea-Level Cabin	12,300
Cruise	Long Range	TAS	156
		Fuel Flow	66
		Altitude	FL 250
		Specific Range	2.364
	Recommended	TAS	203
		Fuel Flow	108
		Altitude	FL 250
		Specific Range	1.880
	High Speed	TAS	213
		Fuel Flow	120
		Altitude	FL 250
		Specific Range	1.775
Ranges	Seats Full	Nautical Miles	535
		Average Speed	138
		Fuel Used	312
		Specific Range/Altitude	1.715/FL 120
	Tanks Full	Nautical Miles	1,343
		Average Speed	159
		Fuel Used	670
		Specific Range/Altitude	2.004/FL 250
Missions (4 occupants)	200 nm	Runway	2,090
		Block Time	1+06
		Fuel Used	167
		Specific Range/Altitude	1.198/FL 200
	500 nm	Runway	2,090
		Block Time	2+31
		Fuel Used	350
		Specific Range/Altitude	1.429/FL 250
		Suggested Base Price	$1,195,000
Remarks		Certification Basis	FAR 23, 1983/88 Garmin G1000 NXi; FIKI optional.

MULTIENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Vulcanair SpA	Vulcanair SpA	Textron Aviation
Model			P.68C P 68C	Victor P 68R	Beech Baron G58 G58
BCA Equipped Price			$1,001,600	$1,179,058*	$1,491,000
Characteristics		Seating	1+5/6	1+5/6	1+4/5
		Wing Loading	22.9	22.7	27.6
		Power Loading	11.49	11.37	9.17
		Noise (dBA)	74.7	78.8	77.6
External Dimensions (ft.)		Length	31.3	31.3	29.8
		Height	11.2	11.2	9.8
		Span	39.4	39.4	37.8
Internal Dimensions (ft.)		Length	10.6	10.6	12.6
		Height	3.9	3.9	4.2
		Width	3.8	3.8	3.5
Power		Engines	2 Lyc IO-360-A1B6	2 Lyc IO-360-A1B6	2 Cont IO-550-C
		Output (hp each)	200	200	300
		Inspection Interval	2,000t	2,000t	1,900t
Weights (lb.)		Max Ramp	4,630	4,548	5,524
		Max Takeoff	4,594	4,548	5,500
		Max Landing	4,365	4,321	5,400
		Zero Fuel	4,167c	4,374b	5,210b
		EOW	3,153	3,197	3,965
		Max Payload	1,014	1,177	1,245
		Useful Load	1,477	1,351	1,559
		Max Fuel	1,063	1,063	1,164
		Available Payload w/Max Fuel	415	289	395
		Available Fuel w/Max Payload	463	174	314
Limits		V_{NE}	194	197	223
		V_{NO}	154	157	195
		V_A	132	127	156
Airport Performance		TO (SL elev./ISA Temp.)	1,312	1,260	2,345
		TO (5,000-ft. elev.@25C)	4,000	4,000	4,144
		A/S (SL elev./ISA)	2,150	1,410	3,009
		A/S (5,000-ft. elev.@25C)	2,950	2,370	4,335
		V_{MCA}	60	60	84
		V_{DEC}	70	70	85
		V_{XSE}	82	82	100
		V_{YSE}	88	88	101
Climb		Time to Climb (min.)/Altitude	12/FL 100	12/FL 100	10/FL 100
		Initial Engine-Out Rate (fpm)	217	217	390
		Initial All-Engine Gradient (ft./nm)	1,100	920	988
		Initial Engine-Out Gradient (ft./nm)	147	147	232
Ceilings (ft.)		Certificated	—	—	—
		All-Engine Service	18,000	20,000	20,688
		Engine-Out Service	5,000	5,650	7,284
Cruise	Long Range	TAS	144	144	185
		Fuel Flow	94	94	144
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.532	1.532	1.285
	Recommended	TAS	155	155	192
		Fuel Flow	108	108	174
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.435	1.435	1.103
	High Speed	TAS	162	162	200
		Fuel Flow	116	116	193
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.397	1.397	1.035
Ranges	Max Payload	Nautical Miles	300	300	250
		Average Speed	140	140	174
		Trip Fuel	315	315	231
		Specific Range/Altitude	0.952/FL 080	0.952/FL 080	1.082/FL 040
	Ferry	Nautical Miles	1,000	1,000	1,480
		Average Speed	145	145	180
		Trip Fuel	975	975	1,081
		Specific Range/Altitude	1.026/FL 080	1.026/FL 080	1.369/FL 120
Missions (4 occupants)	200 nm	Runway	1,450	1,450	2,861
		Block Time	1+28	1+28	1+02
		Fuel Used	140	140	226
		Specific Range/Altitude	1.429/FL 080	1.429/FL 080	0.885/FL 060
	500 nm	Runway	1,500	1,500	2,940
		Block Time	3+25	3+25	2+31
		Fuel Used	375	375	531
		Specific Range/Altitude	1.333/FL 080	1.333/FL 080	0.942/FL 060
		Suggested Base Price	$1,001,600	$1,160,490	$1,486,000
Remarks		Certification Basis	FAR 23, 1976/80 Garmin G1000 NXi with GFC autopilot.	EASA 23, 2009 Garmin G1000 NXi. *BCA estimate.	CAR 3, 1957/69/83/2005 A/C system standard; Garmin G1000 NXi; max payload mission flown with six occupants.

MULTIENGINE PISTONS TURBOCHARGED

Manufacturer			Vulcanair SpA	Piper Aircraft
Model			**P 68C-TC**	**Seneca V PA-34-220T**
BCA Equipped Price			$1,063,200	$1,273,200
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		V_{NE}	194	204
		V_{NO}	154	164
		V_{A}	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
		V_{MCA}	66	66
		V_{DEC}	NA	73
		V_{XSE}	78	83
		V_{YSE}	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	$1,063,200	$1,030,000
Remarks		Certification Basis	FAR 23, 1982 Garmin G1000 NXi. *BCA* estimated data.	FAR 23, 1971/80/97 Garmin G1000 NXi standard.

SINGLE-ENGINE TURBOPROPS

Manufacturer			Mahindra Aerospace	Textron Aviation	Piper Aircraft	Textron Aviation	Daher
Model			**Airvan 10 GA10**	**Cessna Caravan CE-208**	**M500 PA-46-500TP**	**Cessna Grand Caravan EX CE-208B**	**Kodiak Kodiak 100**
BCA Equipped Price			$1,700,000*	$2,000,000	$2,250,000	$2,250,000	$2,454,800
Character-istics		Seating	1+9/9	1+9/13*	1+4/5	1+9/13*	1+6/9
		Wing Loading	28.6	28.6	27.8	31.5	30.2
		Power Loading	10.56	11.85	10.18	10.16	9.67
		Noise (dBA)	79.0	79.0	76.8	84.1	84.4
External Dimensions (ft.)		Length	33.5	37.6	29.6	41.6	33.8
		Height	12.7	14.9	11.3	15.5	14.7
		Span	40.6	52.1	43.0	52.1	45.0
Internal Dimensions (ft.)		Length	16.1	12.7	12.3	16.7	15.8
		Height	3.8	4.5	3.9	4.5	4.8
		Width	4.2	5.3	4.1	5.3	4.5
Power		Engine	RR 250 B-17F/2	P&WC PT6A-114A	P&WC PT6A-42A	P&WC PT6A-140	P&WC PT6A-34
		Output (shp)/Flat Rating	450/ISA+31C	675/ISA+31C	500/ISA+55C	867/ISA+24C	750/ISA+7C
		Inspection Interval	3,500t	3,600t	3,600t	4,000t	4,000t
Weights (lb.)		Max Ramp	4,775	8,035	5,134	8,842	7,305
		Max Takeoff	4,750	8,000	5,092	8,807	7,255
		Max Landing	4,515	7,800	4,850	8,500	7,255
		Zero Fuel	4,182b	7,432b	4,850c	8,152b	7,071c
		BOW	2,475	4,930	3,634	5,510	4,417
		Max Payload	1,707	2,502	1,216	2,642	2,654
		Useful Load	2,300	3,105	1,500	3,332	2,888
		Max Fuel	1,013	2,224	1,160	2,246	2,144
		Available Payload w/Max Fuel	1,287	881	340	1,086	744
		Available Fuel w/Max Payload	594	604	284	691	234
Limits		V_{MO}	157	175	188	175	180
		V_A	133	150	127	148	143
		PSI	—	—	5.6	—	—
Airport Perfor-mance		TO (SL elev./ISA temp.)	1,600	2,055	2,438	2,160	1,468
		TO (5,000-ft. elev.@25C)	2,973	2,973	3,691	3,661	2,396
		V_{SO}	61	61	69	61	60
		V_X	90	90	95	86	73
		V_Y	107	107	125	108	101
Climb		Time to Climb (min.)/Altitude	9/FL 100	9/FL 100	19/FL 250	9/FL 100	10/FL 100
		Initial Gradient (ft./nm)	771	771	753	816	915
Ceilings (ft.)		Certificated	20,000	25,000	30,000	25,000	25,000
		Service	25,000	25,000	30,000	25,000	25,000
		Sea-Level Cabin	—	—	12,600	—	—
Cruise	Long Range	TAS	157	157	179	156	164
		Fuel Flow	281	281	135	328	251
		Altitude	FL 100	FL 100	FL 280	FL 100	FL 120
		Specific Range	0.559	0.559	1.326	0.476	0.653
	High Speed	TAS	186	186	258	185	175
		Fuel Flow	379	379	242	437	335
		Altitude	FL 100	FL 100	FL 280	FL 100	FL 120
		Specific Range	0.491	0.491	1.066	0.423	0.522
NBAA IFR Ranges (100-nm alternate)	Full Fuel (w/available payload)	Nautical Miles	965	965	834	807	1,005
		Average Speed	156	156	171	156	175
		Trip Fuel	1,795	1,799	748	1,761	2,130
		Specific Range/Altitude	0.538/FL 100	0.536/FL 100	1.115/FL 280	0.458/FL 100	0.472/120
	Ferry	Nautical Miles	970	970	834	816	1,236
		Average Speed	156	156	171	156	164
		Trip Fuel	1,800	1,800	748	1,772	2,130
		Specific Range/Altitude	0.539/FL 100	0.539/FL 100	1.115/FL 280	0.460/FL 100	0.580/FL 200
Missions (4 passen-gers)	300 nm	Runway	1,468	1,468	1,550	1,428	1,468
		Flight Time	1+40	1+40	1+22	1+41	1+47
		Fuel Used	648	648	379	750	587
		Specific Range/Altitude	0.463/FL 100	0.463/FL 100	0.792/FL 280	0.400/FL 100	0.511/FL 120
	600 nm	Runway	1,675	1,675	1,625	1,792	1,468
		Flight Time	3+17	3+17	2+32	3+19	3+30
		Fuel Used	1,260	1,260	660	1,462	1,140
		Specific Range/Altitude	0.476/FL 100	0.476/FL 100	0.909/FL 280	0.410/FL 100	0.526/FL 120
	1,000 nm	Runway	NP	NP	1,700	NP	1,467
		Flight Time	NP	NP	4+18	NP	5+47
		Fuel Used	NP	NP	985	NP	1,878
		Specific Range/Altitude	NP	NP	1.015/FL 280	NP	0.532/FL 120
		Suggested Base Price	NA	NA	$2,122,600	NA	$2,150,000
Remarks		Certification Basis	FAR 23 A 62, 2017 Garmin G1000 with GFC700 autopilot. Not approved for FIKI. **BCA* estimated price.	FAR 23, 1984/98 Garmin G1000 NXi with GFC700 autopilot. *Export only.	FAR 23 A 52 Garmin G1000 NXi with SVS. *1,000 nm, three passengers.	FAR 23, 1986/2012 Includes cargo pod; Garmin G1000 NXi with GFC700 autopilot. *Export only.	FAR 23, 2007 Normal category Includes Garmin G1000 and GFC700 autopilot with coupled GA; Summit interior option.

SINGLE-ENGINE TURBOPROPS

Manufacturer			Epic Aircraft	Piper Aircraft	Daher	Daher	Pilatus
Model			**Epic E1000**	**M600 PA-46-600TP**	**TBM 910 TBM 700 N**	**TBM 940 TBM 700 N**	**PC-12 NGX PC-12/47E**
BCA Equipped Price			$3,250,000	$3,261,955	$4,162,365	$4,504,654	$5,353,000
Characteristics		Seating	1+5/6	1+4/5	1+5/6	1+5/6	1+8/9
		Wing Loading	38.6	28.7	38.2	38.2	37.6
		Power Loading	6.67	10.00	8.70	8.70	8.71
		Noise (dBA)	77.3	76.8	76.2	76.2	77.0
External Dimensions (ft.)		Length	35.8	29.6	35.2	35.2	47.3
		Height	12.5	11.3	14.3	14.3	14.0
		Span	43.0	43.2	42.1	42.1	53.3
Internal Dimensions (ft.)		Length	13.9	12.3	15.0	15.0	16.9
		Height	4.5	3.9	4.1	4.1	4.8
		Width	4.5	4.1	4.0	4.0	5.0
Power		Engine	P&WC PT6A-67A	P&WC PT6A-42A	P&WC PT6A-66D	P&WC PT6A-66D	P&WC PT6E-67XP
		Output (shp)/Flat Rating	1,200/ISA+35C	600/ISA+55C	850/ISA+49C	850/ISA+49C	1,200/ISA+35C
		Inspection Interval	3,500t	3,600t	3,500t	3,500t	5,000t
Weights (lb.)		Max Ramp	8,050	6,050	7,430	7,430	10,495
		Max Takeoff	8,000	6,000	7,394	7,394	10,450
		Max Landing	7,600	5,800	7,024	7,024	9,921
		Zero Fuel	7,600c	4,850c	6,032c	6,032c	9,039c
		BOW	5,166	3,850	4,829	4,829	6,803
		Max Payload	2,434	1,000	1,203	1,203	2,236
		Useful Load	2,884	2,200	2,601	2,601	3,692
		Max Fuel	1,770	1,742	2,017	2,017	2,704
		Available Payload w/Max Fuel	1,114	458	584	584	988
		Available Fuel w/Max Payload	450	1,200	1,398	1,398	1,456
Limits		V_{MO}	270	250	266	266	240
		V_A	170	151	160	160	163
		PSI	6.6	5.6	6.2	6.2	5.8
Airport Performance		TO (SL elev./ISA temp.)	1,654	2,635	2,380	2,380	2,485
		TO (5,000-ft. elev.@25C)	2,376	3,998	3,475	3,475	4,080
		V_{SO}	68	62	65	65	67
		V_X	116	95	100	100	120
		V_Y	150	122	124	124	130
Climb		Time to Climb (min.)/Altitude	12/FL 250	21/FL 250	13/FL 250	13/FL 250	19/FL 250
		Initial Gradient (ft./nm)	1,400	785	1,000	1,000	877
Ceilings (ft.)		Certificated	34,000	30,000	31,000	31,000	30,000
		Service	34,000	30,000	31,000	31,000	30,000
		Sea-Level Cabin	15,000	12,600	14,390	14,390	13,100
Cruise	Long Range	TAS	260	184	252	252	225
		Fuel Flow	235	155	241	241	269
		Altitude	FL 340	FL 280	FL 310	FL 310	FL 300
		Specific Range	1.106	1.187	1.046	1.046	0.836
	High Speed	TAS	333	274	330	330	290
		Fuel Flow	436	324	412	412	463
		Altitude	FL 260	FL 280	FL 260	FL 260	FL 240
		Specific Range	0.764	0.846	0.801	0.801	0.626
NBAA IFR Ranges (100-nm alternate)	Full Fuel (w/available payload)	Nautical Miles	NA	1,406	1,514	1,514	1,548
		Average Speed	NA	179	252	252	270
		Trip Fuel	NA	1,324	1,599	1,599	2,235
		Specific Range/Altitude	NA/NA	1.062/FL 280	0.947/FL 310	0.947/FL 310	0.693/FL 300
	Ferry	Nautical Miles	NA	1,406	1,594	1,594	1,571
		Average Speed	NA	179	252	252	275
		Trip Fuel	NA	1,324	1,598	1,598	2,224
		Specific Range/Altitude	NA/NA	1.062/FL 280	0.997/FL 310	0.997/FL 310	0.706/FL 300
Missions (4 passengers)	300 nm	Runway	NA	1,593	1,765	1,765	1,677
		Flight Time	NA	1+21	1+00	1+00	1+08
		Fuel Used	NA	429	440	440	534
		Specific Range/Altitude	NA/NA	0.699/FL 280	0.682/FL 280	0.682/FL 280	0.562/FL 240
	600 nm	Runway	NA	1,687	2,005	2,005	1,866
		Flight Time	NA	2+31	1+55	1+55	2+12
		Fuel Used	NA	735	830	830	977
		Specific Range/Altitude	NA/NA	0.816/FL 280	0.723/FL 280	0.723/FL 280	0.614/FL 260
	1,000 nm	Runway	2,380	1,812	2,380	2,380	2,109
		Flight Time	3+10	4+06	3+10	3+10	3+40
		Fuel Used	1,320	1,142	1,320	1,320	1,525
		Specific Range/Altitude	0.758/FL 290	0.876/FL 280	0.758/FL 290	0.758/FL 290	0.656/FL 280
		Suggested Base Price	NA	$3,081,402	$3,925,715	$4,290,590	$4,390,000
Remarks		Certification Basis	FAR 23, 2019 Garmin G1000 NXi.	FAR 23 A 62, 2016 Garmin G3000 with SVS and enhanced AFCS.	FAR 23, 1990/2006/07/14 Pilot door standard; five-blade propeller; Garmin G1000 NXi; elec-heated seats; five-year system warranty.	FAR 23, 1990/2006/07/14 Pilot door standard; five-blade propeller; HomeSafe; autothrottle; Garmin G3000; AoA-ESP-USP; five-year system warranty.	FAR 23, 1996/2005/08/19 Typically equipped executive interior and avionics.

MULTIENGINE TURBOPROPS ≤12,500-LB. MTOW

Manufacturer			Nextant Aerospace	Vulcanair SpA	Textron Aviation
Model			**G90XT C90**	**Viator AP68TP-600**	**Beechcraft King Air C90GTx C90GTi**
BCA Equipped Price			$2,750,000	$2,965,000	$4,200,000
Characteristics		Seating	1+7/10	1+7/10	1+7/8
		Wing Loading	35.6	33.0	35.5
		Power Loading	9.55	10.08	9.53
		Noise (dBA)	71.7	71.7	74.8
External Dimensions (ft.)		Length	35.5	37.0	35.5
		Height	14.3	11.9	14.3
		Span	NA	39.4	53.7
Internal Dimensions (ft.)		**Length:** OA/Net	12.4/12.4	11.9/17.2	12.6/12.6
		Height	4.8	4.1	4.8
		Width: Max/Floor	4.5/4.1	3.7/3.7	4.5/4.1
Power		Engines	2 GE Czech H75-100	2 RR 250 B17C	2 P&WC PT6A-135A
		Output (shp each)/Flat Rating	550/ISA+8C	328/ISA+25C	550/ISA+30C
		Inspection Interval	4,000t	3,500t	3,600t
Weights (lb.)		Max Ramp	10,560	6,669	10,545
		Max Takeoff	10,500	6,613	10,485
		Max Landing	9,700	6,283	9,832
		Zero Fuel	9,650c	5,621c	9,378c
		BOW	7,200	3,850	7,265
		Max Payload	2,450	1,771	2,113
		Useful Load	3,360	2,819	3,280
		Max Fuel	2,573	1,487	2,573
		Available Payload w/Max Fuel	787	1,332	707
		Available Fuel w/Max Payload	910	1,048	1,167
Limits		V_{MO}	208	200	226
		V_A	169	141	163
		PSI	5.0	—	5.0
Airport Performance		TO (SL elev./ISA temp.)	2,100	2,034	1,984
		TO (5,000-ft. elev.@25C)	2,800	2,950	3,375
		A/S (SL elev./ISA temp.)	3,800	2,034	3,690
		A/S (5,000-ft. elev.@25C)	5,100	2,953	5,855
		V_{MCA}	92	77	80
		V_{DEC}	97	85	97
		V_{XSE}	101	90	100
		V_{YSE}	111	105	108
Climb		Time to Climb (min.)/Altitude	18/FL 250	7/FL 100	18/FL 250
		Initial Engine-Out Rate (fpm)	460	270	460
		Initial All-Engine Gradient (ft./nm)	1,900	1,500	1,900
		Initial Engine-Out Gradient (ft./nm)	260	180	260
Ceilings (ft.)		Certificated	30,000	25,000	30,000
		All-Engine Service	30,000	25,000	30,000
		Engine-Out Service	22,000	8,050	19,230
		Sea-Level Cabin	11,065	—	11,065
Cruise	**Long Range**	TAS	213	169	208
		Fuel Flow	292	261	332
		Altitude	FL 280	FL 100	FL 260
		Specific Range	0.729	0.648	0.627
	High Speed	TAS	283	214	270
		Fuel Flow	578	375	612
		Altitude	FL 240	FL 100	FL 200
		Specific Range	0.490	0.571	0.441
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	324	543	260
		Average Speed	203	180	229
		Trip Fuel	600	781	620
		Specific Range/Altitude	0.540/FL 220	0.695/FL 100	0.419/FL 270
	Max Fuel (w/available payload)	Nautical Miles	1,300	837	1,026
		Average Speed	207	179	252
		Trip Fuel	1,782	1,220	2,044
		Specific Range/Altitude	0.730/FL 280	0.686/FL 100	0.502/FL 270
	Full Fuel (w/4 passsengers)	Nautical Miles	1,290	837	975
		Average Speed	207	179	252
		Trip Fuel	1,769	1,220	1,949
		Specific Range/Altitude	0.729/FL 280	0.686/FL 100	0.500/FL 270
	Ferry	Nautical Miles	1,369	837	1,045
		Average Speed	203	179	255
		Trip Fuel	1,850	1,220	2,053
		Specific Range/Altitude	0.740/FL 280	0.686/FL 100	0.509/FL 270
Missions (4 passengers)	**300 nm**	Runway	3,010	1,247	3,004
		Flight Time	1+06	1+35	1+13
		Fuel Used	584	419	748
		Specific Range/Altitude	0.514/FL 220	0.716/FL 100	0.401/FL 210
	600 nm	Runway	3,350	1,558	3,347
		Flight Time	2+12	3+18	2+22
		Fuel Used	1,162	866	1,353
		Specific Range/Altitude	0.516/FL 280	0.693/FL 100	0.443/FL 230
	1,000 nm	Runway	3,500	NP	3,690
		Flight Time	3+39	NP	3+58
		Fuel Used	1,938	NP	1,996
		Specific Range/Altitude	0.516/FL 280	NP/NP	0.501/FL 270
Remarks		Suggested Base Price	NA	$3,237,140	NA
		Certification Basis	STC ST01902CH; STC SA3593NM; STC SA4010NM; STC SA3593NM; STC SA01902CH; STC SA01456WI-D; STC SA02133SE	FAR 23, 1986 Garmin G1000 NXi; S-TEC Genesys 2100 autopilot. *BCA*-computed performance data.	CAR 3, 1959/2007 Collins Pro Line Fusion standard; STC SA10747SC, weight increase; STC SA02054SE, winglets; STC SA3593NM, swept propellers; STC SA4010NM, dual aft strakes; 1,000-nm mission flown with 755-lb. payload.

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**			$6,390,000	$6,500,000*	$7,695,000
Characteristics		Seating	1+8/10	1+11/19	1+7/9
		Wing Loading	40.3	29.8	70.3
		Power Loading	7.35	10.08	7.12
		Noise (dBA)	81.2	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	181	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 Collins Pro Line Fusion standard; Wi-Fi optional; STC SA02131SE.	EASA/FAR 23 A 57, 2010 **BCA* estimate*	EASA 23, 2014; FAR 23, 2015 Includes Collins Pro Line 21; TCAS I; Iridium satcom; RVSM approved; optional 390-lb. capacity internal tank: $275,000.

MULTIENGINE TURBOPROPS >12,500-LB. MTOW

Manufacturer			Textron Aviation	Textron Aviation
Model			**Beech King Air 350i B300**	**Beech King Air 350iER B300ER**
BCA Equipped Price			$7,755,000	$8,795,400
Characteristics		Seating	1+9/11	1+9/11
		Wing Loading	48.4	53.2
		Power Loading	7.14	7.86
		Noise (dBA)	72.9	81.5
External Dimensions (ft.)		Length	46.7	46.7
		Height	14.3	14.3
		Span	57.9	57.9
Internal Dimensions (ft.)		**Length:** OA/Net	19.5/19.5	19.5/19.5
		Height	4.8	4.8
		Width: Max/Floor	4.5/4.1	4.5/4.1
Power		Engines	2 P&WC PT6A-60A	2 P&WC PT6A-60A
		Output (shp each)/Flat Rating	1,050/ISA+10C	1,050/ISA+10C
		Inspection Interval	3,600t	3,600t
Weights (lb.)		Max Ramp	15,100	16,600
		Max Takeoff	15,000	16,500
		Max Landing	15,000	15,675
		Zero Fuel	12,500c	13,000c
		BOW	9,955	10,215
		Max Payload	2,545	2,785
		Useful Load	5,145	6,385
		Max Fuel	3,611	5,192
		Available Payload w/Max Fuel	1,534	1,193
		Available Fuel w/Max Payload	2,600	3,600
Limits		MMO	0.58	0.58
		Trans. Alt. FL/VMO	FL 210/263	FL 240/245
		VA	184	182
		PSI	6.5	6.5
Airport Performance		TO (SL elev./ISA temp.)	3,300	4,057
		TOFL (5,000-ft. elev.@25C)	5,376	7,675
		Mission Weight	14,196	16,100
		NBAA IFR Range	1,549	2,257
		V2	109	111
		VREF	100	104
		Landing Distance	2,390	2,728
Climb		Time to Climb (min.)/Altitude	15/FL 250	18/FL 250
		*FAR 25 Initial Engine-Out Rate (fpm)	552	337
		FAR 25 Initial Engine-Out Gradient (ft./nm)	304	182
Ceilings (ft.)		Certificated	35,000	35,000
		All-Engine Service	35,000	35,000
		Engine-Out Service	21,500	17,100
		Sea-Level Cabin	15,293	15,293
Cruise	**Long Range**	TAS	235	238
		Fuel Flow	362	402
		Altitude	FL 330	FL 330
		Specific Range	0.649	0.592
	High Speed	TAS	312	303
		Fuel Flow	773	764
		Altitude	FL 240	FL 240
		Specific Range	0.404	0.397
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	896	1,316
		Average Speed	273	261
		Trip Fuel	1,891	2,880
		Specific Range/Altitude	0.474/FL 350	0.457/FL 350
	Max Fuel (w/available payload)	Nautical Miles	1,485	2,223
		Average Speed	280	269
		Trip Fuel	2,944	4,528
		Specific Range/Altitude	0.504/FL 350	0.491/FL 350
	Full Fuel (w/4 passengers)	Nautical Miles	1,533	2,271
		Average Speed	285	271
		Trip Fuel	2,951	4,533
		Specific Range/Altitude	0.519/FL 350	0.501/FL 350
	Ferry	Nautical Miles	1,560	2,338
		Average Speed	289	276
		Trip Fuel	2,958	4,543
		Specific Range/Altitude	0.527/FL 350	0.515/FL 350
Missions (4 passengers)	**300 nm**	Runway	2,586	2,795
		Flight Time	1+02	1+05
		Fuel Used	881	919
		Specific Range/Altitude	0.341/FL 250	0.326/FL 250
	600 nm	Runway	2,702	2,927
		Flight Time	2+02	2+07
		Fuel Used	1,470	1,529
		Specific Range/Altitude	0.408/FL 290	0.392/FL 290
	1,000 nm	Runway	2,827	3,048
		Flight Time	3+27	3+35
		Fuel Used	2,102	2,195
		Specific Range/Altitude	0.476/FL 330	0.456/FL 330
		Suggested Base Price	NA	NA
Remarks		Certification Basis	FAR 23, 1989 Commuter category Collins Pro Line Fusion; Wi-Fi std.; RVSM approved; also available as 350HW with 16,500-lb. MTOW, 15,675-lb. MLW.	FAR 23, 1989/2007 Commuter category Collins Pro Line Fusion MultiScan radar; iTAWS; Wi-Fi standard; RVSM approved.

JETS <10,000-LB. MTOW

Manufacturer			Cirrus Design
Model			**Vision G2 SF-50**
BCA Equipped Price			$2,480,000
Characteristics		Seating	1+4/6
		Wing Loading	30.7
		Power Loading	3.25
		Noise (EPNdB): Lateral/Flyover/Approach	79.6/70.9/80.3
External Dimensions (ft.)		Length	30.7
		Height	10.9
		Span	38.7
Internal Dimensions (ft.)		**Length:** OA/Net	11.5/9.8
		Height/Dropped Aisle Depth	4.1/NA
		Width: Max/Floor	5.1/3.1
Baggage		**Internal:** Cu. ft./lb.	24/NA
		External: Cu. ft./lb.	30/NA
Power		Engine(s)	1 Wms Intl FJ33-5A
		Output (lb. each)/Flat Rating	1,846/ISA+10C
		Inspection Interval/Manu. Service Plan Interval	4,000t/—
Weights (lb.)		Max Ramp	6,040
		Max Takeoff	6,000
		Max Landing	5,550
		Zero Fuel	4,900c
		BOW	3,860
		Max Payload	1,040
		Useful Load	2,180
		Max Fuel	2,000
		Available Payload w/Max Fuel	180
		Available Fuel w/Max Payload	1,140
Limits		MMO	0.530
		Trans. Alt. FL/VMO	FL 183/250
		PSI	7.1
Airport Performance		TOFL (SL elev./ISA temp.)	2,036
		TOFL (5,000-ft. elev.@25C)	3,679
		Mission Weight	6,000
		NBAA IFR Range	1,098
		V2	91
		VREF	87
		Landing Distance	1,628
Climb		Time to Climb/Altitude	23/FL 310
		FAR 25 Engine-Out Rate (fpm)	NA
		FAR 25 Engine-Out Gradient (ft./nm)	NA
Ceilings (ft.)		Certificated	31,000
		All-Engine Service	31,000
		Engine-Out Service	—
		Sea-Level Cabin	NA
Cruise	**Long Range**	TAS	259
		Fuel Flow	300
		Altitude	FL 310
		Specific Range	0.863
	High Speed	TAS	305
		Fuel Flow	384
		Altitude	FL 310
		Specific Range	0.794
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	461
		Average Speed	233
		Trip Fuel	745
		Specific Range/Altitude	0.619/FL 310
	Max Fuel (w/available payload)	Nautical Miles	1,171
		Average Speed	233
		Trip Fuel	1,611
		Specific Range/Altitude	0.727/FL 310
	Four Passengers (w/available fuel)	Nautical Miles	622
		Average Speed	233
		Trip Fuel	941
		Specific Range/Altitude	0.661/FL 310
	Ferry	Nautical Miles	1,220
		Average Speed	233
		Trip Fuel	1,760
		Specific Range/Altitude	0.693/FL 310
Missions (4 passengers)	**300 nm**	Runway	1,867
		Flight Time	1+12
		Fuel Used	548
		Specific Range/Altitude	0.547/FL 310
	600 nm	Runway	2,036
		Flight Time	2+36
		Fuel Used	914
		Specific Range/Altitude	0.656/FL 310
	1,000 nm	Runway	2,437
		Flight Time	4+18
		Fuel Used	1,401
		Specific Range/Altitude	0.714/FL 310
Remarks		Certification Basis	FAR 23, 2016/18 Garmin Perspective Touch+; RVSM standard; Safe Return emergency autoland.

JETS <20,000-LB. MTOW

Manufacturer			Embraer	Nextant Aerospace	Honda Aircraft Co.	Textron Aviation	Syberjet
Model			**Phenom 100 EV EMB-500**	**Nextant 400 XTi BE 400A**	**HondaJet Elite HA-420**	**Cessna Citation M2 CE-525**	**SJ30i SJ30-2**
BCA Equipped Price			$4,250,000	$4,650,000	$5,300,000	$5,305,000	$8,306,452
Character-istics		Seating	1+5/7/7	2+7/9/9	1+5/8/8	1+7/7/7	1+4/6/6
		Wing Loading/Power Loading	53.1/3.09	67.6/2.67	60.6/2.61	44.6/2.72	73.2/3.03
		Noise (EPNdB): Lateral/Flyover/Approach	81.6/70.8/86.1	76.9/91.5/88.8	85.5/73.1/87.4	85.9/73.2/88.5	78.5/86.2/91.8
External Dimensions (ft.)		Length	42.1	48.4	42.6	42.6	46.8
		Height	14.3	13.9	14.9	13.9	14.2
		Span	40.4	43.5	39.8	47.3	42.3
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	9.0/11.0/11.0	15.5/15.5/—	12.1/12.1/NA	8.8/11.0/11.0	12.5/12.5/—
		Height/Dropped Aisle Depth	4.9/0.3	4.8/flat floor	4.8/NA	4.8/0.4	4.4/NA
		Width: Max/Floor	5.1/3.6	4.9/4.0	5.0/NA	4.8/3.1	4.8/2.8
Baggage		**Internal:** Cu. ft./lb.	10/93	27/410	NA/NA	—/—	6/100
		External: Cu. ft./lb.	60/419	26/450	66/600	46/725	53/500
Power		Engines	2 P&WC PW 617F1-E	2 Wms Intl FJ44-3AP	2 GE Honda HF-120-H1A	2 Wms Intl FJ44-1AP-21	2 Wms Intl FJ44-2A
		Output (lb. each)/Flat Rating	1,730/ISA+8C	3,052/ISA+7C	2,050/ISA+10C	1,965/ISA+7C	2,300/ISA+8C
		Inspection Interval/Manu. Service Plan Interval	3,500t/—	5,000t/—	5,000t*/—	3,500t/5,000	3,500t/—
Weights (lb.)		Max Ramp	10,748	16,500	10,780	10,800	14,050
		Max Takeoff	10,703	16,300	10,700	10,700	13,950
		Max Landing	9,998	15,700	9,960	9,900	12,725
		Zero Fuel	9,072c	13,000c	8,900c	8,500c	10,500c
		BOW	7,297	10,950	7,348	6,990	8,917
		Max Payload	1,775	2,050	1,552	1,510	1,583
		Useful Load	3,451	5,550	3,432	3,810	5,133
		Max Fuel	2,804	4,912	2,944	3,296	4,850
		Available Payload w/Max Fuel	647	638	488	514	283
		Available Fuel w/Max Payload	1,676	3,500	1,880	2,300	3,550
Limits		M_{MO}	0.700	0.780	0.720	0.710	0.830
		Trans. Alt. FL/V_{MO}	FL 280/275	FL 290/320	FL 302/270	FL 305/263	FL 295/320
		PSI/Sea-Level Cabin	8.3/21,280	9.1/24,000	8.8/23,060	8.5/22,027	12.0/41,000
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,190	3,821	3,491	3,210	3,939
		TOFL (5,000-ft. elev.@25C)	5,663	5,088	5,166	5,580	8,784
		Mission Weight	10,703	14,500p	10,700	10,700	13,125
		NBAA IFR Range	1,113	1,197	1,191	1,204	1,915
		V_2	99	116	115	111	112
		V_{REF}	95	105	106	101	104
		Landing Distance	2,473	2,960	2,804	2,340	2,657
Climb		Time to Climb/Altitude	19/FL 370	16/FL 370	15/FL 370	18/FL 370	16/FL 370
		FAR 25 Engine-Out Rate (fpm)	747	305	672	618	312
		FAR 25 Engine-Out Gradient (ft./nm)	453	158	303	334	167
Ceilings (ft.)		Certificated	41,000	45,000	43,000	41,000	49,000
		All-Engine Service	41,000	45,000	43,000	41,000	44,000
		Engine-Out Service	24,045	27,500	26,400	26,800	25,800
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	340/543	406/740	360/543	323/516	436/684
		Altitude/Specific Range	FL 410/0.626	FL 450/0.549	FL 430/0.663	FL 410/0.626	FL 450/0.637
	High Speed	TAS/Fuel Flow (lb./hr.)	406/955	447/968	419/999	401/920	475/1,188
		Altitude/Specific Range	FL 330/0.425	FL 430/0.462	FL 330/0.419	FL 350/0.436	FL 360/0.400
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	466	1,024	641	751	1,635
		Average Speed	325	367	332	358	402
		Trip Fuel	1,036	2,411	1,267	1,600	2,908
		Specific Range/Altitude	0.450/FL 410	0.425/FL 450	0.506/FL 430	0.469/FL 410	0.562/FL 470
	Max Fuel (w/available payload)	Nautical Miles	1,194	1,895	1,433	1,357	2,598
		Average Speed	333	384	344	372	410
		Trip Fuel	2,196	3,953	2,414	2,675	4,241
		Specific Range/Altitude	0.544/FL 410	0.479/FL 450	0.594/FL 430	0.507/FL 410	0.613/FL 490
	Four Passengers (w/available fuel)	Nautical Miles	1,092	1,801	1,171	1,183	2,205
		Average Speed	333	383	342	370	408
		Trip Fuel	2,038	3,706	2,044	2,352	3,713
		Specific Range/Altitude	0.536/FL 410	0.486/FL 450	0.573/FL 430	0.503/FL 410	0.594/FL 490
	Ferry	Nautical Miles	1,254	1,981	1,495	1,400	2,667
		Average Speed	329	381	342	378	411
		Trip Fuel	2,220	3,986	2,430	2,705	4,246
		Specific Range/Altitude	0.565/FL 410	0.497/FL 450	0.615/FL 430	0.518/FL 410	0.628/FL 490
Missions (4 passen-gers)	**300 nm**	Runway	2,909	3,015	3,372	2,625	2,822
		Flight Time	0+53	0+48	0+53	0+52	0+45
		Fuel Used	753	786	679	804	846
		Specific Range/Altitude	0.398/FL 390	0.382/FL 390	0.442/FL 430	0.373/FL 370	0.355/FL 410
	600 nm	Runway	3,121	3,044	3,413	2,692	3,025
		Flight Time	1+45	1+30	1+40	1+38	1+26
		Fuel Used	1,236	1,323	1,185	1,362	1,313
		Specific Range/Altitude	0.485/FL 390	0.454/FL 430	0.506/FL 430	0.441/FL 390	0.457/FL 450
	1,000 nm	Runway	3,179	3,101	3,473	3,009	3,336
		Flight Time	2+54	2+28	2+43	2+42	2+21
		Fuel Used	1,919	2,145	1,872	2,018	1,980
		Specific Range/Altitude	0.521/FL 410	0.466/FL 450	0.534/FL 430	0.496/FL 410	0.505/FL 450
Remarks		Certification Basis	FAR 23, 2008	FAR 25, 1981/85 STC 02371LA; STC 10959SC; STC 03960AT	FAR 23, 2015/19 *Mature TBO.	FAR 23, 2013	FAR 23 Commuter category

JETS <20,000-LB. MTOW

Manufacturer			Textron Aviation	Embraer	Textron Aviation	Pilatus Aircraft
Model			Cessna Citation CJ3+ CE-525B	Phenom 300E EMB-505	Cessna Citation CJ4 CE-525C	PC-24
BCA Equipped Price			$8,990,000	$9,650,000	$10,095,000	$11,134,900
Character-istics		Seating	1+8/9/9	1+7/10/10	1+9/10/10	1+8/10/10
		Wing Loading/Power Loading	47.2/2.46	60.5/2.67	51.8/2.36	54.0/2.68
		Noise (EPNdB): Lateral/Flyover/Approach	88.7/74.0/88.6	89.2/70.6/88.9	92.8/75.6/89.5	90.9/77.5/91.5
External Dimensions (ft.)		Length	51.2	51.2	53.3	55.2
		Height	15.2	16.7	15.3	17.3
		Span	53.3	52.2	50.8	55.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	12.3/15.7/15.7	14.8/17.2/17.2	12.9/17.3/17.3	17.0/17.0/23.0
		Height/Dropped Aisle Depth	4.8/0.4	4.9/0.3	4.8/0.4	5.1/flat floor
		Width: Max/Floor	4.8/3.1	5.1/3.6	4.8/3.3	5.6/3.8
Baggage		**Internal:** Cu. ft./lb.	—/—	10/77	7/40	90/1,000
		External: Cu. ft./lb.	65/1,000	74/573	71/1,000	NA/NA
Power		Engines	2 Wms Intl FJ44-3A	2 P&WC PW 535E1	2 Wms Intl FJ44-4A	2 Wms Intl FJ44-4A-QPM
		Output (lb. each)/Flat Rating	2,820/ISA+11C	3,478/ISA+15C	3,621/ISA+11C	3,420/ISA+23C
		Inspection Interval/Manu. Service Plan Interval	4,000t/5,000	5,000t/—	5,000t/5,000	5,000t/5,000
Weights (lb.)		Max Ramp	14,070	18,618	17,230	18,400
		Max Takeoff	13,870	18,552	17,110	18,300
		Max Landing	12,750	17,273	15,660	16,900
		Zero Fuel	10,675c	14,264c	12,500c	14,220c
		BOW	8,540	11,628	10,280	11,720
		Max Payload	2,135	2,636	2,220	2,500
		Useful Load	5,530	6,990	6,950	6,680
		Max Fuel	4,710	5,404	5,828	5,965
		Available Payload w/Max Fuel	820	1,586	1,122	715
		Available Fuel w/Max Payload	3,395	4,354	4,730	4,180
Limits		MMO	0.737	0.800	0.770	0.740
		Trans. Alt. FL/VMO	FL 293/278	FL 276/320	FL 279/305	FL 280/290
		PSI/Sea-Level Cabin	8.9/23,586	9.4/25,560	9.0/24,005	9.1/24,362
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,180	3,209	3,410	2,930
		TOFL (5,000-ft. elev.@25C)	4,750	5,374	5,180	4,980
		Mission Weight	13,870	18,552	16,788	18,300
		NBAA IFR Range	1,918	2,033	2,109	2,000
		V2	114	111	117	106
		VREF	99	103	99	90
		Landing Distance	2,422	2,212	2,281	2,120
Climb		Time to Climb/Altitude	15/FL 370	14/FL 370	14/FL 370	26/FL 450
		FAR 25 Engine-Out Rate (fpm)	808	872	839	665
		FAR 25 Engine-Out Gradient (ft./nm)	425	471	430	379
Ceilings (ft.)		Certificated	45,000	45,000	45,000	45,000
		All-Engine Service	45,000	45,000	45,000	45,000
		Engine-Out Service	26,250	30,137	28,200	30,000
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	352/624	385/783	377/812	358/757
		Altitude/Specific Range	FL 450/0.564	FL 450/0.492	FL 450/0.464	FL 450/0.473
	High Speed	TAS/Fuel Flow (lb./hr.)	415/1,197	464/1,549	442/1,470	438/1,717
		Altitude/Specific Range	FL 350/0.347	FL 350/0.300	FL 370/0.301	FL 300/0.255
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	1,080	1,381	1,425	1,206
		Average Speed	366	397	407	400
		Trip Fuel	2,381	3,369	3,753	3,069
		Specific Range/Altitude	0.454/FL 450	0.410/FL 450	0.380/FL 450	0.393/FL 450
	Max Fuel (w/available payload)	Nautical Miles	1,814	1,932	1,913	2,013
		Average Speed	377	393	413	366
		Trip Fuel	3,846	4,450	4,904	4,920
		Specific Range/Altitude	0.472/FL 450	0.434/FL 450	0.390/FL 450	0.409/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	1,825	2,010	1,927	2,030
		Average Speed	276	387	416	367
		Trip Fuel	3,767	4,471	4,920	4,956
		Specific Range/Altitude	0.484/FL 450	0.450/FL 450	0.392/FL 450	0.410/FL 450
	Ferry	Nautical Miles	1,900	2,094	1,955	2,129
		Average Speed	383	380	420	359
		Trip Fuel	3,872	4,498	4,955	5,046
		Specific Range/Altitude	0.491/FL 450	0.466/FL 450	0.395/FL 450	0.422/FL 450
Missions (4 passengers)	**300 nm**	Runway	2,608	2,899	2,669	2,280
		Flight Time	0+49	0+49	0+46	0+50
		Fuel Used	969	998	1,087	978
		Specific Range/Altitude	0.310/FL 370	0.301/FL 390	0.276/FL 390	0.307/FL 410
	600 nm	Runway	2,609	2,868	2,715	2,320
		Flight Time	1+35	1+29	1+27	1+32
		Fuel Used	1,571	1,653	1,865	1,674
		Specific Range/Altitude	0.382/FL 410	0.363/FL 410	0.322/FL 410	0.358/FL 450
	1,000 nm	Runway	2,720	2,831	2,770	2,360
		Flight Time	2+36	2+24	2+23	2+29
		Fuel Used	2,315	2,533	2,747	2,659
		Specific Range/Altitude	0.432/FL 430	0.395/FL 450	0.364/FL 430	0.376/FL 450
Remarks		Certification Basis	FAR 23, 2004/14 Commuter category Garmin G3000.	FAR 23, 2009/20 Commuter category	FAR 23, 2010 Commuter category	EASA CS 23, 2017; FAR 23, 2018 Approved for unimproved runway operations; standard aircraft with executive interior plus avionics.

JETS ≥20,000-LB. MTOW

Manufacturer			Bombardier	Bombardier	Textron Aviation	Embraer	Embraer
Model			Learjet 75 Liberty Model 45	Learjet 75 Model 45	Cessna Citation XLS+ CE-560XL	Legacy 450 EMB-545	Praetor 500 EMB-545
***BCA* Equipped Price**			$9,900,000	$13,800,000	$13,940,000	$16,570,000	$16,995,000
Characteristics		Seating	2+6/7*/9	2+8/9/9	2+9/12/12	2+7/9/9	2+7/9/9
		Wing Loading/Power Loading	69.6/2.79	69.6/2.79	54.6/2.45	74.0/2.73	77.7/2.87
		Noise (EPNdB): Lateral/Flyover/Approach	87.4/74.3/93.4	87.4/74.3/93.4	86.8/72.2/92.8	84.2/72.9/89.9	84.1/73.5/89.9
External Dimensions (ft.)		Length	58.0	58.0	52.5	64.6	64.6
		Height	14.0	14.0	17.2	21.1	21.1
		Span	50.9	50.9	56.3	66.4	66.4
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	13.4/19.8/19.8	13.4/19.8/19.8	14.3/18.5/18.5	17.4/20.6/24.0	17.4/20.6/24.0
		Height/Dropped Aisle Depth	4.9/flat floor	4.9/flat floor	5.7/0.7	6.0/flat floor	6.0/flat floor
		Width: Max/Floor	5.1/3.2	5.1/3.2	5.5/3.9	6.8/4.7	6.8/4.7
Baggage		**Internal:** Cu. ft./lb.	15/150	15/150	10/100	40/418	40/418
		External: Cu. ft./lb.	50/500	50/500	80/700	110/880	110/880
Power		Engines	2 Hon TFE731-40BR	2 Hon TFE731-40BR	2 P&WC PW545C	2 Hon HTF7500E	2 Hon HTF7500E
		Output (lb. each)/Flat Rating	3,850/ISA+23C	3,850/ISA+23C	4,119/ISA+10C	6,540/ISA+18C	6,540/ISA+18C
		Inspection Interval/Manu. Service Plan Interval	7,000t/—	7,000t/—	5,000t/—	OC/—	OC/—
Weights (lb.)		Max Ramp	21,750	21,750	20,400	35,891	37,699
		Max Takeoff	21,500	21,500	20,200	35,759	37,567
		Max Landing	19,200	19,200	18,700	32,518	34,172
		Zero Fuel	16,500c	16,500c	15,100c	25,904c	25,959c
		BOW	13,598	14,050	12,860	22,983	23,038
		Max Payload	2,902	2,450	2,240	2,921	2,921
		Useful Load	8,152	7,700	7,540	12,908	14,661
		Max Fuel	6,062	6,062	6,740	12,108	13,051
		Available Payload w/Max Fuel	2,090	1,638	800	800	1,610
		Available Fuel w/Max Payload	5,250	5,250	5,300	9,987	11,740
Limits		MMO	0.810	0.810	0.750	0.830	0.830
		Trans. Alt. FL/VMO	FL 270/330	FL 270/330	FL 265/305	FL 295/320	FL 295/320
		PSI/Sea-Level Cabin	9.4/25,700	9.4/25,700	9.3/25,230	9.7/27,140	9.7/27,140
Airport Performance		TOFL (SL elev./ISA temp.)	4,440	4,440	3,560	3,907	4,222
		TOFL (5,000-ft. elev.@25C)	5,272	5,272	5,430	5,189	5,692
		Mission Weight	20,782	20,782	20,200	35,759	37,567
		NBAA IFR Range	2,080	2,026	2,018	2,919	3,412
		V2	125	125	118	117	119
		VREF	113	113	106	101	101
		Landing Distance	2,296	2,338	2,740	2,090	2,086
Climb		Time to Climb/Altitude	15/FL 370	15/FL 370	15/FL 370	14/FL 370	14/FL 370
		FAR 25 Engine-Out Rate (fpm)	430	430	765	831	743
		FAR 25 Engine-Out Gradient (ft./nm)	207	207	389	426	375
Ceilings (ft.)		Certificated	51,000	51,000	45,000	45,000	45,000
		All-Engine Service	44,700	44,700	45,000	43,000	43,000
		Engine-Out Service	27,900	27,900	28,600	27,513	27,513
Cruise	Long Range	TAS/Fuel Flow (lb./hr.)	436/955	437/977	353/865	438/1,404	426/1,352
		Altitude/Specific Range	FL 470/0.457	FL 470/0.447	FL 450/0.408	FL 450/0.312	FL 450/0.315
	High Speed	TAS/Fuel Flow (lb./hr.)	465/1,258	465/1,280	431/1,238	469/2,014	469/2,018
		Altitude/Specific Range	FL 430/0.370	FL 430/0.363	FL 410/0.348	FL 390/0.233	FL 390/0.232
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	Max Payload (w/available fuel)	Nautical Miles	1,491	1,491	1,284	2,170	2,819
		Average Speed	420	420	387	428	423
		Trip Fuel	3,971	3,971	4,020	8,084	9,963
		Specific Range/Altitude	0.375/FL 470	0.375/FL 470	0.319/FL 450	0.268/FL 450	0.283/FL 450
	Max Fuel (w/available payload)	Nautical Miles	1,885	1,884	1,853	2,904	3,282
		Average Speed	424	424	397	431	419
		Trip Fuel	4,821	4,821	5,582	10,285	11,322
		Specific Range/Altitude	0.391/FL 470	0.391/FL 470	0.332/FL 450	0.282/FL 450	0.290/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	2,118	2,058	1,853	2,904	3,340
		Average Speed	425	426	397	431	417
		Trip Fuel	5,077	5,058	5,582	10,285	11,342
		Specific Range/Altitude	0.417/FL 490	0.407/FL 470	0.332/FL 450	0.282/FL 450	0.294/FL 450
	Ferry	Nautical Miles	2,225	2,163	1,918	2,973	3,416
		Average Speed	426	426	404	430	417
		Trip Fuel	5,113	5,093	5,612	10,313	11,357
		Specific Range/Altitude	0.435/FL 490	0.425/FL 490	0.342/FL 450	0.288/FL 450	0.301/FL 450
Missions (4 passengers)	300 nm	Runway	3,569	3,598	2,741	3,674	2,673
		Flight Time	0+46	0+46	0+46	0+45	0+48
		Fuel Used	983	994	1,239	1,543	1,564
		Specific Range/Altitude	0.305/FL 470	0.302/FL 470	0.242/FL 390	0.194/FL 450	0.192/FL 430
	600 nm	Runway	3,613	3,637	2,730	2,696	2,690
		Flight Time	1+25	1+25	1+28	1+26	1+28
		Fuel Used	1,715	1,729	2,081	2,478	2,494
		Specific Range/Altitude	0.350/FL 470	0.347/FL 470	0.288/FL 410	0.242/FL 450	0.241/FL 450
	1,000 nm	Runway	3,672	3,701	2,939	2,873	2,875
		Flight Time	2+18	2+18	2+26	2+21	2+21
		Fuel Used	2,695	2,711	3,198	3,710	3,802
		Specific Range/Altitude	0.371/FL 470	0.369/FL 470	0.313/FL 430	0.270/FL 450	0.263/FL 450
Remarks		Certification Basis	FAR 25; EASA CS 25 *Modsum 045T024322 IAW LR engineering report 45-D6038.	FAR 25; EASA CS 25	FAR 25, 2008	RBAC/FAR 25, 2015; EASA CS 25, 2015	RBAC/FAR 25, 2015/19; EASA CS 25, 2015/19 Mod: DCA 0550-000-00100-2018.

JETS ≥20,000-LB. MTOW

Manufacturer			**Textron Aviation**	**Textron Aviation**	**Embraer**	**Embraer**
Model			**Cessna Citation Latitude CE-680A**	**Cessna Citation Sovereign+ CE-680**	**Legacy 500 EMB-550**	**Praetor 600 EMB-550**
BCA Equipped Price			$18,195,000	$19,730,000	$19,995,000	$20,995,000
Character-istics		Seating	2+9/9/9	2+9/12/12	2+8/12/12	2+8/12/12
		Wing Loading/Power Loading	56.8/2.61	56.7/2.60	79.4/2.73	88.7/2.85
		Noise (EPNdB): Lateral/Flyover/Approach	87.7/73.5/87.7	87.8/71.9/87.9	85.5/73.1/89.9	86.9/75.1/90.3
External Dimensions (ft.)		Length	62.3	63.5	68.1	68.1
		Height	20.9	20.3	21.2	21.2
		Span	72.3	72.3	66.4	70.5
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	15.9/21.8/21.8	17.4/25.3/25.3	21.3/24.1/27.5	21.3/24.1/27.5
		Height/Dropped Aisle Depth	6.0/flat floor	5.7/0.7	6.0/flat floor	6.0/flat floor
		Width: Max/Floor	6.4/4.1	5.5/3.9	6.8/4.7	6.8/4.7
Baggage		**Internal:** Cu. ft./lb.	27/245	35/435	45/418	45/418
		External: Cu. ft./lb.	100/1,000	100/1,000	110/880	110/880
Power		Engines	2 P&WC PW306D1	2 P&WC PW306D	2 Hon HTF7500E	2 Hon HTF7500E
		Output (lb. each)/Flat Rating	5,907/ISA+15C	5,907/ISA+16C	7,036/ISA+18C	7,528/ISA+18C
		Inspection Interval/Manu. Service Plan Interval	6,000t/—	6,000t/—	OC/—	OC/—
Weights (lb.)		Max Ramp	31,050	31,025	38,537	42,990
		Max Takeoff	30,800	30,775	38,360	42,857
		Max Landing	27,575	27,575	34,524	37,478
		Zero Fuel	21,430c	21,000c	26,500	28,660
		BOW	18,656	18,231	23,700	24,658
		Max Payload	2,774	2,769	2,800	4,002
		Useful Load	12,394	12,794	14,837	18,332
		Max Fuel	11,394	11,394	13,058	16,138
		Available Payload w/Max Fuel	1,000	1,400	1,779	2,194
		Available Fuel w/Max Payload	9,620	10,025	12,037	14,330
Limits		MMO	0.800	0.800	0.830	0.830
		Trans. Alt. FL/VMO	FL 298/305	FL 298/305	FL 295/320	FL 295/320
		PSI/Sea-Level Cabin	9.7/26,800	9.3/25,230	9.7/27,140	9.7/27,140
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,580	3,530	4,084	4,717
		TOFL (5,000-ft. elev.@25C)	5,070	4,760	5,523	6,431
		Mission Weight	30,675	30,250	38,360	42,857
		NBAA IFR Range	2,700	3,112	3,131	4,040
		V2	115	117	120	128
		VREF	95	96	102	104
		Landing Distance	2,085	2,160	2,114	2,165
Climb		Time to Climb/Altitude	16/FL 370	13/FL 370	14/FL 370	13/FL 370
		FAR 25 Engine-Out Rate (fpm)	652	735	841	777
		FAR 25 Engine-Out Gradient (ft./nm)	340	377	420	364
Ceilings (ft.)		Certificated	45,000	47,000	45,000	45,000
		All-Engine Service	43,000	45,000	44,000	43,000
		Engine-Out Service	27,620	29,740	28,189	28,189
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	368/1,114	368/1,059	440/1,441	433/1,449
		Altitude/Specific Range	FL 430/0.330	FL 450/0.347	FL 450/0.305	FL 450/0.299
	High Speed	TAS/Fuel Flow (lb./hr.)	432/1,765	448/1,756	467/1,741	466/1,826
		Altitude/Specific Range	FL 390/0.245	FL 390/0.255	FL 430/0.268	FL 430/0.255
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,135	2,484	2,603	3,277
		Average Speed	394	396	438	426
		Trip Fuel	7,901	8,170	9,908	12,600
		Specific Range/Altitude	0.270/FL 450	0.304/FL 470	0.263/FL 450	0.260/FL 450
	Max Fuel (w/available payload)	Nautical Miles	2,645	2,996	2,998	3,878
		Average Speed	401	400	440	425
		Trip Fuel	9,586	9,658	11,151	14,357
		Specific Range/Altitude	0.276/FL 450	0.310/FL 470	0.269/FL 450	0.270/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	2,678	3,069	3,125	4,018
		Average Speed	401	402	433	423
		Trip Fuel	9,594	9,679	11,222	14,404
		Specific Range/Altitude	0.279/FL 450	0.317/FL 470	0.278/FL 450	0.279/FL 450
	Ferry	Nautical Miles	2,731	3,138	3,153	4,102
		Average Speed	405	405	440	421
		Trip Fuel	9,628	9,708	11,250	14,436
		Specific Range/Altitude	0.284/FL 450	0.323/FL 470	0.280/FL 450	0.284/FL 450
Missions (4 passengers)	**300 nm**	Runway	2,760	2,591	2,822	2,745
		Flight Time	0+46	0+45	0+45	0+46
		Fuel Used	1,610	1,506	1,545	1,558
		Specific Range/Altitude	0.186/FL 390	0.199/FL 390	0.194/FL 450	0.193/FL 450
	600 nm	Runway	2,845	2,600	2,817	2,746
		Flight Time	1+29	1+26	1+26	1+26
		Fuel Used	2,573	2,404	2,478	2,580
		Specific Range/Altitude	0.233/FL 430	0.250/FL 430	0.242/FL 450	0.233/FL 450
	1,000 nm	Runway	2,951	2,650	2,963	2,810
		Flight Time	2+25	2+21	2+21	2+18
		Fuel Used	3,989	3,750	3,750	3,969
		Specific Range/Altitude	0.251/FL 430	0.267/FL 430	0.267/FL 450	0.252/FL 450
Remarks		Certification Basis	FAR 25, 2015 Garmin G5000.	FAR 25, 2013 Garmin G5000.	RBAC/FAR/EASA CS 25, 2014	ANAC 2019; RBAC/FAR/EASA CS 25, 2014/19 Mod: DCA 0550-000-00026-2016.

JETS ≥20,000-LB. MTOW

Manufacturer			Gulfstream Aerospace	Bombardier	Textron Aviation	Dassault
Model			Gulfstream 280 G280	Challenger 350 BD-100-1A10	Cessna Citation Longitude CE-700	Falcon 2000S Falcon 2000EX
BCA Equipped Price			$24,500,000	$26,673,000	$28,345,000	$29,950,000
Characteristics		Seating	2+9/10/19	2+10/11/19	2+8/12/12	2+10/10/19
		Wing Loading/Power Loading	80.0/2.60	77.6/2.77	73.5/2.58	77.7/2.93
		Noise (EPNdB): Lateral/Flyover/Approach	89.5/75.2/90.5	87.6/75.3/89.6	78.7/61.6/81.1	91.8/75.1/90.5
External Dimensions (ft.)		Length	66.8	68.7	73.2	66.3
		Height	21.3	20.0	19.4	23.3
		Span	63.0	69.0	68.9	70.2
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.7/25.8/32.3	16.6/25.2/28.6	16.5/25.2/28.1	17.1/26.2/31.0
		Height/Dropped Aisle Depth	6.1/4.5	6.0/flat floor	6.0/flat floor	6.2/flat floor
		Width: Max/Floor	6.9/5.4	7.2/5.1	6.4/4.1	7.7/6.3
Baggage		**Internal:** Cu. ft./lb.	154/1,980	106/750	112/1,115	131/1,600
		External: Cu. ft./lb.	—/—	—/—	NA/NA	8/92
Power		Engines	2 Hon HTF7250G	2 Hon HTF7350	2 Hon HTF7700L	2 P&WC PW308C
		Output (lb. each)/Flat Rating	7,624/ISA+17C	7,323/ISA+15C	7,665/ISA+19C	7,000/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	7,000c/—
Weights (lb.)		Max Ramp	39,750	40,750	39,700	41,200
		Max Takeoff	39,600	40,600	39,500	41,000
		Max Landing	32,700	34,150	33,500	39,300
		Zero Fuel	28,200c	28,200c	26,000c	29,700c
		BOW	24,200	24,800	23,600	24,750
		Max Payload	4,000	3,400	2,400	4,950
		Useful Load	15,550	15,950	16,100	16,450
		Max Fuel	14,600	14,045	14,500	14,600
		Available Payload w/Max Fuel	950	1,905	1,600	1,850
		Available Fuel w/Max Payload	11,550	12,550	13,700	11,500
Limits		MMO	0.850	0.830	0.830	0.862
		Trans. Alt. FL/VMO	FL 280/340	FL 290/320	FL 293/325	FL 250/370
		PSI/Sea-Level Cabin	9.2/25,000	8.8/23,338	9.7/26,800	9.3/25,300
Airport Performance		TOFL (SL elev./ISA temp.)	4,750	4,829	4,810	4,325
		TOFL (5,000-ft. elev.@25C)	7,320	6,451	6,810	6,055
		Mission Weight	39,600	39,495	38,725	39,950
		NBAA IFR Range	3,600	3,250	3,520	3,600
		V2	137	133	136	123
		VREF	115	111	110	106
		Landing Distance	2,373	2,302	2,595	2,295
Climb		Time to Climb/Altitude	14/FL 370	14/FL 370	13/FL 370	16/FL 370
		FAR 25 Engine-Out Rate (fpm)	845	552	1,330	528
		FAR 25 Engine-Out Gradient (ft./nm)	371	249	456	257
Ceilings (ft.)		Certificated	45,000	45,000	45,000	47,000
		All-Engine Service	45,000	44,000	45,000	43,265
		Engine-Out Service	27,500	27,800	28,420	22,187
Cruise	Long Range	TAS/Fuel Flow (lb./hr.)	459/1,488	459/1,590	449/1,478	437/1,400
		Altitude/Specific Range	FL 450/0.308	FL 450/0.289	FL 450/0.304	FL 470/0.312
	High Speed	TAS/Fuel Flow (lb./hr.)	482/1,925	470/1,832	478/1,937	482/2,075
		Altitude/Specific Range	FL 430/0.250	FL 430/0.257	FL 430/0.247	FL 410/0.232
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	Max Payload (w/available fuel)	Nautical Miles	2,577	2,719	3,074	2,450
		Average Speed	448	447	452	426
		Trip Fuel	9,591	10,689	11,600	9,640
		Specific Range/Altitude	0.269/FL 450	0.254/FL 450	0.265/FL 450	0.254/FL 450
	Max Fuel (w/available payload)	Nautical Miles	3,636	3,235	3,422	3,445
		Average Speed	452	449	453	429
		Trip Fuel	12,757	12,206	12,763	12,740
		Specific Range/Altitude	0.285/FL 450	0.265/FL 450	0.268/FL 450	0.270/FL 470
	Four Passengers (w/available fuel)	Nautical Miles	3,646	3,250	3,500	3,540
		Average Speed	451	448	454	430
		Trip Fuel	12,761	12,212	12,763	12,740
		Specific Range/Altitude	0.286/FL 450	0.266/FL 450	0.274/FL 450	0.278/FL 470
	Ferry	Nautical Miles	3,724	3,307	3,500	3,615
		Average Speed	452	450	454	430
		Trip Fuel	12,789	12,236	12,787	12,740
		Specific Range/Altitude	0.291/FL 450	0.270/FL 450	0.274/FL 450	0.284/FL 470
Missions (4 passengers)	300 nm	Runway	2,957	3,611	2,744	2,795
		Flight Time	0+47	0+47	0+44	0+47
		Fuel Used	1,505	1,583	1,516	1,525
		Specific Range/Altitude	0.199/FL 450	0.190/FL 450	0.198/FL 450	0.197/FL 470
	600 nm	Runway	2,997	3,656	2,880	2,855
		Flight Time	1+26	1+26	1+23	1+27
		Fuel Used	2,412	2,577	2,457	2,465
		Specific Range/Altitude	0.249/FL 450	0.233/FL 450	0.244/FL 450	0.243/FL 470
	1,000 nm	Runway	3,136	3,718	3,025	2,920
		Flight Time	2+18	2+18	2+16	2+20
		Fuel Used	3,645	3,925	3,746	3,755
		Specific Range/Altitude	0.274/FL 450	0.255/FL 450	0.267/FL 450	0.266/FL 470
Remarks		Certification Basis	FAR 25, 2012; EASA CS 25, 2013	FAR 25 A 98; JAR 25 Chg 15 Collins Pro Line 21 Advanced.	FAR 25, 2019 Garmin G5000. Pre-certification data estimates.	FAR/EASA CS 25, 2013 EASy II flight deck. 2019 delivery price.

JETS ≥20,000-LB. MTOW

Manufacturer			Bombardier	Dassault	Dassault	Bombardier
Model			**Challenger 650** **CL-600-2B16**	**Falcon 2000LXS** **Falcon 2000EX**	**Falcon 900LX** **Falcon 900EX**	**Global 5500** **BD-700-1A11**
BCA Equipped Price			$32,350,000	$35,100,000	$44,800,000	$46,000,000
Character-istics		Seating	2+12/13/19	2+8/10/19	2+12/12/19	3+13/15/19
		Wing Loading/Power Loading	98.6/2.61	81.2/3.06	92.9/3.27	90.6/3.06
		Noise (EPNdB): Lateral/Flyover/Approach	86.2/81.2/90.3	91.7/76.4/90.5	90.3/78.2/92.1	79.7/88.9/89.4
External Dimensions (ft.)		Length	68.4	66.3	66.3	96.8
		Height	20.7	23.3	25.2	25.5
		Span	64.3	70.2	70.2	94.0
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	15.4/25.6/28.3	17.1/26.2/31.0	23.5/33.2/39.3	27.2/40.7/45.7
		Height/Dropped Aisle Depth	6.0/flat floor	6.2/flat floor	6.2/flat floor	6.2/flat floor
		Width: Max/Floor	7.9/6.9	7.7/6.3	7.7/6.3	7.9/6.5
Baggage		**Internal:** Cu. ft./lb.	112/900	131/1,600	127/2,866	195/1,000
		External: Cu. ft./lb.	—/—	8/92	—/—	—/—
Power		Engines	2 GE CF34-3B	2 P&WC PW308C	3 Hon TFE731-60	2 RR BR700-710D5-21*
		Output (lb. each)/Flat Rating	9,220*/ISA+15C	7,000/ISA+15C	5,000/ISA+17C	15,125/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	7,000c/—	6,000c/—	OC/—
Weights (lb.)		Max Ramp	48,300	43,000	49,200	92,750
		Max Takeoff	48,200	42,800	49,000	92,500
		Max Landing	38,000	39,300	44,500	78,600
		Zero Fuel	32,000c	29,700c	30,864c	58,000c
		BOW	27,250	24,750	26,750	50,861
		Max Payload	4,750	4,950	4,114	7,139
		Useful Load	21,050	18,250	22,450	41,889
		Max Fuel	19,852	16,660	20,905	38,959
		Available Payload w/Max Fuel	1,198	1,590	1,545	2,930
		Available Fuel w/Max Payload	16,300	13,300	18,336	34,750
Limits		MMO	0.850	0.862	0.870	0.900
		Trans. Alt. FL/VMO	FL 222/348	FL 250/370	FL 250/370	FL 301/340
		PSI/Sea-Level Cabin	8.8/23,000	9.3/25,300	9.6/25,300	10.3/30,125
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	5,640	4,675	5,360	5,436
		TOFL (5,000-ft. elev.@25C)	9,233	6,840	7,615	7,284
		Mission Weight	47,802	42,010	48,255	92,500
		NBAA IFR Range	4,011	4,100	4,685	5,978
		V2	147	127	134	138
		VREF	117	106	111	107
		Landing Distance	2,365	2,295	2,455	2,189
Climb		Time to Climb/Altitude	21/FL 370	17/FL 370	19/FL 370	18/FL 370
		FAR 25 Engine-Out Rate (fpm)	581	463	723	523
		FAR 25 Engine-Out Gradient (ft./nm)	237	221	324	227
Ceilings (ft.)		Certificated	41,000	47,000	51,000	51,000
		All-Engine Service	38,250	42,315	39,630	42,900
		Engine-Out Service	20,000	21,010	24,980	20,600
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	424/1,832	437/1,485	431/1,665	470/2,646
		Altitude/Specific Range	FL 410/0.231	FL 450/0.294	FL 430/0.259	FL 450/0.178
	High Speed	TAS/Fuel Flow (lb./hr.)	470/2,448	483/2,325	474/2,225	499/3,266
		Altitude/Specific Range	FL 370/0.192	FL 390/0.208	FL 390/0.213	FL 410/0.153
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	3,790	4,949
		Average Speed	417	427	422	488
		Trip Fuel	14,256	11,438	16,340	31,615
		Specific Range/Altitude	0.211/FL 410	0.255/FL 450	0.232/FL 430	0.157/FL 450
	Max Fuel (w/available payload)	Nautical Miles	3,974	3,990	4,565	5,849
		Average Speed	419	430	421	488
		Trip Fuel	17,939	14,798	18,909	36,262
		Specific Range/Altitude	0.222/FL 410	0.270/FL 470	0.241/FL 430	0.161/FL 490
	Four Passengers (w/available fuel)	Nautical Miles	4,011	4,065	4,650	5,978
		Average Speed	419	430	420	488
		Trip Fuel	17,953	14,798	18,909	36,322
		Specific Range/Altitude	0.223/FL 410	0.275/FL 470	0.246/FL 430	0.165/FL 490
	Ferry	Nautical Miles	4,085	4,155	4,740	6,035
		Average Speed	419	431	419	488
		Trip Fuel	17,982	14,798	18,909	36,348
		Specific Range/Altitude	0.227/FL 410	0.281/FL 470	0.251/FL 430	0.166/FL 490
Missions (4 passengers)	**300 nm**	Runway	3,389	2,795	2,730	2,542
		Flight Time	0+47	0+47	0+47	0+46
		Fuel Used	1,595	1,525	1,595	2,321
		Specific Range/Altitude	0.188/FL 410	0.197/FL 470	0.188/FL 470	0.129/FL 470
	600 nm	Runway	3,421	2,855	2,865	2,559
		Flight Time	1+27	1+27	1+27	1+23
		Fuel Used	2,835	2,465	2,625	3,822
		Specific Range/Altitude	0.212/FL 410	0.243/FL 470	0.229/FL 470	0.157/FL 490
	1,000 nm	Runway	3,483	2,920	2,880	2,596
		Flight Time	2+19	2+20	2+20	2+13
		Fuel Used	4,532	3,755	4,070	5,871
		Specific Range/Altitude	0.221/FL 410	0.266/FL 470	0.246/FL 450	0.170/FL 490
Remarks		Certification Basis	FAR 25, 1980/83/87/95/2006/15 Collins Pro Line 21 Advanced. *9,220 max takeoff; 8,729 normal takeoff.	FAR/EASA CS 25, 2013 EASy II flight deck. 2019 delivery price.	FAR 25/EASA 25, 1979/2010 EASy II flight deck. 2019 delivery price.	FAR 25, 1998/2004/19; EASA 25, 2004 Global Vision flight deck. *Marketed as Pearl 15. ModSums: 700T901902; 700T03185; 700T63572.

JETS ≥20,000-LB. MTOW

Manufacturer			Gulfstream Aerospace	Bombardier	Dassault	Airbus
Model			Gulfstream 500 GVII-G500	Global 5000 BD-700-1A11	Falcon 7X	A320 Prestige A320-251N*
BCA **Equipped Price**			$48,500,000	$50,441,000	$53,800,000	$115,000,000**
Characteristics		Seating	2+13/19/19	3+13/15/19	3+12/14/19	4+18/179/—
		Wing Loading/Power Loading	83.8/2.63	90.6/3.14	92.0/3.64	126.2/3.21
		Noise (EPNdB): Lateral/Flyover/Approach	87.4/75.5/91.0	88.7/83.5/89.7	90.1/82.3/92.6	85.7/81.6/92.6
External Dimensions (ft.)		Length	91.2	96.8	76.7	123.3
		Height	25.5	25.5	26.2	38.6
		Span	86.3	94.0	86.0	117.4
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	26.3/41.5/47.6	27.2/40.7/45.7	26.2/39.1/46.5	89.9/89.9/—
		Height/Dropped Aisle Depth	6.2/flat floor	6.2/flat floor	6.2/flat floor	7.4/flat floor
		Width: Max/Floor	7.6/6.1	7.9/6.5	7.7/6.3	12.1/11.7
Baggage		**Internal:** Cu. ft./lb.	175/2,250	195/1,000	140/2,004	NA/NA
		External: Cu. ft./lb.	—/—	—/—	—/—	985/NA
Power		Engines	2 P&WC PW814GA	2 RR BR700-710A2-20	3 P&WC PW307A	2 CFMI LEAP-1A26
		Output (lb. each)/Flat Rating	15,144/ISA+15C	14,750/ISA+20C	6,402/ISA+17C	27,120/ISA+29C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	7,200c/—	OC/—
Weights (lb.)		Max Ramp	80,000	92,750	70,200	175,045
		Max Takeoff	79,600	92,500	70,000	174,165
		Max Landing	64,350	78,600	62,400	148,592
		Zero Fuel	52,100c	58,000c	41,000c	141,757c
		BOW	46,850	50,861	36,600	110,000***
		Max Payload	5,250	7,139	4,400	31,757
		Useful Load	33,150	41,889	33,600	65,045
		Max Fuel	30,250	38,959	31,940	60,803
		Available Payload w/Max Fuel	2,900	2,930	1,660	4,243
		Available Fuel w/Max Payload	27,900	34,750	29,200	33,288
Limits		M_{MO}	0.925	0.890	0.900	0.820
		Trans. Alt. FL/V_{MO}	NA/NA	FL 303/340	FL 270/370	FL 250/350
		PSI/Sea-Level Cabin	10.7/31,900	10.3/30,125	10.2/29,200	8.3/NA
Airport Performance		TOFL (SL elev./ISA temp.)	5,300	5,540	5,710	6,920
		TOFL (5,000-ft. elev.@25C)	7,340	7,223	8,045	9,355
		Mission Weight	79,600	92,500	69,140	171,950
		NBAA IFR Range	5,200	5,467	5,795	NA
		V_2	148	138	133	NA
		V_{REF}	118	107	106	NA
		Landing Distance	2,620	2,189	2,120	2,400
Climb		Time to Climb/Altitude	15/FL 370	18/FL 370	19/FL 370	23/FL 360
		FAR 25 Engine-Out Rate (fpm)	NA	457	597	NA
		FAR 25 Engine-Out Gradient (ft./nm)	NA	199	269	NA
Ceilings (ft.)		Certificated	51,000	51,000	51,000	39,000
		All-Engine Service	NA	44,600	40,215	NA
		Engine-Out Service	NA	20,600	25,480	NA
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	488/2,445	470/2,856	459/2,260	451/4,113
		Altitude/Specific Range	FL 470/0.200	FL 450/0.165	FL 430/0.203	FL 370/0.110
	High Speed	TAS/Fuel Flow (lb./hr.)	516/3,087	499/3,582	497/3,205	473/5,096
		Altitude/Specific Range	FL 430/0.167	FL 410/0.139	FL 390/0.155	350/0.093
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	4,562	4,920	5,000	2,100
		Average Speed	478	463	453	428
		Trip Fuel	24,910	33,374	26,820	27,936
		Specific Range/Altitude	0.183/FL 470	0.147/FL 470	0.186/FL 450	0.075/FL 350
	Max Fuel (w/available payload)	Nautical Miles	5,212	5,395	5,670	6,000
		Average Speed	480	464	454	438
		Trip Fuel	27,368	35,702	29,560	54,000
		Specific Range/Altitude	0.190/FL 490	0.151/FL 470	0.192/FL 470	0.111/FL 390
	Four Passengers (w/available fuel)	Nautical Miles	5,292	5,546	5,760	6,100
		Average Speed	480	464	454	438
		Trip Fuel	27,400	36,010	29,560	54,000
		Specific Range/Altitude	0.193/FL 490	0.154/FL 470	0.195/FL 470	0.113/FL 390
	Ferry	Nautical Miles	5,362	5,598	5,840	62,000
		Average Speed	480	464	454	438
		Trip Fuel	27,425	36,034	29,560	54,000
		Specific Range/Altitude	0.196/FL 510	0.155/FL 470	0.198/FL 470	1.148/FL 390
Missions (4 passengers)	**300 nm**	Runway	3,480	2,487	2,500	3,670
		Flight Time	0+46	0+46	0+46	0+55
		Fuel Used	2,375	2,773	2,075	3,709
		Specific Range/Altitude	0.126/FL 490	0.108/FL 450	0.145/FL 450	0.081/FL 350
	600 nm	Runway	3,500	2,575	2,515	3,700
		Flight Time	1+23	1+23	1+25	1+34
		Fuel Used	3,647	4,445	3,285	6,157
		Specific Range/Altitude	0.165/FL 490	0.135/FL 490	0.183/FL 470	0.097/FL 390
	1,000 nm	Runway	3,525	2,697	2,640	3,760
		Flight Time	2+13	2+13	2+17	2+28
		Fuel Used	5,398	6,752	4,945	9,539
		Specific Range/Altitude	0.185/FL 490	0.148/FL 470	0.202/FL 470	0.105/FL 390
Remarks		Certification Basis	FAR 25, 2018; EASA CS 25, 2020	FAR 25, 1998/2004; EASA 25, 2004 Global Vision flight deck.	FAR/EASA 25, 2007 EASy II flight deck; DFCS. 2019 delivery price.	FAR 25, 1999/2016 *Also available as -271N with IAE PW1127G engines rated at 27,075 lbf; includes four additional center tanks and VIP cabin. ***BCA* estimate. ****BCA* estimate.

ULTRA-LONG-RANGE JETS

Manufacturer			Gulfstream Aerospace	Bombardier	Gulfstream Aerospace	Dassault	Bombardier
Model			**G550 GV-SP**	**Global 6500 BD-700-1A10**	**G600 GVII-600**	**Falcon 8X Falcon 7X**	**Global 6000 BD-700-1A10**
BCA Equipped Price			$54,500,000	$56,000,000	$58,500,000	$59,300,000	$62,310,000
Character-istics		Seating	4+16/18/19	4+13/15/19	4+16/19/19	3+12/14/19	4+13/15/19
		Wing Loading/Power Loading	80.1/2.96	97.5/3.29	81.5/3.02	95.9/3.62	97.5/3.37
		Noise (EPNdB): Lateral/Flyover/Approach	90.2/79.3/90.8	88.7/82.2/89.4	88.3/78.3/91.3	88.7/80.1/90.6	88.7/83.5/89.7
External Dimensions (ft.)		Length	96.4	99.4	96.1	80.2	99.4
		Height	25.8	25.5	25.3	26.1	25.5
		Span	93.5	94.0	94.1	86.3	94.0
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	30.3/42.6/50.1	27.3/43.3/48.3	30.2/45.2/51.3	29.8/42.7/50.1	27.3/43.3/48.3
		Height/Dropped Aisle Depth	6.0/flat floor	6.2/flat floor	6.2/flat floor	6.2/flat floor	6.2/flat floor
		Width: Max/Floor	7.0/5.4	7.9/6.5	7.6/6.1	7.7/6.3	7.9/6.5
Baggage		**Internal:** Cu. ft./lb.	170/2,500	195/1,000	175/2,250	140/2,004	195/1,000
		External: Cu. ft./lb.	—/—	—/—	—/—	—/—	—/—
Power		Engines	2 RR BR700-710C4-11	2 RR BR700-710D5-21*	2 P&WC PW815GA	3 P&WC PW307D	2 RR BR700-710A2-20
		Output (lb. each)/Flat Rating	15,385/ISA+15C	15,125/ISA+15C	15,680/ISA+15C	6,722/ISA+17C	14,750/ISA+20C
		Inspection Interval/Manu. Service Plan Interval	8,000t or OC/—	OC/OC	10,000t or OC/—	7,200c/—	OC/OC
Weights (lb.)		Max Ramp	91,400	99,750	95,000	73,200	99,750
		Max Takeoff	91,000	99,500	94,600	73,000	99,500
		Max Landing	75,300	78,600	76,800	62,400	78,600
		Zero Fuel	54,500c	58,000c	57,440c	41,000c	58,000c
		BOW	48,700	52,230	51,470	36,800	52,230
		Max Payload	5,800	5,770	5,970	4,200	5,770
		Useful Load	42,700	47,520	43,530	36,400	47,520
		Max Fuel	40,994	45,050	41,730	35,141	45,050
		Available Payload w/Max Fuel	1,706	2,470	1,800	1,259	2,470
		Available Fuel w/Max Payload	36,900	41,750	37,560	32,200	41,750
Limits		MMO	0.885	0.900	0.925	0.900	0.890
		Trans. Alt. FL/VMO	FL 270/340	FL 301/340	NA/NA	FL 270/370	FL 303/340
		PSI/Sea-Level Cabin	10.2/29,200	10.3/30,125	10.7/31,900	10.2/30,300	10.3/30,125
Airport Performance		TOFL (SL elev./ISA temp.)	5,910	6,278	5,900	5,880	6,476
		TOFL (5,000-ft. elev.@25C)	9,070	8,422	NA	8,540	7,926
		Mission Weight	91,000	99,317p	94,600	72,591	94,628p
		NBAA IFR Range	6,738	6,639	6,200	6,415	5,560
		V2	147	143	NA	138	142
		VREF	112	110	NA	107	110
		Landing Distance	2,240	2,243	2,550	2,245	2,243
Climb		Time to Climb/Altitude	18/FL 370	21/FL 370	18/FL 370	20/FL 370	21/FL 370
		FAR 25 Engine-Out Rate (fpm)	594	401	NA	774	324
		FAR 25 Engine-Out Gradient (ft./nm)	242	168	NA	339	137
Ceiling (ft.)		Certificated	51,000	51,000	51,000	51,000	51,000
		All-Engine Service	42,700	41,600	NA	40,075	41,600
		Engine-Out Service	25,820	20,500	NA	26,645	18,800
Cruise	**Long Range**	TAS	459	470	488	459	470
		Fuel Flow	2,563	2,841	2,865	2,254	3,046
		Altitude	FL 450	FL 450	FL 450	FL 430	FL 450
		Specific Range	0.179	0.165	0.170	0.204	0.154
	High Speed	TAS	488	499	516	497	499
		Fuel Flow	3,228	3,451	3,945	3,172	3,796
		Altitude	FL 430	FL 390	FL 410	FL 390	FL 410
		Specific Range	0.151	0.145	0.131	0.157	0.131
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	5,767	5,909	5,609	5,555	5,882
		Average Speed	452	464	480	452	464
		Trip Fuel	33,993	38,375	34,617	29,507	40,415
		Specific Range/Altitude	0.170/FL 490	0.154/FL 470	0.162/FL 450	0.188/FL 470	0.146/FL 470
	Max Fuel (w/available payload)	Nautical Miles	6,698	6,575	6,500	6,325	6,130
		Average Speed	454	488	481	453	464
		Trip Fuel	38,202	41,782	38,882	32,558	41,505
		Specific Range/Altitude	0.175/FL 490	0.157/FL 470	0.167/FL 490	0.194/FL 470	0.148/FL 470
	Eight Passengers (w/available fuel)	Nautical Miles	6,708	6,672	6,518	6,235	6,220
		Average Speed	453	488	481	453	464
		Trip Fuel	38,205	42,061	38,887	32,204	41,782
		Specific Range/Altitude	0.176/FL 490	0.159/FL 470	0.168/FL 490	0.194/FL 470	0.149/FL 470
	Ferry	Nautical Miles	6,853	6,792	6,658	6,475	6,330
		Average Speed	454	488	481	454	464
		Trip Fuel	38,251	42,113	38,930	32,653	41,831
		Specific Range/Altitude	0.179/FL 510	0.161/FL 470	0.171/FL 490	0.198/FL 470	0.151/FL 470
Missions (8 passengers)	**1,000 nm**	Runway	3,436	2,727	NA	2,715	2,852
		Flight Time	2+20	2+13	2+12	2+12	2+13
		Fuel Used	5,599	5,984	5,798	5,440	6,842
		Specific Range/Altitude	0.179/FL 490	0.167/FL 470	0.172/FL 490	0.184/FL 450	0.146/FL 470
	3,000 nm	Runway	3,599	3,503	NA	3,730	3,858
		Flight Time	6+42	6+20	6+19	6+19	6+20
		Fuel Used	15,474	17,283	16,352	15,945	19,538
		Specific Range/Altitude	0.194/FL 490	0.174/FL 470	0.183/FL 490	0.188/FL 450	0.154/FL 470
	6,000 nm	Runway	5,277	5,508	NA	5,785	6,293
		Flight Time	13+15	12+32	12+29	12+45	12+39
		Fuel Used	33,428	37,137	35,191	32,200	41,053
		Specific Range/Altitude	0.179/FL 490	0.162/FL 490	0.170/FL 490	0.186/FL 470	0.146/FL 490
Remarks		Certification Basis	FAR 25, 1997/2003; EASA CS 25, 2004	FAR 25, 1998/2003/19; EASA CS 25, 1998/2019 BEVS and Global Vision flight deck standard. *Marketed as Pearl 15. ModSums: 700T901901; 700T03185; 700T63572.	FAR 25, 2020; EASA CS 25 pending	FAR/EASA 25, 2016 EASy III flight deck; DFCS. 2020 delivery price.	FAR 25, 1998/2003; EASA CS 25, 1998 BEVS and Global Vision flight deck standard.

ULTRA-LONG-RANGE JETS

Manufacturer			Gulfstream Aerospace	Gulfstream Aerospace	Bombardier	*Gulfstream Aerospace*
Model			**G650 GVI**	**G650ER GVI**	**Global 7500 BD-700-1A10**	***G700 GVII-G700***
BCA Equipped Price			$68,500,000	$70,500,000	$75,000,000	*$75,000,000*
Character-istics		Seating	4+16/19/19	4+16/19/19	4+17/19/19	*4+16/19/19*
		Wing Loading/Power Loading	77.6/2.95	80.7/3.07	91.6/3.04	*83.8/2.95*
		Noise (EPNdB): Lateral/Flyover/Approach	89.8/77.5/88.3	89.6/78.7/88.3	91.6/80.3/88.8	*NA/NA/NA*
External Dimensions (ft.)		Length	99.8	99.8	111.0	*109.9*
		Height	25.7	25.7	27.0	*25.4*
		Span	99.6	99.6	104.0	*103.0*
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	32.7/46.8/53.6	32.7/46.8/53.6	36.0/54.4/60.6	*40.8/56.9/63.7*
		Height/Dropped Aisle Depth	6.3/flat floor	6.3/flat floor	6.2/flat floor	*6.3/flat floor*
		Width: Max/Floor	8.2/6.7	8.2/6.7	8.0/6.8	*8.2/6.7*
Baggage		**Internal:** Cu. ft./lb.	195/2,500	195/2,500	195/—	*195/2,500*
		External: Cu. ft./lb.	—/—	—/—	—/—	*—/—*
Power		Engines	2 RR BR700-725A1-12	2 RR BR700-725A1-12	2 GE Passport 20-19BB1A	*2 RR Pearl 700**
		Output (lb. each)/Flat Rating	16,900/ISA+15C	16,900/ISA+15C	18,920/ISA+15C	*18,250/NA*
		Inspection Interval/Manu. Service Plan Interval	10,000t/—	10,000t/—	OC/OC	*NA/—*
Weights (lb.)		Max Ramp	100,000	104,000	115,100	*108,000*
		Max Takeoff	99,600	103,600	114,850	*107,600*
		Max Landing	83,500	83,500	87,600	*83,500*
		Zero Fuel	60,500c	60,500c	67,500c	*62,750c*
		BOW	54,500	54,500	61,700	*56,365*
		Max Payload	6,000	6,000	5,800	*6,385*
		Useful Load	45,500	49,500	53,400	*51,635*
		Max Fuel	44,200	48,200	51,510	*49,400*
		Available Payload w/Max Fuel	1,300	1,300	1,890	*2,235*
		Available Fuel w/Max Payload	39,500	43,500	47,600	*45,250*
Limits		MMO	0.925	0.925	0.925	*0.925*
		Trans. Alt. FL/VMO	FL 290/340	FL 290/340	FL 320/350	*NA/340*
		PSI/Sea-Level Cabin	10.7/31,900	10.7/31,900	10.3/30,125	*10.7/31,900*
Airport Performance		TOFL (SL elev./ISA temp.)	5,858	6,299	5,760	*6,250*
		TOFL (5,000-ft. elev.@25C)	9,000	11,139	8,679	*NA*
		Mission Weight	99,600	103,600	114,850p	*107,600*
		NBAA IFR Range	6,912	7,437	7,800	*7,500*
		V2	146	148	137	*151*
		VREF	114	114	108	*116*
		Landing Distance	2,680	2,680	2,240	*2,550*
Climb		Time to Climb/Altitude	19/FL 370	21/FL 370	20/FL 370	*20/FL 370*
		FAR 25 Engine-Out Rate (fpm)	NA	NA	418	*NA*
		FAR 25 Engine-Out Gradient (ft./nm)	NA	NA	183	*NA*
Ceiling (ft.)		Certificated	51,000	51,000	51,000	*51,000*
		All-Engine Service	42,700	41,000	43,000	*41,000*
		Engine-Out Service	25,000	25,000	25,000	*NA*
Cruise	**Long Range**	TAS	488	488	488	*488*
		Fuel Flow	2,825	2,883	2,983	*2,945*
		Altitude	FL 450	FL 450	FL 450	*FL 450*
		Specific Range	0.173	0.169	0.164	*0.166*
	High Speed	TAS	516	516	516	*516*
		Fuel Flow	3,136	3,136	3,224	*3,540*
		Altitude	FL 450	FL 450	FL 450	*FL 450*
		Specific Range	0.165	0.165	0.160	*0.146*
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	5,934	6,459	6,902	*6,560*
		Average Speed	481	481	474	*481*
		Trip Fuel	36,285	40,285	44,610	*42,030*
		Specific Range/Altitude	0.164/FL 490	0.160/FL 490	0.155/FL 470	*0.156/FL 490*
	Max Fuel (w/available payload)	Nautical Miles	6,981	7,507	7,700	*7,450*
		Average Speed	482	482	475	*482*
		Trip Fuel	41,129	45,129	48,512	*46,301*
		Specific Range/Altitude	0.170/FL 510	0.166/FL 510	0.159/FL 510	*0.161/FL 510*
	Eight Passengers (w/available fuel)	Nautical Miles	6,912	7,437	7,725	*7,500*
		Average Speed	481	482	475	*482*
		Trip Fuel	40,820	44,820	48,519	*46,319*
		Specific Range/Altitude	0.169/FL 510	0.166/FL 510	0.159/FL 510	*0.162/FL 510*
	Ferry	Nautical Miles	7,105	7,636	7,860	*7,660*
		Average Speed	482	482	476	*482*
		Trip Fuel	41,168	45,168	48,560	*46,364*
		Specific Range/Altitude	0.173/FL 510	0.169/FL 510	0.162/FL 510	*0.165/FL 510*
Missions (8 passengers)	**1,000 nm**	Runway	3,241	3,241	3,442	*3,210*
		Flight Time	2+10	2+10	2+14	*2+10*
		Fuel Used	5,942	5,942	5,879	*5,993*
		Specific Range/Altitude	0.168/FL 510	0.168/FL 510	0.170/FL 510	*0.167/FL 510*
	3,000 nm	Runway	3,591	3,591	3,567	*3,490*
		Flight Time	6+17	6+17	6+21	*6+17*
		Fuel Used	16,280	16,280	16,799	*16,564*
		Specific Range/Altitude	0.184/FL 510	0.184/FL 510	0.179/FL 510	*0.181/FL 510*
	6,000 nm	Runway	5,241	5,241	4,678	*5,060*
		Flight Time	12+28	12+28	12+32	*12+27*
		Fuel Used	34,622	34,622	35,761	*35,372*
		Specific Range/Altitude	0.173/FL 510	0.173/FL 510	0.168/FL 510	*0.170/FL 510*
Remarks		Certification Basis	FAR, EASA CS 25, 2012	FAR 25, 2014; EASA CS 25, 2018 ASC 014	FAR 25, 2018; EASA CS 25, 2019	*FAR 25 pending; EASA CS 25 pending 2022 delivery price. *Marketing name only.*

ULTRA-LONG-RANGE JETS

Manufacturer			Boeing	Boeing	Airbus	Boeing
Model			BBJ MAX7 737-7	BBJ MAX8 737-8	ACJ319NEO A319-151N*	BBJ MAX9 737-9
BCA Equipped Price			$91,200,000	$99,000,000	$105,000,000**	$107,900,000
Characteristics		Seating	4+19/71/172	4+19/71/189	4+19/19/156	4+19/75/220
		Wing Loading/Power Loading	132.0/3.02	135.1/3.09	123.5/3.55	145.2/3.32
		Noise (EPNdB): Lateral/Flyover/Approach	NA/NA/NA	NA/NA/NA	84.9/81.4/92.0	NA/NA/NA
External Dimensions (ft.)		Length	116.7	129.7	111.0	138.3
		Height	40.3	40.3	38.6	40.3
		Span	117.8	117.8	117.4	117.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	83.9/85.5/85.5	91.9/98.5/98.5	79.0/79.0/—	100.6/107.2/107.2
		Height/Dropped Aisle Depth	7.1/flat floor	7.1/flat floor	7.4/flat floor	7.1/flat floor
		Width: Max/Floor	11.6/10.7	11.6/10.7	12.2/11.6	11.6/10.7
Baggage		**Internal:** Cu. ft./lb.	NA/NA	NA/NA	160/NA	NA/NA
		External: Cu. ft./lb.	274/NA	654/NA	128/NA	821/NA
Power		Engines	2 CFMI LEAP-1B	2 CFMI LEAP-1B	2 CFMI LEAP-1A24	2 CFMI LEAP-1B
		Output (lb. each)/Flat Rating	29,300/ISA+15C	29,300/ISA+15C	24,010/ISA+30C	29,300/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	OC/—
Weights (lb.)		Max Ramp	177,500	181,700	171,299	195,200
		Max Takeoff	177,000	181,200	170,417	194,700
		Max Landing	145,600	152,800	140,875	163,900
		Zero Fuel	138,700c	145,400c	132,939c	156,500c
		BOW	105,830	109,890	104,000***	117,900
		Max Payload	35,400	35,510	28,939	38,600
		Useful Load	71,670	71,810	67,299	77,300
		Max Fuel	70,109	70,149	66,196	73,734
		Available Payload w/Max Fuel	1,561	1,661	1,103	3,567
		Available Fuel w/Max Payload	36,300	36,300	38,360	38,700
Limits		MMO	0.820	0.820	0.820	0.820
		Trans. Alt. FL/VMO	FL 260/340	FL 260/340	FL 250/350	FL 260/340
		PSI/Sea-Level Cabin	9.0/24,000	9.0/24,000	9.0/24,000	9.0/24,000
Airport Performance		TOFL (SL elev./ISA temp.)	6,630	6,630	6,036	8,200
		TOFL (5,000-ft. elev.@25C)	NA	NA	8,360	NA
		Mission Weight	NA	NA	NA	NA
		NBAA IFR Range	NA	NA	NA	NA
		V2	NA	NA	137	NA
		VREF	122	122	111	124
		Landing Distance	2,440	2,440	2,220	2,570
Climb		Time to Climb/Altitude	24/FL 350	24/FL 350	22/FL 360	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	NA	36,000	NA
		Engine-Out Service	NA	NA	18,000	NA
Cruise	**Long Range**	TAS	455	455	447	457
		Fuel Flow	NA	NA	4,100	NA
		Altitude	FL 380	FL 380	FL 370	FL 360
		Specific Range	NA	NA	0.109	NA
	High Speed	TAS	471	471	470	471
		Fuel Flow	NA	NA	5,050	NA
		Altitude	FL 360	FL 360	FL 370	FL 360
		Specific Range	NA	NA	0.093	NA
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,692	2,692	2,679	2,628
		Average Speed	NA	NA	434	NA
		Trip Fuel	NA	NA	NA	NA
		Specific Range/Altitude	NA/FL 370	NA/FL 370	NA/FL 370	NA/FL 350
	Max Fuel (w/available payload)	Nautical Miles	NA	NA	6,750	NA
		Average Speed	NA	NA	442	NA
		Trip Fuel	NA	NA	61,785	NA
		Specific Range/Altitude	NA/FL 390	NA/FL 390	0.109/FL 410	NA/FL 390
	Eight Passengers (w/available fuel)	Nautical Miles	7,000	6,640	6,750	6,515
		Average Speed	NA	NA	442	NA
		Trip Fuel	NA	NA	61,785	NA
		Specific Range/Altitude	NA/FL 390	NA/FL 390	0.109/FL 410	NA/FL 410
	Ferry	Nautical Miles	NA	NA	6,800	NA
		Average Speed	NA	NA	442	NA
		Trip Fuel	NA	NA	61,785	NA
		Specific Range/Altitude	NA/FL 390	NA/FL 390	0.110/FL 410	NA/FL 410
Missions (8 passengers)	**1,000 nm**	Runway	NA	NA	4,075	NA
		Flight Time	NA	NA	2+26	NA
		Fuel Used	NA	NA	9,017	NA
		Specific Range/Altitude	NA/NA	NA/NA	0.111/FL 410	NA/NA
	3,000 nm	Runway	NA	NA	4,280	NA
		Flight Time	NA	NA	6+54	NA
		Fuel Used	NA	NA	26,148	NA
		Specific Range/Altitude	NA/NA	NA/NA	0.115/FL 410	NA/NA
	6,000 nm	Runway	NA	NA	6,160	NA
		Flight Time	NA	NA	13+35	NA
		Fuel Used	NA	NA	56,981	NA
		Specific Range/Altitude	NA/NA	NA/NA	0.105/FL 410	NA/NA
Remarks		Certification Basis	FAR 25, 2018 15,500-lb. interior allowance. All data preliminary.	FAR 25 A 137, 2017 18,000-lb. interior allowance. All data preliminary.	FAR 25, 1999/2018 *Also available with IAEV2527M-A5 engines with 26,500 lbf; includes five additional center tanks plus VIP cabin. ***BCA* estimate. ****BCA* estimate.	FAR 25 A 141, 2018 21,000-lb. interior allowance. All data preliminary.

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Hawkeye Aircraft Acquisitions is a boutique aircraft acquisition consulting company that helps companies and individuals interested in buying a jet or private aircraft solution for their travel needs.

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Mike McCracken
President

"I have known Mike for a number of years. He is knowledgable, responsive, and trustworthy. Mike would be a good choice to help sort out aviation options and assist with the purchase" —CEO Florida

"I retained Mike to assist me on the review of plane ownership options which ultimately lead to his guidance on the acquisition of a Citation XLS. Throughout that process Mike was extremely knowledgable about the aircraft that would best serve my needs….I highly recommend Mike." —CEO Montana

"I have known Mike for over 20 years. During that period, I have purchased three jet aircraft and sold one jet aircraft through Mike. I have found Mike to be very knowledgable about the market for aircraft through research and in researching available aircraft. He has a tried and proven systematic process for due diligence and researching available aircraft….I would recommend Mike's services to anyone contemplating the purchase or sale of a sophisticated aircraft" —CEO Georgia

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Kent S. Jackson
Contributing Editor
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Self-Insurance?

You must **be feeling lucky**

EVEN BEFORE COVID-19 CLOSURES BEGAN RAVAGING THE AVIATION world, the aviation insurance marketplace had become a painful one for aircraft operators. Premium increases of 20-30% on renewals have been the norm over the last year. Owners with recent losses are experiencing even steeper escalations.

Why? The end finally came to an unusually extended "soft" market in which competition drove premiums below the point at which insurers had adequate reserves to pay for large losses. These were not just the mega-losses that make headlines such as the Kobe Bryant and Boeing 737 MAX crashes. Rather, they included the everyday, generally unremarkable claims. Keep in mind that all segments of the aviation industry were enjoying strong levels of activity before COVID-19 struck, and those increased operations resulted in more non-catastrophic accidents and claims that, together, added up to unanticipated higher payouts by the insurance companies.

Consequently, some insurers simply chose to leave the market rather than compete in a low-premium business that could not sustain further losses. Others decided to reduce or eliminate coverage availability to some operators, such as older pilots, and/or for owner-flown turbine aircraft.

Given those circumstances, is self-insurance a viable alternative and what is it exactly? The term simply describes a company or individual choosing to forgo paying a third-party to provide coverage for property loss and liability in the event of an accident. The self-insuring company or individual intends to simply pay costs out-of-pocket, should an accident occur.

Historically, some cash-rich industries would take a creative approach: They purchased aircraft liability insurance, but not "hull" coverage for their aircraft. So, if the aircraft was later damaged or totaled, that loss was out of pocket, but if someone was injured, insurance coverage was available to provide legal defense costs and to pay any settlements or judgments.

Who can self-insure? While there are federal insurance requirements for FAR Part 135 and Part 121 air carriers, most Part 91 operators have no obligation to carry insurance. Some states, as part of their aircraft registration requirements, mandate minimum aircraft liability insurance. For instance, Virginia requires even Part 91 operators to have liability coverage. Those operators wanting to self-insure have the option of delivering $250,000 in cash to the Virginia Department of Aviation, or an irrevocable letter of credit for $250,000.

Does it sound expensive to park $250,000 with a state agency in case of an accident? Perhaps, but can you imagine an aviation liability claim in which such an amount would be adequate to cover the settlement or judgment? The average "slip and fall" settlement is between $15,000 and $45,000. The average settlement in the U.S. for an aviation fatality is $4.5 million. Of course, if your company has cash reserves in the millions, and a jury finds that the accident was a result of gross negligence, then the plaintiffs' attorneys will be seeking additional "punitive damages." Juries have often made such awards in the hundreds of millions of dollars against "deep pockets" defendants in aviation.

> The cost of legal defense after a fatal accident can quickly reach six figures, but the **insurance company does not deduct this cost from your liability limits.**

If you or your company is financing an aircraft purchase, then self-insurance is not an option. Banks typically will not loan money without proof that the borrower doesn't really need it. Nevertheless, even though you can demonstrate to the bank that you or your company doesn't need the loan, you won't be able to convince the bank that you have enough cash to self-insure. Banks will insist that you carry "hull" insurance to cover the full cost of the aircraft, and a healthy amount of liability coverage as well.

An often-overlooked benefit of liability insurance is the legal defense provided by the insurance carrier. Promptly after an accident, the insurer will hire counsel, at its cost, to represent the insured person or company. Even though the insured company may have in-house counsel, it will get the benefit of experienced aviation counsel at no charge. That counsel will provide advice through the harrowing legal process that will proceed at a glacial pace for months and even years after an accident. The insurance company pays these attorneys, but they work for the insured. Their experience gives them unique insight in how to work through the aftermath of an accident.

The cost of legal defense after a fatal accident can quickly reach six figures, but the insurance company does not deduct this cost from your liability limits. If the policy is for $50 million and the insurance company pays $100,000 in legal fees, the full $50 million is still available to pay settlements or judgments.

Self-insurance may seem like a reasonable risk in the face of rising premiums and an uncertain economy. However, in safety management system terms, it represents a low probability/high severity risk. At the end of an accident-free year, premiums look expensive, but premiums seem quite cheap when a plaintiff's lawyer serves you or your company with a lawsuit in the wake of an accident. **BCA**

Fred George
Senior Editor
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Embraer Legacy 650

Best value for money in transatlantic class

THINK OF THE LEGACY 650 AND 650E, RESPECTIVELY BUILT FROM 2011 to 2016 and 2016 to 2019, as mini BBJs. They're tough, capable jetliners converted into business aircraft. They can fly 8 passengers 3,800+ nm, or London — New York. Compared to the Legacy 600, the 650 has 2,600 lb. more fuel capacity for 600 additional miles. It also has higher thrust, more fuel-efficient engines, a stronger wing with bolt-in winglets, and larger landing gear and rolling stock to handle a nearly 4,000 lb. weight increase.

These aircraft offer three-zone cabins, a large aft lavatory with windows and a 240-cu. ft., full-time access, aft baggage compartment, by far the largest in its class with no inflight access restrictions. There's another 46 sq. ft. of carry-on luggage room. They typically are configured for 13 passengers. Competitive-range aircraft have larger cross-sections, but the Legacy 650/650E have 42.4-ft. long interiors that are nearly as long as that of the Falcon 8X.

EMBRAER EXECUTIVE AIRCRAFT

The 650 has a single aft lav whereas the 650E comes with a second crew lav up front and upgraded Honeywell Primus Elite avionics. Both aircraft have much upgraded interior furnishings and lower interior sound levels compared to Legacy 600. Embraer did all the business jet conversion work in-house, adding aux belly tanks, developing several interior configurations, increasing operating weights and refining exterior features to slash drag. The fully integrated product is type certified as the EMB-135BJ.

The Legacy 650 is ideal for charter because it has unsurpassed dispatch reliability, easy maintenance and rock bottom operating costs, say David Rimmer, president of New York-based Talon Air and seconded by Ralph Michiell, president of Custom Jet Charters in West Palm Beach, Florida.

The Legacy 650 can be viewed as a flying Checker Cab. It's no luxury limo, even though it's comfortably outfitted. It flies low, slow and short, compared to three-section cabin jets from Bombardier, Dassault and Gulfstream. It initially climbs only into the mid-thirties and cruises at Mach 0.74/425 KTAS on long-range missions. So, plan on 9 hr. inflight for a 3,800 nm mission. On shorter trips, bank on 400 to 420 kt. block speeds. Average fuel burn is 2,000 lb./hr. and direct operating cost (DOC) is $4,250 per hour, assuming 2+00 average missions and 500 flight hours per year.

Interior fit and finish is much improved from early Legacy 600s. Almost all aircraft are configured with a forward galley, a forward four-chair club section, a central four-seat conference grouping flanked by a cross-side credenza and an aft section with a convertible sofa/sleeper plus two facing chairs. The externally serviced, aft lavatory is spacious and it has left- and right-side windows that provide bright daylight illumination. An optional forward crew lav is available, but it shares galley space when its privacy doors are deployed. It also adds weight up front to an already nose-heavy aircraft.

Cockpits feature Honeywell Primus Elite avionics with flat panel displays. The Legacy 650E comes with standard autothrottles and docking stations for iPads. The aircraft is Cat II approach capable. Swift Broadband or Gogo Biz systems provide internet connectivity.

Since its commercial precursor was designed for quick turnarounds, checklists are short and systems are highly automated. Notably, a reduced takeoff thrust rating decreases engine wear and thus maintenance expense. Full rated thrust is available if available either runway length or climb gradient are factors.

The Legacy 650 has improved runway performance compared to Legacy 600. Assuming standard day conditions, takeoff field length (TOFL) is 3,573 ft. for a 1,000 nm mission. At MTOW, TOFL is 5,741 ft. for an ISA departure and 7,979 ft. when departing *BCA*'s 5,000-ft. elevation, ISA+20C airport. The Rolls-Royce AE3007 engines are flat-rated to ISA+15C, so hot-and-high departures may result in reduced weight takeoffs.

Basic maintenance intervals are 500 hr. or 6 months and 900 flight cycles/2,000 flight hours or 24 months with +/-20 flight hours and +/-15 day tolerances. Heavy maintenance, such as corrosion inspections, are due at 4,000 flight hours or 48 months, 8,000 flight hours or 72 months and 4,000 flight cycles or 96 months. Embraer Executive Care (EEC), a comprehensive maintenance program, provides predictable operating costs, including coverage for APU, avionics, tires, brakes, batteries, cabin systems and optional equipment. The top tier EEC enhanced program runs about $24,000 per month and $880 per hour for aircraft out of the 10-yr. warranty. Rolls-Royce corporate care runs close to $640 per hour for both engines, according to Ron Dech, president of Business Aircraft Solutions in Merritt Island, Florida.

The Legacy 650's main competitors are Bombardier Challenger 850, a converted CRJ200, having a longer and wider cabin but poorer runway performance, plus purpose-built business jets such as the Gulfstream IV, IV-SP and G450, Bombardier Challenger 601 and Dassault Falcon 900B.

While the Legacy 650 has comparatively low DOCs, unrivaled dispatch reliability and airline-frugal replacement parts costs, Minielli and Dech both say that Embraer's product and engineering support, along with parts availability, need improvement.

Early 2011 models sell for as little as $10 million and 2019 models command more than $12 million. **BCA**

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On Duty

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

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

▶ **All In Aviation,** Las Vegas, Nevada, announced that owner **Paul Sallach** has been selected as Small Business Person of the Year 2020 for Nevada by the U.S. Small Business Administration.


WU ZHENDONG

▶ **Asian Sky Group,** Hong Kong, appointed **Wu Zhendong** as the company's new chairman, leading all of ASG and Asian Sky Media's business unites, alongside Jeffery Lowe, managing director. Zhendong has over 35 years of general aviation experience working with clients in Hong Kong, mainland China and the U.S.

▶ **Aviation Partners,** Seattle, Washington, named **Gary Dunn** to the position of president. Dunn, 48, has served the company for more than two decades.


STEVE HUGHES

▶ **Fargo Jet Center,** Fargo, North Dakota, named **Anthony Manzeella** maintenance service advisor. **Bill Berg** has been promoted to assistant chief inspector and **Keith Lowe** has been promoted to aviation maintenance technician.

▶ **Inflite The Jet Centre,** United Kingdom, announced the appointment of **Steve Hughes** as general manager and CAMO of Excellence Aviation Services Limited & Excellence Aviation Limited. He joins the company from Luxaviation.


JOHN WASMUND

▶ **JetHQ,** Kansas City, announced that **Kani Saritas** has joined the company as vice president of sales based in the international headquarters in Dubai. He most recently served as senior director regional sales at Jet Aviation.

▶ **Keystone Aviation,** Salt Lake City, Utah, announced that **J. Dan Govatos** is the new director of Operation based in Salt Lake City. He will provide enhanced focus of aircraft operations, safety and training while strengthening aviation industry best practices and relationships for the company.


JOHN BERIZZI

▶ **Priester Aviation,** Wheeling, Illinois, announced that four new sales team members have joined the company: **Toby Batchelder, Greg Cummings, Deborah W. Maestas and G. Scott Shatzer.**

▶ **Universal Avionics,** Tucson, Arizona, appointed **John Berizzi** regional sales manager for the South-Central U.S. based in Duluth, Georgia. **John Wasmund** is the regional sales manager for the Southwest U.S. based in the Phoenix, Arizona area. **BCA**

Gone West

▶ **Kirby Harrison** died in April from COVID-19. He was a freelance writer for *The Weekly of Business Aviation, Business & Commercial Aviation* and others in the Informa publishing chain. Harrison joined the Navy in 1962 and spent 20 years in the service, virtually all of it as a photojournalist, traveling from small islands in the South Pacific to Vietnam to the bombing of the Marine barracks in Lebanon. When Harrison retired from the Navy, he went back to college and graduated in 1971 from Syracuse University with a Bachelor's Degree in Photojournalism. Along the way, he spent two years as a news photographer at the *Daily Press & Times Herald* in Newport News, Virginia, and three years working for Studio Sebe in Nice, France as a photographer. More recently, before retiring, he worked nearly 20 years for Naval Aviation News. He is survived by his wife, Svetlana Harrison.

Products & Services Previews

By Jessica A. Salerno jessica.salerno@informa.com

1. Heron Teams with AVIM

Heron Aviation announced that AVIM Group will support the company with an integrated technology backend that will consolidate infrastructure and centralize processes across the recruitment spectrum, bringing the crewing pipeline under one roof. The new services will allow Heron to cut down recruiting times, according to the company. Also announced, is the integration into the AVIM software suite as launch partner for their flagship product, The AVIM Clearinghouse.

Heron Aviation
www.heronaviation.de

2. GlobalAir.com and Conklin & de Decker Collaborate With Online Resources

Conklin & de Decker is teaming up with online aviation resource GlobalAir.com to offer customers streamlined access to important aircraft operating expense and life cycle cost data during the research process for jets, turboprops, helicopter and piston aircraft. When browsing GlobalAir.com, prospective buyers can now preview a selection of key aircraft data points including range, speed, payload, cabin area and wingspan direct from the advanced aircraft comparison tool, the Conklin & de Decker Report.

GlobalAir.com
GlobalAir.com

3

3. Elliott Guarantees Downtime

Elliott Aviation announced a $3,000 per day guaranteed four-week downtime on standalone Citation Excel/XLS Garmin G5000 retrofits. Elliott has delivered an industry-leading 12 G5000-equipped Excel/XLS aircraft. The company also offers free avionics familiarization with all Garmin G5000 installations at their headquarters in Moline, Illinois.

Elliott Aviation
www.elliottaviation.com

4. Engine Assurance Program Defers Minimum Flight Hours Requirement

Engine Assurance Program (EAP) will defer its already low hourly minimum usage requirements until 2021 to help operators who may be flying less as a result of the current pandemic. EAP's 75-hr. yearly minimum usage requirement is a benefit of its engine maintenance program and EAP will waive minimums for 2020 if operators fly 150 hr. by the end of 2021.

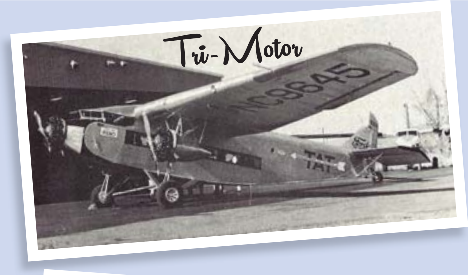
Engine Assurance Program
www.eap.aero

June/July 1970 News

During these days of **dismal economics,** one of the favorite topics of conversation along hangar row begins with the questions: Where has the aircraft industry **gone wrong?** What should it have done that it didn't do? – *BCA Staff*

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

Putting a CAS into operations now would tell us more about the collision avoidance problem in one year then 15 more years of meetings, proposals and ad nauseam rhetoric.



A Gander at the Goose: A legendary Ford Tri-Motor is aloft and well. Harrah's Automotive Collection, Reno, Nevada, which spent 4 yr. restoring a Tin Goose from 1928, plans to show it at fly-ins on the West Coast. TWA, an early user of the aircraft, will feature the model in promotions.

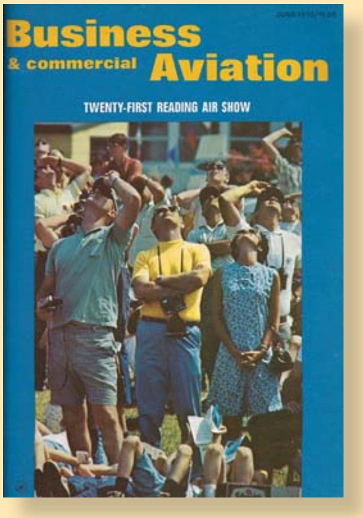
STOL conversions for the zipper Cherokee 235 are available from Robertson Aircraft. FAA certificated, the plane can fly slower than 45 mph and operate at maximum gross weight of 2,900 lb. from fields less than 700 ft. long.

Inside the Beechcraft Duke's dukedom quarters, though hardly of ballroom dimension, are ample and comfortable for six.

The Cessna 414's cabin provides passengers with more room than the first-class section of most airliners. While the airplane takes advantage of the high routes, its 4.2 psi system keeps the inside atmosphere at comfortably low levels.

Reading '70: Compilers of statistics determined that 6,514 people registered, 152 exhibitors hawked their wares in 231 booths (same as last year) and crowds watching the Thunderbirds, Hoover, Gaffaney, et al were generously estimated at 100,000. Much put upon tower operators logged aircraft movements of 2,588, 2,862 and 1,646 for the four-day show.

THE ARCHIVE



Business & commercial Aviation

TWENTY-FIRST READING AIR SHOW

The Reading Air Show, that rural Pennsylvania happening that became a general aviation institution, was captured by photographer Tony Linck as the Navy's Blue Angels performed last June. This month, the crowd will be back, but the Air Force Thunderbirds will be demonstrating their brand of precision-formation aerobatics.

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