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AIRCRAFT UPDATE

Leonardo AW609
Bringing tiltrotor technology to civil aviation

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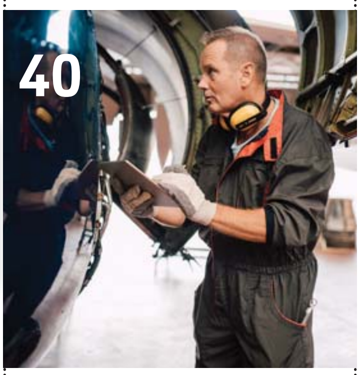

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Splendid Six

They continue a **tradition of excellence**

SITTING IN 15A ON A PAX-PACKED AIRBUS A321 TRANSCON, precious Purell at the ready, alert to and alarmed by every sneeze and cough, two things came to mind: (1) how I'd so rather be in a business jet and (2) with worries over the coronavirus emptying convention halls, stadiums and airports worldwide, I wondered how the March 12 gathering would fare.

By way of background, our sibling publication *Aviation Week & Space Technology* has annually celebrated the best in aerospace for more than 60 years. We editors decide which companies, teams and individuals are deserving of a Laureate, and the process culminates in a grand awards gala that in recent years has taken place at the National Building Museum in Washington, D.C.

I've attended many Laureate dinners over the years, and for several of them even served as master of ceremonies. It's always been a fun, glitzy night — tuxedoes and evening dress uniforms, shimmering gowns, champagne flutes, videos on giant screens, sincere speech making, where laughter and photo bombing abound. This year, the business aviation hosts were to be Fred George, our senior editor and chief pilot, partnered with Molly McMillin, editor-in-chief of the *Weekly of Business Aviation* and regular *BCA* contributor. In reviewing our community's six honorees, theirs would be a night to remember and absolutely deserving celebration.

However, as in years past, this year's honorees continued a tradition of business aviation **leading the way in innovation and are most deserving of thanks and applause.**

The 2020 Business Aviation Laureates and their respective categories follow:

▶ **Robotic Skies for Maintenance, Repair & Overhaul.** In anticipation of the widespread growth of commercial unmanned aircraft systems, Robotic Skies has created an expanding global network of repair stations to maintain and service the burgeoning fleet and serves as its broker/manager. In addition, it develops maintenance programs for operators, trains technicians and has teamed with Boeing to manage and optimize the supply chain.

▶ **Pratt & Whitney PT6-E series for Propulsion.** The first general aviation turboprop engine to feature a dual-channel, integrated electronic propeller and engine control system, the next generation PT6-E also delivers 10% more power than its predecessor model and features an unprecedented time-between-overhaul of 5,000 hr.

▶ **Switzerland's Rega air rescue service for Operations.** To operate during periods of reduced visibility in the Alps, Rega helped develop a low-altitude, helicopter-specific instrument route and approach system using satellite navigation, along with its own weather reporting multiple airborne optical systems to help pilots spot obstacles and conduct searches. Its fixed-wing air ambulances operate globally.

▶ **Wing Aviation for Technology & Innovation.** A subsidiary of Google parent Alphabet, last April, Wing became the first commercial drone delivery service to be awarded an FAR Part 135 air carrier certificate by the FAA. Its Hummingbird, a drone capable of vertical takeoffs and landings as well as wing-borne flight, conducted the first scheduled delivery by drone to a house in October.

▶ **Gulfstream's G500 and G600 for Platform.** The first of what's becoming an all-new GVII family of large-cabin, intercontinental Gulfstreams, the G500 and G600 feature the Symmetry flight deck including fly-by-wire controls, active sidesticks, 10 touch-screen controllers and links to most aircraft systems through GE Aviation's Data Concentration Network. Their three-section, super-quiet cabins maintain a 4,850-ft. altitude at FL 510.

▶ **Garmin Autoland for Safety.** The push of a red button by a pilot or untrained passenger activates the remarkable Autoland, a virtual copilot that takes complete control of the aircraft. The system automatically evaluates winds, weather and fuel reserves, then selects a suitable divert airport, alerts ATC of its intention, accelerates assuming a medical emergency, flies to the field, descends, extends landing gear and flaps, lands and rolls out on centerline. And stops. All with a single press of a button. For this ultimate in safety technology, Autoland was named the group's Grand Laureate.

All in all, an amazingly diverse set of product and service offerings that are not only technically advanced, but pioneering, proven and practical. These six have raised the bar for the entire aerospace community and not simply business aviation's segment. However, as in years past, this year's honorees continued a tradition of business aviation leading the way in innovation and are most deserving of thanks and applause.

Unfortunately, while the thanks are sincere, the grand hall was silent and empty that night. Hours after the president proclaimed the U.S. border closed to European visitors, came the hard but correct decision to postpone the Laureates celebration until some latter time and place after the virus threat passes. When and wherever that occurs, my admittedly biased suspicion is that the modus operandi then preferred by out-of-towner attendees will have considerably fewer than 15 rows of seats. **BCA**

Readers' Feedback

Remembered Always

Thank you for your kind words about [Pro Pilot Publisher] Murray Smith **(Viewpoint, February 2020).** My words of eulogy at his memorial service struggled to describe how much his life impacted our perceptions of aviators, aircraft and aviation. They were a small measure of the esteem in which the man's life was held and how dearly his friendship is missed.

I treasured our friendship for 48 years. His legacy leaves us a future full of promise. I'm certain that's the way he wanted "to slip the surly bonds."

Capt. Don Van Dyke
Montreal, Quebec

Good Work

I really liked "There I was . . ." **(February, 2020)**. I flew C-5 Galaxys for a number of years at Dover and Altus Air Force Bases. Its bank angle limit below 50 ft. was 5 deg.; 8 deg. was a wing scrape. So, we taught crab down final and then push out the crab in the flare. The C-5 rudder is huge and very effective. With a really strong crosswind, you could actually touch the upwind aft truck as you were touching down and straightening the fuselage. The hardest thing to teach a C-5 pilot was to touch down on centerline with no crab. We had an incident at Dover in wich a pilot had a wingtip scrape in a crosswind. He was wing lowing it on final. That didn't work in the C-5.

And we used 'reference ground speed' in the C-5 on final to account for wind shear and sudden wind speed changes. We'd bump up Vapch (VREF) on final to match the calculated reference ground speed. With a 145 VAPCH and 20 kt. reported headwind at the surface, your reference ground speed would be 125. If the ground speed on the INS was lower, we'd bump up VAPCH to match the calculated reference ground speed (maximum 20 kt. as I recall). The flight engineer would give us the reference ground speed. I liked the concept.

Keep up the good work. I love your articles.

Col. John C. Scherer, USAF (ret.)
ATP/CFII SMEL
Via email

Here's a Few More

I read "Struggling Through Sand" **(Cause & Circumstance, January 2020)** with interest and want to comment on it. Some years ago, I was involved in a flight test accident that was precipitated by sand getting into the angle of attack

It's easy to get caught up in the tidal wave of it all (eVTOL). But for most of it's history, civil aviation has advanced incrementaly, with demonstrated safety of flight its pacing item.

William Garvey *Viewpoint, March 2020*

(AOA) vane. The effect can be lagging data and "sticky" or sudden release of the indicated AOA and result in an inoperative or late stall warning. While modern airplanes generally use multiple AOA vanes, this represents a potential vulnerability that may not manifest itself until long after a dust storm encounter. So, what I am suggesting is to physically check the AOA probes for smooth operation after exposure to blowing sand.

Dave Gollings
President
MrG Associate
Atlanta, Georgia

From the Web

Comments regarding Challenging Airports by David Esler, March, BCA

Yes, David, you have shown and, I assume, you have flown into the airports discussed in your story. As a pilot that has flown for 50+ years in the U.S. Air Force, Mass. ANG, and the civilian sector, I cannot match the airports you have picked. However, there are two I have flown into that are worth

mentioning. The airport going into the Azores has cliffs on the approach that are REALLY ugly! While in the U.S. Air Force returning to the USA after about three weeks in SAC Alert in Spain flying a B-47, we were to land in the Azores to have a faulty fuel pump replaced. We made two approaches to the Azores airbase — saw nothing! Captain Lloyd Gray asked me if we had enough fuel to make one more approach to the airbase. Looking at the fuel gauges in a 'squided' angle, I said, ". . . Yes, no problem . . . ." Well, we landed, got fuel, and flew back to our home base, in Little Rock, Arkansas. The second airbase is in St. Thomas, U.S. Virgin Islands. The runway goes through the town with a "highway" crossing it so when aircraft are landing or taking off, road traffic is stopped while the aircraft land or takeoff. Really crazy!

Jgodston

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*

INTELLIGENCE

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NEWS / ANALYSIS / TRENDS / ISSUES

▶ **GULFSTREAM'S NEW, LONGEST-RANGE AND ROOMIEST** business jet, the G700, made its first flight Feb. 14, departing Savannah/Hilton Head International Airport in Georgia at 1:17 p.m. EST, according to flight tracking service FlightAware. It landed 2 hr., 32 min. later. Gulfstream unveiled a full-scale mockup of the $75 million business jet last October at the NBAA Convention and Exhibition in Las Vegas and announced launch orders from Qatar Airways and Flexjet. First deliveries are planned for 2022. The aircraft has an advertised range of 7,500 nm at Mach 0.85, but industry observers expect it to have a range beyond 7,700 nm after flight testing. The G700 is powered by two Rolls-Royce Pearl 700 turbofans and includes an all-new winglet, fly-by-wire, Honeywell's Epic-based Symmetry flight deck, BAE Systems' active sidesticks and touch-screen controls.

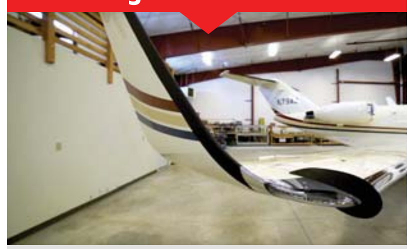
▶ **IN THE NEXT 10 YEARS, THE BUSINESS AIRCRAFT FLEET IN ASIA** is expected to grow 2.5% annually from 1,360 aircraft in 2020 to nearly 1,395 by 2029, according to Aviation Week Network's 2020 Business Aviation Fleet & MRO Forecast. Asia's fleet share is expected to grow to 5% of the world's fleet in 2029, from 4% in 2020. The Asian region is expected to take delivery of 565 new business jets and turboprop aircraft over the next decade, including 55 in 2020, according to the forecast. Business jets will hold a 75% share of the in-service business fleet in Asia in 2020, growing at a 3%, 10-year compound annual growth rate, and will comprise an even larger share, 80% of the fleet, by 2029. Asia is expected to hold 5% of the world's business jet fleet at the end of 2029, according to the forecast. The Gulfstream G650 will lead the in-service fleet in Asia in 2020, followed by the Gulfstream GV-SP (G500/G550) and Bombardier Global Express/XRS/6000. By 2029, the G650 is expected to remain in first place with 10.4% of the Asian fleet, followed by the GV-SP at 6.4% and the King Air 300/350 at 5%. Meanwhile, the maintenance, repair and overhaul market in Asia is expected to increase to $1 billion by 2029 from $666 million in 2020, at an average compound annual growth rate of 4.7%. The Asian business aircraft fleet is expected to create $875 billion in MRO requirements over the next 10 years, with the top-five aircraft manufacturers generating 93% of the total.

▶ **EMBRAER HAS ANNOUNCED THAT 2019 DELIVERIES** of 109 business jets, including 62 light jets and 47 large jets, were up from 91 business jet deliveries in 2018. Embraer delivered 46 business jets in the fourth quarter, including 20 light and 26 large aircraft, compared to 36 the year before. Deliveries in 2019 included 51 Phenom 300 and Phenom 300E light jets. Fourth-quarter business jet shipments were stronger than expected, Cowen and Co. analyst Cai von Rumohr wrote in a report to investors. Higher deliveries were mostly driven by higher shipments of Legacy 450s and Legacy 500s. In addition, deliveries of Legacy 650, Praetor 500 and Phenom 100 aircraft were higher than estimated by one or two aircraft each, offsetting fewer-than-expected deliveries of Phenom 300s.

Airbus Helicopters Deliveries Rise in 2019

Airbus Helicopters delivered 332 rotorcraft in 2019 compared to 323 in 2018, the company announced. Airbus Helicopters took gross orders for 369 units, or 310 net orders. Combined with support and services revenue, the orders are worth more than $7.59 billion. Deliveries include 130 H125 helicopters and 91 H145s.

Tamarack Celebrates 100th Winglet Installation



Tamarack Aerospace Group celebrated the 100th installation of its Active Winglet System at its Sandpoint, Indiana, headquarters. The company developed the winglet technology, which enables aircraft to use less fuel and fly farther with greater payloads. Larry McKoane, a retired California Air National Guard jet pilot and owner of a Cessna Citation, received the 100th Active Winglet installation.

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

FAI Aviation Partners With McLaren Racing

FAI Aviation Group, a provider of mission-critical aviation services, has partnered with McLaren Racing. The company will provide private aviation services to the Formula 1 group. The multiyear partnership begins at the start of the 2020 season. As part of the partnership, FAI Aviation Group will be represented on the inside of the rear wing endplate of the McLaren MCL35 race car for the 2020 Formula 1 season.

FlightSafety Adds PC-24 Training at Paris Facility

FlightSafety International has launched training for the Pilatus PC-24 business jet at its Paris Le Bourget Learning Center to serve its European customers. FlightSafety also offers training for the aircraft at its Dallas facility. The program uses a new PC-24 simulator equipped with Honeywell Primus Apex avionics that incorporates the SmartView synthetic vision system, CrewView display and VITAL 1150 visual system. The simulator has been qualified to Level D.

DASSAULT HAS COMPLETED THE CRITICAL DESIGN REVIEW of its next business aircraft, the long-range, widebody Falcon 6X twinjet, and is closing in on the preliminary design of the advanced low-noise follow-on, unofficially known as the 9X. Company Chairman and CEO Eric Trappier said of the 9X: "We are mobilizing significant resources for our next model, which we plan to unveil [later this] year. Development of the new aircraft will be

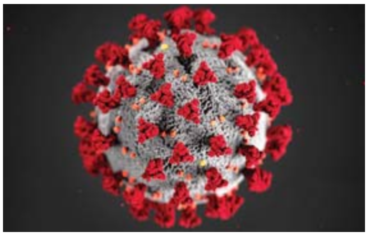
accompanied by further advances in our transition toward a fully digital enterprise." Although virtually no details of the concept have been revealed, the 9X is expected to be a medium- to long-range design, with the wide cabin cross-section of the 6X and a configuration optimized to reduce noise and fuel burn. Dassault's participation in several ongoing European and French national research efforts is expected to yield technologies that could be featured on the 9X. These potentially include an extended laminar flow wing; a fuel cell to replace or supplement the auxiliary power unit; and even an unconventional, U-shape noise-shielding empennage. Meanwhile, Dassault has entered the industrialization and manufacturing stages of the Falcon 6X by making parts. The first fuselage has been assembled in Dassault's French facilities, starting in Biarritz and moving to the Bordeaux-Merignac site for completion and mating with the wings. The first wings have been assembled in Martignas. When last reviewed, in October 2019, testing of the aircraft's Pratt & Whitney PW812D engine was progressing on schedule, with six involved in the certification effort, including one in a standard United Technologies-developed nacelle on the engine maker's Boeing 747SP flying testbed. The 13,000- to 14,000-lb.-thrust business aircraft engine is based on the smaller core of the PW1200G geared turbofan developed for the Mitsubishi MRJ/SpaceJet airliner and was selected for the new Falcon variant late in 2017. Dassault's switch to the 6X followed the axing of the shorter-fuselage Falcon 5X in the wake of delays to the Safran Silvercrest engine, which was earmarked for the now-canceled project.

GENERAL AVIATION GROUPS HAVE LAUNCHED A 2020 EUROPEAN General Aviation survey to understand the trends in flight activity, aircraft equipment and fleet composition in Europe to support safety analysis. The survey is sponsored by the General Aviation Manufacturers Association (GAMA) and the International Council of Aircraft Owners and Pilots Associations (IAOPA) with the support of the European Aviation Safety Agency (EASA) and AERO Friedrichshafen. Last year's survey results were used by EASA in its 2019 Annual Safety Review to calculate accident rates for noncommercial aircraft. Initial results will be presented at AERO 2020 on April 1-4 in Friedrichshafen, Germany. To take the survey, go to **https://tinyurl.com/w856jkk**

SATCOM DIRECT (SD), BASED IN MELBOURNE, FLORIDA, is expanding its hardware portfolio with the launch of a new tail-

mounted antenna series. The company's launch of its Plane Simple antenna portfolio positions SD as a single-source provider of end-to-end connectivity products for business jet and government operators around the world, it said. The new tail-mounted antenna system offers two variants for operation in Ku- or Ka-band frequencies. The Ku-band variant is expected to be available in early 2021, followed by the Ka-band version later in the year. SD has partnered with Inmarsat for Jet ConneX service and Intelsat for FlexExec connectivity.

WITH THE OUTBREAK OF THE NOVEL CORONAVIRUS, the charter flight industry has been responding to requests for charters related to travel disruptions brought on by the virus. Air Charter Service, based in the UK, has been "inundated with requests," the company reports. So has Air Partner, also based there. "Since the outbreak, our offices



around the world have been arranging flights on local carrier aircraft as the world deals with the travel disruption and overall cut to capacity in the region," said Justin Lancaster, Air Charter Service commercial director. Air Charter Service arranges flights for clients. "We have flown everything from four passengers on a private jet, to hundreds on larger aircraft, to 100 tons of surgical masks. It has been all systems go since the epidemic was first reported." Some customers have tried to avoid the COVID-19 infection by not flying on commercial aircraft with large numbers of passengers. Several organizations and governments have evacuated en masse on larger aircraft, such as on an Airbus A380. It has also flown relief cargo into the region, including protective overalls, medical gloves and millions of surgical masks, Lancaster said. Air Partner has evacuated nearly 340 British and EU nationals from Wuhan, China, and delivered more than 600 boxes of medical supplies. The challenges were many. Air Partner worked with aviation regulators and public health organizations to put in place safeguards and protocols for the flight crew. UK medical professionals were also on board. Securing the required overflight and landing permissions was also challenging and deadlines were tight. Air Partner also encountered difficulties. "We have faced various challenges in booking the flights, including passengers requesting crew that had not been to China since the beginning of January, clients not willing to put their cargo on aircraft that have recently been to the region [and] obtaining diplomatic permits," Lancaster said. Staff from three Air Charter Service regional offices have been working from home to minimize the risk of infection. Its U.S., European and Middle East offices have also been involved in booking the charters. Its biggest challenge is making sure all government and medical advice is being followed. During the week of Feb. 10, Air Charter Service had to cancel four flights due to changes in regulations in certain countries, it said.

PRIVATE JET CHARTER OPERATOR XOJET IS MOVING its headquarters from Northern California to Fort Lauderdale, Florida. "[The change] allows us the ability to work more closely with our key partners, and Florida offers a more business-friendly environment," said Kevin Thomas, XOJet president and COO. "Also in South Florida, there is a tremendous pool of aviation talent and by relocating to the East Coast, we can begin our day with the rest of aviation." The move is proceeding in two phases. The first, at Fort Lauderdale

Executive Airport, where the office opened Feb. 3, is temporary and calls for moving employees from Sacramento, California. The second phase calls for new construction of an operations center, with the exact location and contractors to be determined. It will be built at either Fort Lauderdale Executive Airport or Fort Lauderdale-Hollywood International Airport. XOJet will retain its small sales office in San Francisco and its corporate air shuttle operation, which will continue to operate from Sacramento McClellan Airport. "Relocation to Florida propels XOJet into a new growth phase," Thomas said. "We're looking at more people in addition to those relocating. Our immediate plans are for a total of 250 employees at the new operations center, but over the next several years, we expect it will grow to 400."

King Aerospace Records Growth in 2019

King Aerospace, based in Dallas, recorded an increase in business in 2019 with the completion of maintenance, avionics, paint and interior refurbishment on 40 Boeing Business Jets, Boeing 737s and 757s, and 45 corporate aircraft. By comparison, it completed work on 29 Boeing aircraft and 44 corporate aircraft in 2018. King's facilities include four hangars with 200,000 sq. ft. of space.

Vertis Aviation Launches Carbon Offset Program

Swiss-based charter company Vertis Aviation has introduced a new carbon offset program called VA Footprints. The program aims to offset 100% of carbon emissions generated by the charter flights it arranges for clients. Vertis says it will pay the full carbon credit amount on behalf of the customer to demonstrate its commitment to a lower carbon aviation future. The company will vary the organizations it uses and choose a different project each month.

Guardian Flight to Open Helicopter Base in Alaska

Guardian Flight, a Global Medical Response critical care air transport company, will open its first rotary-wing base in Alaska at Kenai Municipal Airport this spring. The Airbus H125 helicopter will serve Kenai Peninsula hospitals including South Peninsula Hospital in Homer, Central Peninsula Hospital in Soldotna and Providence Seward Medical Center in Seward. The Kenai base will operate 24/7 with a crew of four pilots, four clinicians and two mechanics.

Textron Aviation Signs 20-Year Wind Energy Agreement

Textron Aviation has signed a multi-year agreement with Evergy Inc. to meet nearly all of its electricity needs at the company's facilities in Wichita and Independence, Kansas, by utilizing renewable wind energy. The multi-year agreement will provide Textron's Kansas facilities with 55 megawatts of energy from a 300-MW wind farm being constructed near Manhattan, Kansas. The Soldier Creek Wind Farm is scheduled to be online by the end of 2020.

THE UK WILL WITHDRAW AS A MEMBER STATE OF THE EUROPEAN Union Aviation Safety Agency (EASA) after a transition period and shift responsibility for aircraft certification and safety regulation to its own Civil Aviation Authority (CAA), said UK Transportation Secretary Grant Shapps. Shapps, in Washington for meetings with U.S. officials, said the withdrawal from Cologne, Germany-based EASA was being negotiated at EU headquarters in Brussels. The break will happen after Dec. 31, when EU law no longer applies to the UK. So, the powers will revert to the CAA, which is probably one of the world's leading regulators and the expertise will need to come home to do that, but well do it in a gradual way, Shapps said. Outside of EASA membership, the UK will seek mutual recognition of certifications in bilateral agreements with other countries and blocks, he said. **The CAA eventually will assume responsibility for new aircraft type certificates and airworthiness approvals.** Shapps suggested urban air mobility (UAM) vehicles will be among the first examples, saying he had met with UAM developer Joby Aviation during his trip. "Over a period of time we'll be wanting to develop our own [aircraft] certifications," Shapps said. One of the things we'll want to do is be particularly forward-leaning in technology and automation. We'll make sure our legislative framework is in a great place to enable those kinds of organizations to excel in the UK market." Since its Brexit withdrawal from the EU in January, the UK has been considered a third country within EASA, a status that will continue through the end of the year. The transition period can be extended between the parties once by up to two years, says EASA, which does not mention any UK withdrawal. A decision to extend the transition period would have to be made by July 1, the agency says. Shapps said EASA has initiated infraction proceedings against the UK over its decision not to enact Standardized European Rules of the Air visibility and distance from cloud minima in Class D airspace.

WHEELS UP HAS ACQUIRED Gama Aviation, doing business as Gama Aviation Signature and the exclusive operator of Wheels Up's fleet of King Air and Citation aircraft. **The deal will make Wheels Up one of the world's largest aircraft companies, second only to NetJets,** experts note. Gama Aviation Signature is the largest FAR Part 135 operator in the U.S. Gama, which will operate as a subsidiary of Wheels Up, will continue to provide aircraft management and charter services from its current location in Shelton, Connecticut. Financial terms were not disclosed. The acquisition follows recent deals with Delta Air Lines and the acquisitions of Delta Private Jets, Travel Management Co. and Avianis Systems. With the latest purchase, Wheels Up owns or manages more than 300 aircraft. "This transaction supports our long-term vision for the future of Wheels Up, and as we continue to build the fleet and offer aircraft management services, we are uniquely positioned in the market with a full ecosystem for all private aviation needs," said Kenny Dichter, Wheels Up founder and CEO. (See *Fast Five* interview on page 18.)

GULFSTREAM AEROSPACE IS EXPANDING OPERATIONS in the Dallas-Fort Worth area with the construction of a $35 million service center at Fort Worth Alliance Airport. The facility will complement Gulfstream's service center at Dallas Love Field. Work is expected to begin in the third quarter of 2020 with plans to open by fall 2021. It will create about 50 new jobs. The 160,000-sq.-ft. facility will provide maintenance, repair and overhaul services and include hangar space, back shops and employee and customer offices. About 150 to 200 of Gulfstream's customer support employees at Love Field will relocate to Alliance airport, 35 mi. away. About 30 to 80 employees will remain at Love Field to provide maintenance and service to on-site and transient operators. Gulfstream's midsize cabin aircraft completions business in Dallas, with five hangars and 350 employees, will remain at Love Field.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AvAir Opens Facility At Dublin Airport

Phoenix-based AvAir, a global supplier of aftermarket aviation parts, announced it will open a 25,000-sq.-ft. warehouse facility at Dublin Airport. "The new Dublin location will allow us to provide better service to our customers in Europe, Asia and the Middle East," said CEO Mike Bianco. "With this new facility, we are removing nearly 5,000 mi. from the total distance much of our inventory would need to travel, allowing us to be more responsive to our customers, while saving time and money."

Van Nuys Airport Completes Taxiway B Rehabilitation

Los Angeles World Airports has announced the completion of a $29.7 million, 14-month project to reconstruct Taxiway B at Van Nuys Airport. Reconstruction of the 8,800-ft. taxiway was accomplished in nine phases and included full-depth asphalt pavement reconstruction, including taxiway shoulder construction, new markings, installation of LED centerline and edge lights, upgraded signage, new jet-blast-resistant fencing, and grading and drainage improvements.

DELIVERIES OF BUSINESS JETS AND PISTON AIRCRAFT ROSE in 2019, while turboprop deliveries declined compared to 2018, according to the General Aviation Manufacturers Association. GAMA announced the results Feb. 19 at its annual State of the Industry press conference at the National Press Club in Washington. Manufacturers of business and general aviation aircraft delivered 2,658 aircraft in 2019, including 917 in the fourth quarter, GAMA figures say. That compares to 2,441 deliveries in 2018, including 809 in the fourth quarter. Billings totaled $23.51 billion in 2019, compared to $20.56 billion the previous year. Manufacturers delivered 809 business jets during the year, compared to 703 in 2018 and 677 in 2017. Business jet deliveries were the highest in a decade, beating delivery numbers each year since 2009 when 874 jets were delivered. The largest number of business jet deliveries were in the midsize category, with 440 deliveries, followed by 207 large jet and 162 light jet deliveries. Turboprops deliveries declined from 592 in 2018 to 525 last year based on data from the same reporting manufacturers. (Viking Air reported an additional nine deliveries in 2018 but did not provide deliveries for the 2019 report.) **Piston deliveries totaled 1,324 aircraft in 2019, up 16.4% from 1,137 in 2018. "It is great to see two of our fixed-wing sectors, piston airplane and business jet shipments, reached decade highs," said Pete Bunce, GAMA president and CEO.** "Looking ahead, manufacturers are excited about the future, especially given the ongoing innovation in manufacturing that directly relates to safety and the progress being made in the development of supersonic and electrically propelled aircraft. GAMA and its member companies will support this momentum and technological advancement through our workforce, sustainability, regulatory and legislative efforts." The North American piston-engine market accounted for 66.4% of overall shipments. The second-largest market for piston aircraft for the fifth time in a row was Asia-Pacific at 12.8%. Turboprop shipments to North American customers totaled 50.3% of global deliveries. The North American market also accounted for 67.1% of business jet deliveries. The second-largest market for business jet deliveries in 2019 was Europe at 14.3%.

GENERAL AVIATION SUPPORTS MORE THAN 1.1 MILLION JOBS and has a total economic output in the U.S. of $245.8 billion, an updated study by PricewaterhouseCoopers says. The study calculated the direct, indirect, induced and enabled economic impacts based on 2018 data, the most recent data available. The growth trend and opportunity will increase as supersonic and electrically propelled business aircraft continue into their development phases, said Pete Bunce, General Aviation Manufacturers Association (GAMA) president and CEO. The industry must continue to keep pace with innovation to improve safety and focus on workforce development, Bunce added.

THE AIRCRAFT OWNERS AND PILOTS ASSOCIATION AIR SAFETY Institute has released a new episode in its Accident Case Study video series. The episode analyzes a Learjet 35A flight from Philadelphia that crashed while circling to land at Teterboro Airport, New Jersey, in visual conditions and the chain of events that led up to the accident. There are lessons to be learned that apply to all general aviation operations, the AOPA said. Each case study video uses the actual radio communications recordings and on-scene videos combined with animation developed by technical experts to explain the dynamics and chain of events.

YINGLING AVIATION, A WICHITA FBO AND MAINTENANCE, repair and overhaul (MRO) provider, is in the final days of an expansion that includes a dedicated business jet maintenance hangar, paint support and interior completions facility, and additional hangar and office space. A hangar dedicated to strip and paint aircraft opened in June. It is the largest facility, services and employee expansion in the company's 74-year history and triples its size to more than 200,000 sq. ft. Completion is expected in the next 30 to 45 days. Located at Wichita Dwight D. Eisenhower National Airport, Yingling took over space formerly leased by Hawker Beechcraft Services and began remodeling and upgrades. The site will add 40,000 sq. ft. of hangar space and 15,000 sq. ft. of office space. It also acquired the location once used by the Cessna Flying Club, which moved to the former Beechcraft facility in East Wichita. Yingling razed the facility and constructed 20,000 sq. ft. of new hangar space and 3,000 sq. ft. of office space. The expansion supports growth into the service of business jets, something it had previously performed on a smaller scale. "We needed the new jet hangar because of the increase in our business and the increase in the size of the airplanes that we're working on," said Jerry Pickett, Yingling vice president of business development. "It made a huge difference." It will now be able to accommodate all sizes of Textron Aircraft jets. The expansion also allows Yingling to strip and paint aircraft, a capability it was missing in the past. "We had paint booths but not a paint hangar," said Andrew Nichols, Yingling's new president. Currently three Citation business jets are in the paint process. Paint services are sold out for the next three months. The additions make Yingling a "one-stop MRO shop," Pickett said. Yingling has long been known as an FBO, but that accounts for only 10% to 15% of its business, Nichols said. "The rest of our business is from the MRO side." The company has grown employment from 100 a year ago to more than 125. Its goal is to employ 150 by the end of 2020. Yingling opened in 1946 as the first authorized Cessna facility. It also serves as an authorized service center for Beechcraft, Garmin, Collins, Bendix-King, Pratt & Whitney, McCauley, Hartzell and other products. Services include piston, turboprop and turbine maintenance; modifications; avionics; interiors; parts; and paint services. The business was founded by Vic Yingling, an Army Air Corps captain and son of a Wichita car dealer. Lynn Nichols, Yingling chairman and CEO, purchased the business in 2000 from then-owner Jerry Vanier and began expanding hangar and maintenance space, refreshing its interior and adding a Subway Cafe and Mama DeLuca's restaurant. It also added Aviator's Attic, with pilot-related products. In September, Lynn Nichols promoted his son, Andrew, from CFO to president, the "next logical step" in the company's generational succession plan, Lynn Nichols said. Andrew Nichols began working for his dad as a janitor at Yingling at age 14. Now a licensed pilot, he holds degrees in finance and business management. He began working at Yingling full-time in 2009 after serving in the finance department of Cessna Aircraft. In the next few years, as business continues to expand, the company may look outside Wichita to grow. "This is our home," Nichols said. "We've got good momentum here. We don't want to lose sight of that. But I think it would be silly not to look outside Wichita."

Blackhawk Aerospace Composites Celebrates 10 Years

Blackhawk Aerospace Composites (BAC) celebrated its 10th year in business in fourth quarter 2019. The Kentucky-based company manufactures aftermarket composite components for the business and military aviation markets and provides research and development services for several original equipment manufacturers and U.S. Defense Department companies.

ACI Jet Opens Bombardier Parts Depot in California

ACI Jet has established a California-based Bombardier parts depot for Global- and Challenger-series business jets. It has invested more than $1 million in parts inventory and has established a new 5,000-sq.-ft. facility at its San Luis Obispo Regional Airport headquarters. Customers of the new parts depot have access to numerous delivery options, including same-day delivery throughout much of California based on parts availability and time of order.

Kenny Dichter
Founder & CEO, Wheels Up,
New York, New York

An irrepressible entrepreneur, Dichter launched his business career as an undergraduate at the University of Wisconsin selling Badger T-shirts to fellow students, ultimately becoming a part owner of a campus gift store before departing Madison to make his mark on a larger scale. He went on to help start a company that produced music, CDs and videos for sports fans. Often traveling in business aircraft, he found their convenience, comfort and time efficiency so compelling, he decided to alter his focus and find a way to profit from the experience by sharing it with many. And thus was born in 2001 — after repeated pitches to a reluctant Richard Santulli — the Marquis Jet card program, which allowed members to use Santulli's NetJets aircraft by buying time in 25-hr. blocks. By 2010 when NetJets took Marquis in house, Dichter's team had sold $4 billion worth of cards and $1 billion in fractional shares. Within 3 yr., he launched Wheels Up, a travel membership program, with the announced purchase of 105 King Air 350i turboprops. The ultimate Badger has been busy ever since.

Questions for Kenny Dichter

1 **Your original goal was to create a new group of business aviation users. How goes that?**

Dichter: Our intent was to democratize private jet travel, and I think the record shows we're succeeding. As of right now there are more than 8,000 Wheels Up members — three quarters of them individuals and the rest corporate — and I think we'll easily exceed 10,000 by the close of this year. We started out with zero aircraft and today our owned and managed fleet exceeds 300, ranging from King Airs to large jets, and operating throughout North America. Last year we redefined the entry point to private aviation access even further with the introduction of Connect, an as-available and shared aircraft travel option, with an entry fee of just $2,995. We've already sold more than 1,000 Connect memberships since launch and five years out should have tens of thousands.

2 **Is the furious pace of acquisitions and partnership formation continuing?**

Dichter: No question, we've had full days for the past year or so with the recent Delta Air Lines deal, the acquisitions of Delta Private Jets, Travel Management Company and Avianis Systems and now the just-announced addition of Gama Aviation Signature as well. We now have all the chess pieces . . . at least for the short term. Through all that we've become a private aviation powerhouse, able to offer our members access to one of the world's largest owned and managed fleets of private aircraft, and over 1,250 Wheels Up safety-vetted and verified partner aircraft. We're always looking for new opportunities, but it's good to take a moment to digest what we've served up.

3 **You've mentioned operating in Western Europe. Is that still the case?**

Dichter: Yes, but why restrict it to the western portion? All of Europe is definitely on our radar. Our partnership with Delta and its Sky Team alliance puts us in a unique position to launch a European operation with gravitas. We would like to be up and running there in 24 months or so.

4 **Wheels Up has had solid private financial backing, but will you go public at some point?**

Dichter: T. Rowe Price, Franklin Templeton and Fidelity have been our anchor investors, and now Delta has joined them with a 27% interest in our business. Prior to the Gama acquisition, our enterprise value was pegged at $1.5 billion, but since then it's increased. Gama may not have the consumer recognition of the Delta brand, but it's significance to our business cannot be overstated. We're growing a company that's built to last and run it just like a public company already. So, if and when the market conditions are right, we'll be ready to go.

5 **Electric urban air mobility is drawing heavy outside investment. Is there a Wheels Up role?**

Dichter: We're monitoring that emerging market very closely. I'm not interested in being an electric VTOL or urban mobility pioneer, but I am interested in the evolution of that segment. When someone gets the equipment, safety and regulatory oversight right, we'll be right in there with our brand and our members. BCA

Oceanic Fuel Planning

Staying **legal and safe**

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

Is fuel planning for an oceanic trip just another mundane task you cede to your flight-planning service or does it force you back into a more primal stage of pilotage in which the details require extra scrutiny? Does a transatlantic trip from Westchester County Airport in White Plains, New York (KHPN) to Shannon, Ireland (EINN) prompt more steps than one to Los Angeles International (KLAX)? The latter will take more fuel and time, so why is the former any big deal?

As with many things in aviation, the answers to such questions depend on your level of experience, but not necessarily the way you think. I believe a more experienced international pilot will exercise greater caution, not less, than the novice.

For those with some oceanic experience, when you started "hopping the pond" your cockpit was probably cluttered with checklists to make sure you didn't forget anything important because everything seemed important. As your comfort level went up, the number of checklists went down. Perhaps an example will not only illustrate the process, but also convince you of the importance of each item on what could very well be the most important oceanic crossing checklist.

The distances are more extreme in the Pacific, to be sure. But nowhere in the world are there more complicating factors than in crossing the North Atlantic. So, let's consider an easily flown trip from Bedford, Massachusetts (KBED) to London Farnborough, UK (EGLF) in a Gulfstream G500.

Flight Plan KBED To EGLF GA5C M90

	Fuel	Time	Distance
DEST EGLF	016453	05:14	2918
RESV	000000	00:00	
ALT	000000	00:00	
HOLD	000000	00:00	
REQD	016453	05:14	
TAXI	000200		
XTRA	005000	01:44	
TOTL	021653	06:58	

KBED DCT LBSTA ALLEX ACADN N203B NICSO4850N 5040N 5130N 5320N MALOT MORAG P155 HON UL612 COWLY Q41 PEPIS DCT EGLF

WIND P058 MXSH 5/ALLEX AVG WIND 251/060 TAS 518 FL 410

DATA SOURCE: ARINCDIRECT

Step One: From Point A to Point B

Fuel planning for an oceanic trip starts just like it does for one over land. You run a flight plan from point A to point B, taking into consideration the fuel needed for engine start, taxi out, takeoff, climb, cruise, descent, landing and any reserves required by regulations and your company SOPs. In the case of our example flight, we would type into our flight-planning software our desire to climb at Mach 0.87, cruise at FL 430 doing Mach 0.90, and land with 5,000 lb. of fuel.

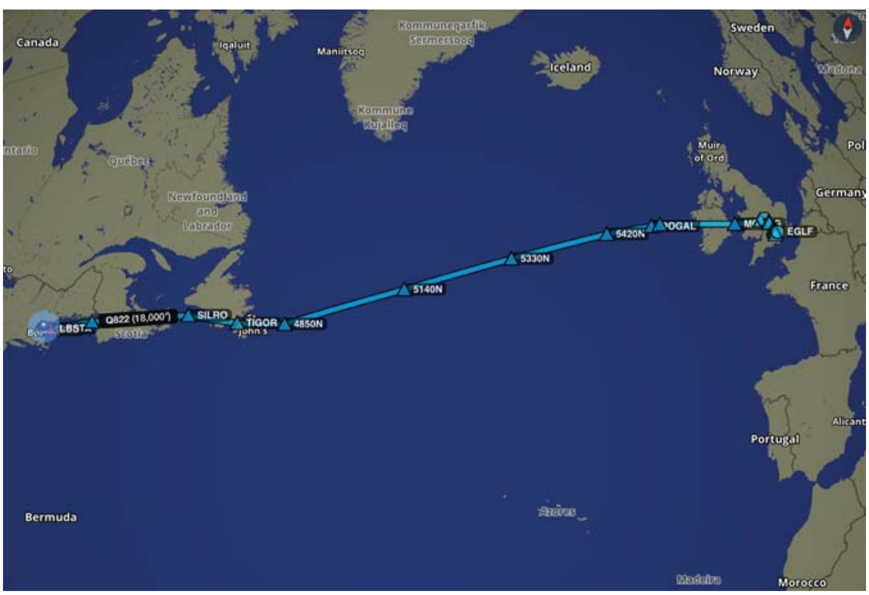
In just a few seconds we discover the airplane can do all this at FL 410 and it will take 16,453 lb. of fuel. So, adding our 200 lb. of taxi fuel and 5,000 lb. of desired fuel on landing means we need to load 21,653 lb. of Jet-A total. Easy. It's pretty much a straight shot. Right? Not so fast. Let's say the weather at Farnborough requires an alternate.

Step Two: Destination Alternate

It is just a matter of finding the right box and typing. London Luton, UK (EGGW) is a pretty good choice: The airport handles business jets and has airline service, the roads into London are pretty good and it is just 39 nm to the north of the city as the crow flies. Unless you are a crow, however, that direct routing is just about impossible.

Depending on your flight-planning software's defaults, as the crow flies may be exactly what you have planned and that could be a rude shock as you

FOREFLIGHT



A typical U.S. to UK flight

FOREFLIGHT

Farnborough to Luton, as the crow flies

Flight Plan KBED To EGLF GA5C M90			
	Fuel	Time	Distance
DEST EGLF	016453	05:14	2918
RESV	000000	00:00	
ALT EGGW	001160	00:24	123
HOLD	000000	00:00	
REQD	017613	05:38	
TAXI	000200		
XTRA	003840	01:20	
TOTL	021653	06:58	
KBED DCT LBSTA ALLEX ACADN N203B NICSO 4850N 5040N 5130N 5320N MALOT MORAG P155 HON UL612 COWLY Q41 PEPIS DCT EGLF			
WIND P058 MXSH 5/ALLEX AVG WIND 251/060 TAS 518 FL 410			

DATA SOURCE: ARINCDIRECT

look at your fuel gauges after toggling the Take Off/Go Around (TOGA) function of your flight director. Even if fuel isn't a concern, a Safety Assessment of Foreign Aircraft (SAFA) inspector will be looking for realistic alternate fuel numbers on your flight plan.

A good way to anticipate missed approach routing is to look at any standard instrument departures from your arrival airport and any standard arrivals into the alternate airport. Most flight-planning service providers will do this for you automatically, but you may have to specify this in your account configuration. As a matter of fact, the expected routing to our missed approach alternate is quite a bit farther than what that crow would have flown.

It may seem strange that this didn't change our total fuel required at all, but notice the alternate fuel was subtracted from our 5,000 lb. on landing at Farnborough.

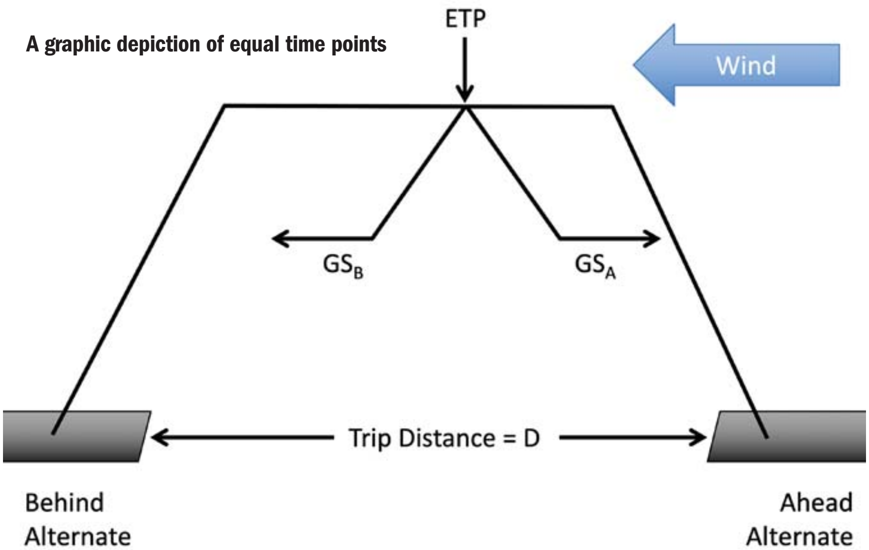
So, we have fuel computed from takeoff to destination, as well as a missed approach at our destination and the expected routing followed by an instrument approach and landing at our alternate. Job done. If this were a trip across the U.S., it would be. But what if we have some kind of problem en route?

Most of us understand what an equal time point is and that the math is fairly straightforward. We know that our divert decisions are based on where we are in relation to one or more equal time points. We long ago gave up the math. Now, we simply assume the latitude and longitude of the ETPs shown in our flight plan have our best interests in mind.

The formats differ among providers and there is more than one type of ETP; but let's consider the ETP given an engine failure. It is important to realize that in the phrase "equal time point" there are two contradictory meanings. First, an "equal time" is a time given in hours and minutes. Second, "point" is a location in space, given in latitude and longitude. Here we see two ETPs that can lead to three different decisions.

The first point, given at 36 deg., 24.6 min. west longitude, is a point in space at which we'll arrive 2 hr. and 44 min. after takeoff. If we have an engine failure at this precise location, it will take us 2 hr. and 21 min. to fly on the remaining engine and our best

A graphic depiction of equal time points



JAMES ALBRIGHT/BCA

1E INOP		
LAT/LONG N50 50.2/W036 24.6	CYQX	BIKF
TIME TO ETP DIVRSN PT	02.44	
DIST TO ETP DIVRSN PT	01521	
FUEL TO ETP DIVRSN PT/RMNG	009548/011907	
FL/BURN/TIME TO ETP AP	320/04254/02.21	330/04289/02.21
TAS/ETA/DIST TO ETP AP	325/1705/00712	332/1705/000904
MAG HDG/AVG WIND COMP TO EPT AP	277/M028	045/P053
ISA TEMP DEV TO ETP AP	M008	M003
HOLD FUEL/TIME AT ETP AP	000000/00.00	000000/00.00
TOTAL FUEL TO ETP AP/RMNG FOD	013802/007653	013837/007618

DATA SOURCE: ARINCDIRECT

1E INOP		
LAT/LONG N52 58.5/W025 45.5	BIKF	EINN
TIME TO ETP DIVRSN PT	03.27	
DIST TO ETP DIVRSN PT	01937	
FUEL TO ETP DIVRSN PT/RMNG	011764/009691	
FL/BURN/TIME TO ETP AP	330/02701/01.32	330/02718/01.32
TAS/ETA/DIST TO ETP AP	332/1659/00669	335/1659/000611
MAG HDG/AVG WIND COMP TO EPT AP	021/P109	104/P061
ISA TEMP DEV TO ETP AP	M002	P001
HOLD FUEL/TIME AT ETP AP	000000/00.00	000000/00.00
TOTAL FUEL TO ETP AP/RMNG FOD	014465/006990	014482/006973

DATA SOURCE: ARINCDIRECT

single-engine cruise altitude to get to Gander, Newfoundland (CYQX), or to Keflavik, Iceland (BIKF). The times are equal. If we have an engine failure before this point, it will be faster to turn back to Gander.

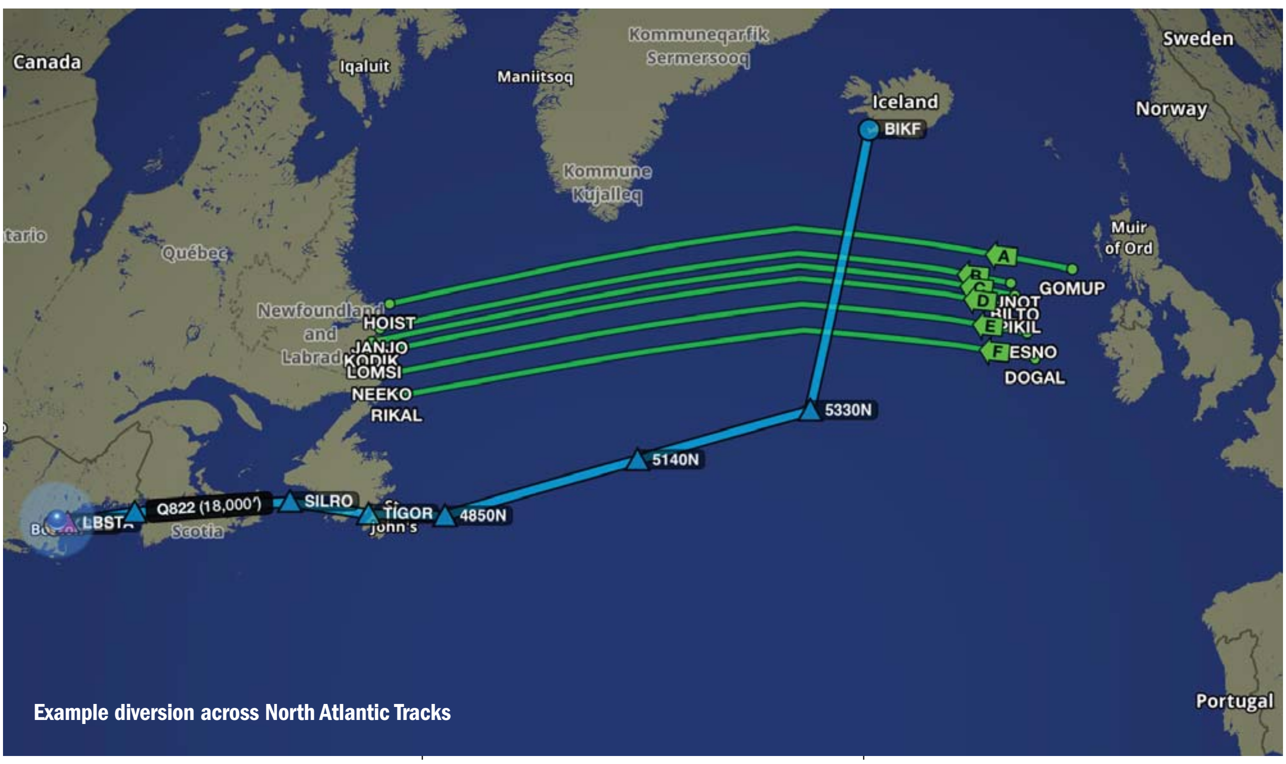
The second point, given at 25 deg., 45.5 min. west longitude, is another point in space that we will get to 43 min. later. If we lose an engine at this point, it will take us 1 hr. and 32 min. to turn to Keflavik or to press on to Shannon. The times are equal again, but different than the first set of times. If we lose an engine prior to this point but after the first, we head to Keflavik. After this point, it is faster to head for Shannon.

So, if we have an engine failure at 30 deg. west, we turn left to Keflavik. We usually train for this by doing an engine-out drift down: Set the operating engine(s) to a maximum allowed for continuous operation, allow the speed to decrease to an optimal figure, and then slowly descend in a bid to maximize forward distance against altitude loss. This can be as little as 500 ft. per minute but is more typically around 1,000 ft. per minute. Thus we are doing everything possible to increase our chances of a safe diversion. At least that used to be true. Let's look at another factor.

Let's say on this particular time and date, the westbound North Atlantic Tracks are active and between us and our Keflavik ETP airport. Our reaction to this used to be like this: We are the emergency aircraft, everyone else can get out of our way. You don't climb your way up the ranks of professional pilots and end up as an international jet pilot without knowing you need to maintain a listening watch on guard, so the risks are small.

If you still think this way, let me offer the following as a hypothetical. Let's say one of those airplanes on a westbound track that you are about to drift through is an Airbus A330 carrying a crew of 12 and 228 passengers. Let's also say the only experienced pilot on the airplane is in back during a permitted rest period and up front you have two first officers, the most experienced of whom has 7,000 hr. total time and the pilot flying the airplane has about 3,000 hr. Both have less than six years of experience with the airline and about half of that flying oceanic. Those were the circumstances aboard Air France Flight 447 in 2009 when the two pilots up front didn't know what to do when the autopilot disconnected at 35,000 ft. and they ended up stalling the airplane right down to the ocean, killing everyone on board.

You may think the odds of this kind of crew component has decreased since then, but it has been just the opposite. So, does that change your decision making when deciding to cross the tracks? What are the odds those two



Example diversion across North Atlantic Tracks

JAMES ALBRIGHT/BCA

Fueling: Can you have too much?

youngsters are faithfully listening to guard channel?

The correct answer, in my book, is to descend below the tracks before you get to them. My flight-planning service doesn't figure for a drift down in fuel planning but does compute a straight line. If I were headed north, I doubt I would end up on a straight line while trying to get below the tracks. I would add fuel to allow for the maneuvering. Or I might consider another option.

Lajes Airport in the Azores to the south is often a good option, depending on the weather. In this case, flying a straight line south doesn't take much more gas than the northerly option. But the chances of getting to fly that straight line are higher. Sometimes the tracks are north of you, sometimes they are south of you. This is something you have to consider the day of the flight, since the people placing those tracks are only doing so half a day earlier.

Many flight-planning service providers default to zero holding time at ETP airports in an effort to minimize the fuel burn. But what are the odds you are going to be permitted to bust right into the traffic pattern at your ETP alternate and immediately land? You are an emergency aircraft. But does the weather care? It might be a wise idea to plan on some holding fuel here.

This doesn't necessarily mean you are going to have to carry more fuel, but you might. I recently saw a flight plan for a Bombardier Challenger 605 from Onizuka Kona International Airport, Kona, Hawaii (PKOA) to John Wayne-Orange County Airport, Santa Ana, California (KSNA) that planned on only 342 lb. of ETP fuel in the event of a depressurization. I've seen Gulfstream G550 polar flight plans with less ETP fuel than that. Your service may not flag this kind of planned minimum fuel, so it is up to you to check. In the case of our example flight to London, it actually takes less gas to get to our ETP alternates than it does to get to our destination, so we are good.

Now, finally, we have enough fuel to taxi, take off, make an approach at our destination, go missed, make another approach and land at our alternate; and we know that we can divert en route while oceanic to one of three different ETP airports. Perfect, right? Well, not yet.

Step Four: Reserve Fuel

A 14 CFR Part 91 operator flying under IFR rules must have enough fuel to make it to the destination plus enough for an additional 45 min. at normal cruising speed. If an alternate is required, you must have enough juice to make it to your destination, shoot and miss the approach, and fly to the alternate, plus an additional 45 min. at normal cruising speed.

Flight Plan KBED To EGLF GA5C M90

	Fuel	Time	Distance
DEST EGLF	016608	05:14	2918
RESV	000000	00:00	
ALT EGGW	001153	00:24	
HOLD	001546	00:45	
REQD	019307	06:23	
TAXI	000200		
XTRA	002301	00:48	
TOTL	021808	07:11	

KBED DCT LBSTA ALLEX ACADN N203B NICSO 4850N 5040N 5130N 5320N MALOT MORAG P155 HON UL612 COWLY Q41 PEPIS DCT EGLF

WIND P058 MXSH 5/ALLEX AVG WIND 251/060 TAS 518 FL 410

DATA SOURCE: ARINCDIRECT

Step Five: Maintaining Altitude and Mach

Your company's rules might add even more fuel. Ours doesn't, so in the end we are going to need 21,808 lb. to meet all requirements. That gets us to our destination with 5,000 lb., our ETP alternates with more than that and our destination alternate with less. If we show up on the day of the flight and find the airplane has 4,000 lb. of Jet-A in the tanks, how much fuel do we need to upload?

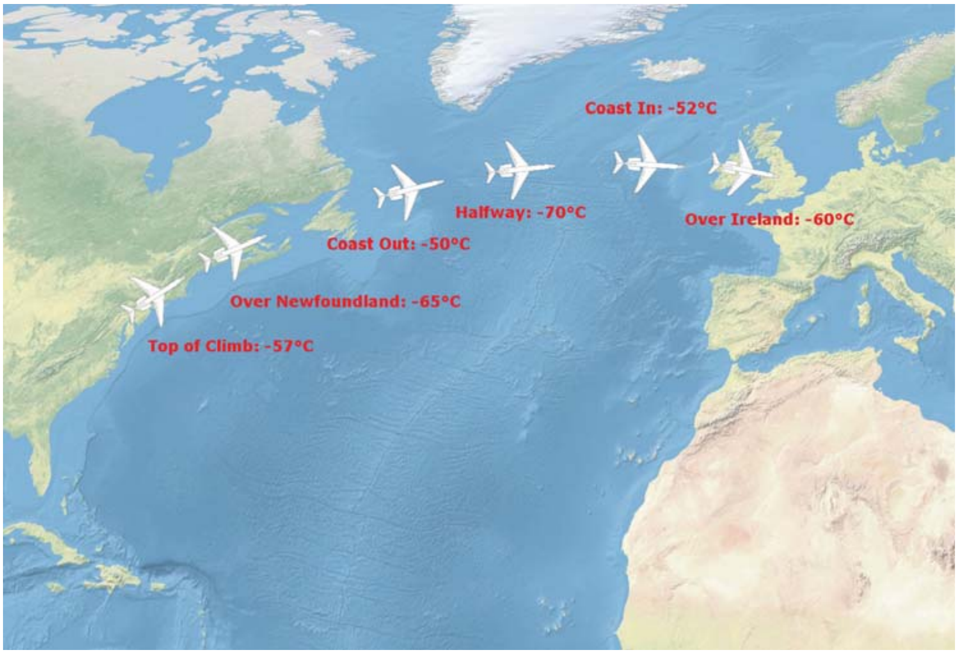
We could estimate, saying we want about 22,000 lb. After all, we have 4,000 lb., so we need to upload 18,000 lb., which comes to 1,800 gal. plus half again, or 900. So, we ask the fuel truck driver for 2,700 gal.

Now, be honest, when the fuel truck driver asks you "How much?" are you really going to say 2,700 gal.? Or is something inside you tempted to say 2,800?

There is an old Air Force saying that goes like this: You can never have too much gas, long pause, unless you are on fire. Commercial aviators will add: . . . or unless you are too heavy to land at your destination. Let me add something for oceanic flight: . . . or unless you are too heavy to maintain altitude and Mach over water. Let's look at a typical day over the North Atlantic on our way to London.

Your temperature most of the year at top of climb heading to Newfoundland will be around -57C. What's another term for that? ISA, that's a standard temperature day at

KTRINKO



Typical outside air temperatures at 41,000 ft. over the North Atlantic

high altitudes. In the case of our G500, the airplane shoots right up there and has a comfortable airspeed and thrust margin. No problem, right?

Flying farther north over Newfoundland you might even see the temperature drop to -65C. That means it takes less thrust to maintain Mach and you might even be tempted to climb. The flight plan was based on 41,000 ft. but you really wanted 43,000 ft. You would be wise to resist that temptation.

Just after coast out, -50C isn't typical but it isn't uncommon, either. A swing of 15 deg. in less than an hour can seem like a cruel joke, but it happens over the North Atlantic all the time -- in fact this is typical. If you climbed an extra 2,000 ft. you might find yourself needing to request lower. If you loaded an extra 2,000 lb. of fuel, ditto. Over the years I've heard at least a dozen aircraft on the radio begging for lower because of this. I've heard two cases of aircraft declaring an emergency because they were getting close to the stall and air traffic control denied their request for lower because the tracks below were taken.

After you've burned off some fuel you might be able to request and receive clearance for a climb. In fact, halfway across it isn't unusual to see the temperatures drop quite a bit. These days with data link, if you are flying above the tracks, getting a climb or speed change is not too hard.

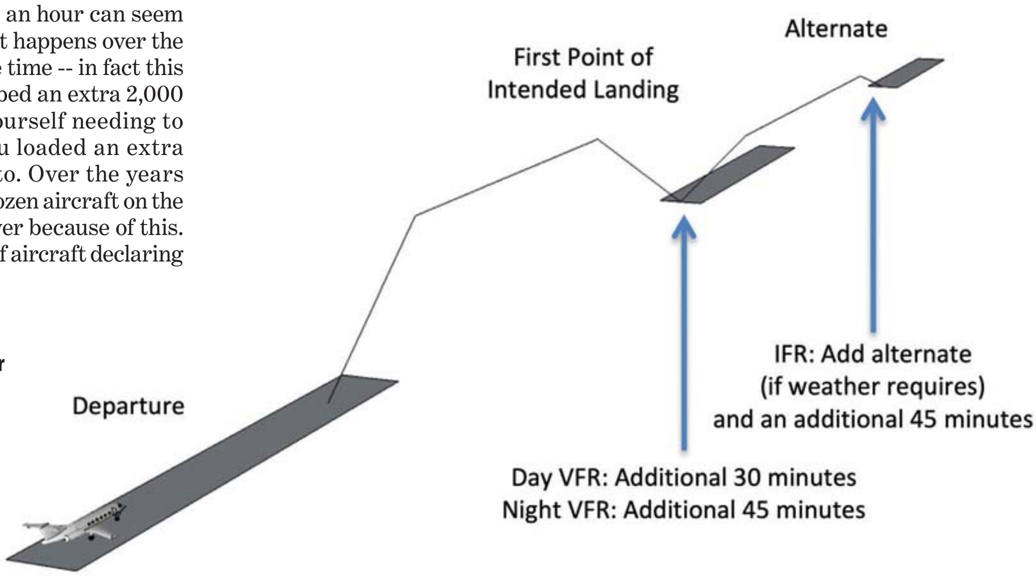
It should be noted that you will have the exact same situation coming the other way. Temperatures over Ireland can be at ISA or lower. But just west of Ireland you can see the temperature climb a good 10 deg. or more.

Putting It All Together

The lesson here is clear: If you are tempted to add a few hundred gallons of fuel, keep in mind the impact it will have on your ability to make your cruise altitude and then to hold it once you are there.

So, the steps when it comes to flying oceanic begin the same way they do when flying domestically. You have to get to your destination with enough fuel to fly an approach, go missed approach, and then shoot another approach and land at your alternate with adequate reserves. What's adequate? Typically that is an additional 45 min. of flying time. This fuel might be enough to safely get to your oceanic equal time point alternates, but it might not. It is up to you to examine each ETP scenario to make sure the fuel is adequate for routing that keeps you out of the way from other traffic and gets you to where you need to be.

And the last point to remember: There is a minimum fuel to get the job done, but there is also a maximum fuel to consider. What happens when the minimum is too high or the maximum is too low? Sometimes you'll need to cancel the trip. **BCA**



A summary of minimum fuel requirements under 14 CFR 91

JAMES ALBRIGHT/BCA


Castle & Cooke

Who Says It's Ready?

Exemplary **performance and broken** airplanes

BRISBANE AIRPORT CORP. IMAGE MODIFIED BY AUSTRALIAN TRANSPORT SAFETY BUREAU

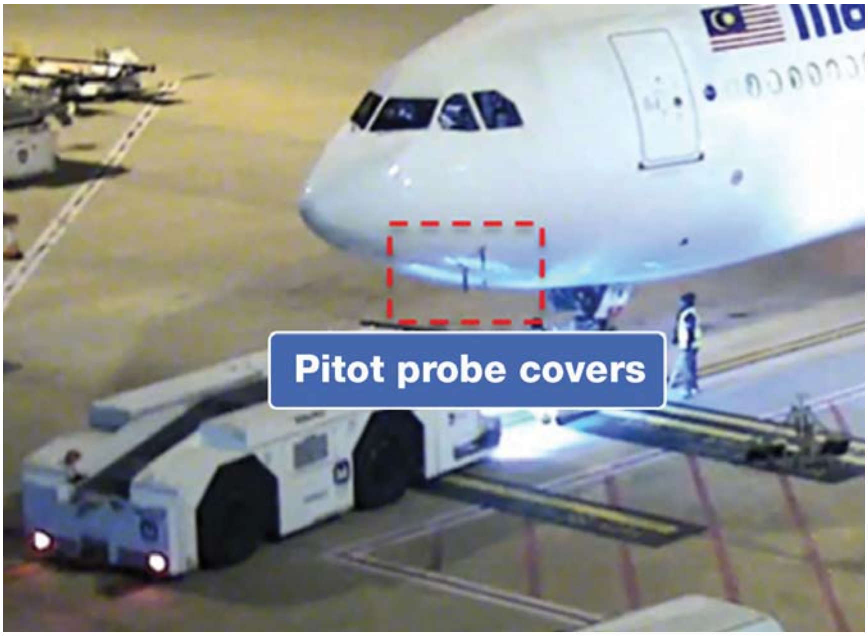


Figure 1: Aircraft about to be pushed back with pitot covers in place (two of three visible)

BY **ROSS DETWILER** rossdetwiler.com

Sometimes you read an accident or incident report and when you're done, you feel desperation for the operation's safety hogan. This month's *Cause & Circumstance* looks at two such events. Although the information is based on two preliminary reports, the lack of definitive causes at this point, I think, leads to more potential areas to explore as we try to understand what happened. In both cases, the crews performed in an exemplary fashion and returned broken airplanes with not a hair out of place on any of the passengers.

But how in the heck. . . .

On Oct. 27, 2017, at about 1900 Coordinated Universal Time, the crew of a Jetstar Airways Airbus A320 (VH-VGY) was going through normal preparation procedures for a scheduled passenger service from Auckland International Airport, New Zealand, to Sydney. The captain was designated as the pilot flying (PF) and the first officer was the pilot monitoring (PM).

It was an absolutely normal setup, a relatively short international flight, and a beautiful and modern machine in which to accomplish the task at hand. Back to the report.

At about 1909, the so-called "leading hand" had finished loading the last container into the aircraft's hold and was organizing his paperwork. It was raining, so he decided to put the clipboard in the right engine (No. 2) cowling to protect the papers, with the intention of retrieving them later. He went to the flight deck, gave some documents to the flight crew, and returned to the ground to organize the aircraft's pushback.

"Leading hand" is not a term with which I was familiar. Doing research on Australian and New Zealand job positions I found that the person so designated typically performs all or some of the following duties: They supervise and train subordinate personnel — in this case, the ground personnel. They also sometimes supervise contractors and subcontractors, oversee the operation of vehicles and construction materials, set schedules, and monitor health and safety through quality assurance and environmental planning. In other words, this is the main person around the airplane while it's on the ground.

At about 1919, the dispatcher cleared the ground and servicing equipment from the aircraft and conducted the "duty of care" walk-around. In so doing, she noticed the clipboard in the right engine and thought that the leading hand would return for it, so she continued with the walk-around. Soon after, the engines reportedly started normally.

Minutes later, as the aircraft was taxiing, the leading hand realized his clipboard was missing and thought the dispatcher had the paperwork. When he asked her about it, she mentioned having seen it in the right engine. When the ground crew returned to where they had prepared the aircraft, they noticed paper debris on the ground and alerted operations to contact the pilots.

However, the Airbus had launched before word of the missing clipboard reached the crew. As they climbed through FL 150, the pilots received a radio call from Auckland Approach directing them to contact the surface movement controller. The captain handed control to the first officer and made the call. Only then was he advised that the ground crew had lost their paperwork and it may have been placed on the engine. The captain asked whether the paper was on top of the engine or inside the inlet and was told the latter. Checking the engine instruments, the pilots saw no abnormal indications.

The captain then contacted his carrier's engineer at the airport and asked whether the missing paperwork had been loose or held by a clipboard with a metal clip. The engineer advised that there had been a clipboard and that a piece of sheared metal had been found. The flight crew decided to return to Auckland.

After landing at about 2048, the No. 2 engine was inspected by technicians, who discovered paper throughout. They also found minor damage to a fan blade and attrition liner.

Additional Notes

The leading hand later explained that he had felt the need to shelter the paperwork from the wind and rain. Normally, staff use the pushback tractor for shelter during adverse weather and to prepare paperwork for the flight. There is a metal box on the loader to store the folder. However, as the pushback tractor was not yet present at the bay, he used the engine cowling. He recalled that he did not feel pressured to rush the departure.

The dispatcher stated that she did not view the clipboard as a foreign object damage (FOD) threat as it belonged to the leading hand and held the paperwork for the flight. She assumed that he would retrieve it prior to engine start-up.

The captain stated that, to obtain more information about the incident, numerous calls were made to other agencies, which took considerable time. Further, due to poor communications, he was unable to contact the operator's maintenance controller to discuss the engine's status.

Procedures

The internal investigation into the incident by the ground-handling operator noted that the Jetstar Airways operational manual stated that all staff operating near the aircraft were to be constantly observant for abnormalities and to report these to the leading hand or supervisor prior to the aircraft departing.

The investigation also noted that there was no procedure for the ground crew to establish communications with the flight crew in the event of a non-normal or emergency situation, either prior to or after the aircraft's departure. Further, there was no guidance on how paperwork was to be prepared and managed by ground crew during adverse weather conditions.

Safety Action

Both the airline and the ground-handling company issued a notice which outlines that FOD also includes items accidentally left behind. It further states that engines are not to be touched or used for the placement of items, and emphasizes the responsibilities of ground crews to manage foreign object debris by clearing it and reporting its presence to other crewmembers.

As a result of this incident, Jetstar Airways released an updated aircraft dispatch procedure, which included:

▶ A specific warning about not placing items in the engine cowling.

▶ Improved detail around checks and responsibilities.

▶ A section on emergency and non-normal procedures.

▶ Detailed methods for re-establishing communications between ground crews and flight crews, such as visually gaining the attention of the flight or contacting them via radio.

We'll discuss this further in the "Solid Ground Procedures" sidebar, but for now, let's have a look at the second incident I wanted to review.

Here too, there are still too many unknown factors and operational considerations to assess blame. Nevertheless, someone missed a very simple, very important step. Without an operational airspeed indicator, the flight crew's use of their aircraft's angle of attack (AOA) indicators for speed information and GPS for altitude were exceptional. There can be no doubt about that. Nevertheless, we can all ask why such exemplary airmanship became necessary in the first place.

GOOGLE EARTH/ATSB

Figure 2: Flight path of 9M-MTK during turn-back

On July 18, 2018, a Malaysia Airlines Airbus A330-300 (9M-MTK) was scheduled to operate a passenger flight from Brisbane, Australia, to Kuala Lumpur, Malaysia. The scheduled departure time was 2320 local.

The aircraft had landed at Brisbane Airport at 2011, after a flight from Kuala Lumpur. The captain, first officer and certifying maintenance engineer from the previous night's flight, who had been resting at a Brisbane hotel, arrived at the airport to begin their duties for the outbound flight.

Soon after the aircraft had landed, covers were placed on its three pitot probes. Subsequent inspections during the turnaround did not identify the presence of the covers and they were not removed prior to the aircraft's departure. **(See Figure 1 on the opposite page.)**

The first officer was the PF and the captain was the PM. Prior to aircraft pushback, the two calculated the aircraft's critical "V" speeds for the takeoff with V1 at 153 kt. and VR at 160 kt. The airline's standard operating procedures for takeoff required the PM to announce when the airspeed reached 100 kt. and for the PF to cross-check this airspeed indication.

The wind was calm and the sky was clear. At 2324, the flight crew began to taxi to Runway 1. They started their takeoff roll at 2331:05, and 33 sec. later the captain called "100 kt." The PF initiated rotation at 2331:47; groundspeed at the time was 165 kt.

The flight crew recalled that they detected an airspeed anomaly during the takeoff roll, including red speed (SPD) flags on both primary flight displays (PFDs).

The SOPs stated that the captain held responsibility for the decision to reject the takeoff or to continue. It noted that rejecting a takeoff between 100 kt. and V1 was a serious matter, that a captain should be "go-minded," and under those circumstances few situations justified rejecting the takeoff. There was no indication on the CVR that the pilots discussed rejecting the takeoff.

Probably one of the hardest decisions a pilot can make is a high-speed abort below V1. Every second of indecision adds more speed and eats up hundreds of feet more runway. Many serious incidents have occurred in this speed range. A few miraculous saves have been made when pilots aborted a takeoff above V1. Also, V1 may be predicated on a much shorter "balanced field" than the runway that is actually available. While heavier loads can be flown by unbalancing the field, and we did in the U.S. Air Force Airlift Command, this was not a standard procedure in my civilian experience. That means there can be a very large gray area involved. Is it wrong to abort a takeoff, just before rotation and well-past V1, if the computed balanced field is 5,500 ft. and the flight is departing on a 13,000-ft. runway?

After takeoff, the flight crew carried out actions for unreliable airspeed indications and made a PAN call to air traffic control (ATC), advising they had unreliable airspeed indications.

The flight crew continued to climb above 10,000 ft. and maneuvered the aircraft to the northeast of Brisbane Airport where they carried out several checklists, troubleshooting and preparation for an approach and landing on Runway 1. **(See Figure 2 on page 27.)**

In accordance with published procedures, the pilots turned off the three air data reference systems (ADRs) at 1343. This activated the aircraft's backup speed scale (BUSS), which provided a color-coded speed scale derived from AOA and other information, and altitude derived from GPS data. **(See Figure 3.)** The flight crew also obtained groundspeed information from ATC, and used the aircraft's radar altimeter.

Normal landing-gear extension could not be accomplished with all three ADRs off. The flight crew performed a landing-gear gravity extension before conducting an overweight landing at 0033.

After landing, the pilots stopped the aircraft on the runway as nosewheel steering was unavailable following a landing-gear gravity extension. The main landing gear doors, which remain open following a gravity extension, had

Accidents in Brief

Compiled by Jessica A. Salerno

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

▶ **February 22 — About 1111 CDT, a** Beech A36 (N3266Q) was destroyed after crashing near Rogers, Minnesota. The pilot was killed. The airplane was registered to and operated by the pilot as Part 91 personal flight. It was VFR and no flight plan was filed. The Beech departed from Flying Cloud Airport (FCM), Eden Prairie, Minnesota, about 1100 and was destined for Breezy Point Airport (8MN3), Breezy Point, Minnesota. According to ATC data, after departure the airplane turned north and climbed to 2,000 ft. MSL. While cruising at 170 kt., the airplane climbed to 2,300 ft. and decelerated to 100 kt., then began a descending left turn to 190 deg. It descended on this heading for 30 seconds at 70-75 kt. At 1,100 ft., which was about 200 ft. AGL, the airplane turned right, and the last ATC data recorded at 1110:43 was 1,000 ft. MSL, 72 kt. and 243 deg. A witness observed the Beech A36 turning at low altitude. He subsequently noticed the airplane's bank angle increase and a rapid descent. The airplane crashed into a forested area and a post-crash fire ensued. Flight control continuity was established for the ailerons, rudder, and elevators. The engine was retained for further examination.

▶ **February 20 — About 0600 CDT, a** Beechcraft King Air B200 (N860J) crashed near Lake Coleman, Texas, in open ranchland. The pilot and two passengers were killed, and the airplane was destroyed. The King Air was registered to TLC Air, LLC and operated by Lauren Engineers & Constructors, Inc. The flight was conducted under Part 91, as a cross-country flight. It was IFR and the flight was operating under a IFR flight plan. The flight originated from Abilene Regional Airport, (ABI), Abilene, Texas, and was en route to the Valley International Airport (HRL), Harlingen, Texas.

A preliminary review of ATC communications with the pilot revealed the airplane was cleared for takeoff from Runway 35L, shortly afterwards the pilot was instructed to climb to 12,000 ft. and was then cleared to climb to FL 230. The pilot reported to the controller that they encountered freezing drizzle and light rime icing on the climb from 6,400 ft. to 8,000 ft.

As the airplane climbed through 11,600 ft., the pilot reported that they were having an issue with faulty deicing equipment and needed to return to the airport. The controller instructed the pilot to descend to 11,000 ft. and cleared them direct to the ABI. The flight was then instructed to descend to 7,000 ft. and asked if there was an emergency. The pilot responded in the negative and stated that they blew a breaker when they encountered icing conditions, and that it was not resetting.

The controller then instructed the pilot to descend to 5,000 ft. and to expect the ILS Runway 35R approach. The controller then instructed the pilot to turn to a minor damage where they contacted the runway surface. The aircraft was towed to the gate, where the passengers and crew disembarked. There were no reported injuries during the flight.

A subsequent inspection identified that the pitot probe covers were still fitted to the aircraft's three pitot probes after it landed.

Recorded Data

The Australian Transport Safety Bureau (ATSB) recovered and downloaded data from the aircraft's CVR and FDR, and obtained data from its digital ACMS (aircraft condition and monitoring system) recorder (DAR), used for routine monitoring by the operator.

The data from the CVR and FDR contained all of the occurrence flight, while the DAR included all data up to 2348 and intermittent data after that time. At the time of publication, the ATSB had not fully validated the data and analysis was ongoing.

The aircraft had three sources of airspeed:

▶ ADR1, processing data for the captain's pitot probe on the left side of the airframe, and usually presented on the captain's PFD.

▶ ADR2, processing data from the first officer's pitot probe on the right side of the airframe, and usually presented on the first officer's PFD.

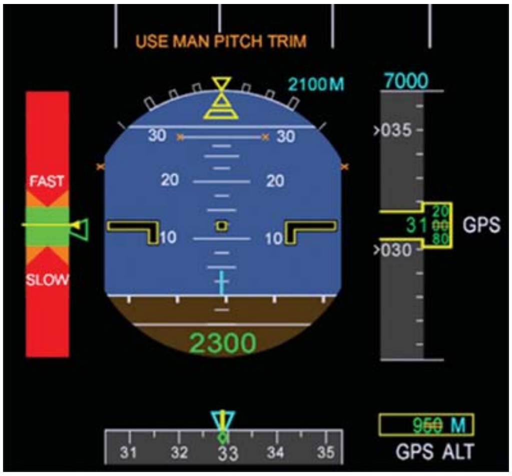
▶ ADR3, processing data from the standby pitot probe on the left side of the airframe, and usually presented on the integrated standby instrument system to the right of the captain's instruments.

Airspeed was not recorded or displayed to the flight crew when it had a calculated value below 30 kt.

The FDR recorded airspeed from ADR3 once per second, and additionally from any one of the three ADRs twice per second depending on flight crew selection and data validity. Data from the FDR showed that ADR1 first sensed airspeed above 30 kt. at 2331:39. At rotation, the FDR recorded 38-kt. airspeed from ADR1 and the airspeed from ADR3 had not yet reached 30 kt. ADR3 first sensed airspeed above 30 kt. at 2331:54.

The DAR sampled airspeed once per second and preliminary analysis shows broadly similar values as the FDR.

The maximum recorded airspeeds



AIRBUS

Figure 3: Example of the backup speed scale (BUSS), showing the color-coded scale (left) that indicates derived speed, and a GPS altitude scale (right)

heading of 310. Shortly afterwards the controller asked the pilot if they were turning to the assigned heading; the pilot responded that they were having issues with faulty instruments. When controller asked the aircraft to report their altitude, the pilot reported that they were at 4,700 ft. The controller then instructed the pilot to maintain 5,000 ft. The pilot responded he was "pulling up." There was no further communication with the pilot.

Preliminary review of the airplane's radar track showed the airplane's departure from ABI and the subsequent turn and southeast track towards its destination. The track appeared as a straight line before a right turn was observed. The turn radius decreased before the flight track disappeared.

The airplane crashed in a right wing low attitude, followed by the right engine, then left engine. The wreckage path was on an initial heading of 320 deg., and continued for about 570 ft. The wreckage was highly fragmented and spread-out along the wreckage path.

At 0552, the automated weather station located at ABI recorded wind from 040 deg. at 7 kt., 10 mi. visibility, broken clouds at 900 ft., broken clouds at 1,400 ft., overcast clouds at 3,100 ft., a temperature of 14F, dewpoint of 41F, and an altimeter setting of 30.34 in. of mercury.

▶ **February 15 — About 1430 EST, a** Rockwell International 112B (N377SB) was heavily damaged during a runway excursion while landing at the Knoxville Downtown Island Airport (DKX), Knoxville, Tennessee. The private pilot received minor injuries and the passenger was not injured. The airplane was operated under Part 91 as a personal flight. It was VFR and no flight plan was filed for the flight that originated about 1330, from Bowman Field Airport, Louisville, Kentucky.

The pilot stated that after departure he proceeded to DKX which had calm winds, and he entered an extended left base leg of the airport traffic pattern for Runway 8. The pilot turned onto the final approach leg of the airport traffic pattern and reported a normal landing. About 1-2 sec. after the airplane began to slow, it "swerved violently to the left," which the pilot described as if the flight had suddenly encountered a 20+ knot crosswind. He applied right rudder input but that did not correct the left turning tendency. The airplane departed the runway onto grass, where he attempted to slow the airplane. The airplane then veered again to the left and this time he had no rudder authority. He instructed the passenger to brace for impact and reported coming to an abrupt stop. When the pilot exited the airplane he noted that the left main landing gear tire was deflated.

According to the FAA inspector who examined the accident site and airplane, rubber transfer on the runway that was consistent from the left tire began about 1,900 ft. from the approach end of the runway. After exiting the runway, the airplane traveled about 600 ft., impacted a water drainage ditch, and the nose landing gear collapsed. The left main landing gear tire exhibited a flat spot through the tread.

The airplane was recovered for further examination of the brake system.

ATSB

Figure 4: Pitot probe covers removed from 9M-MTK after the incident flight

after takeoff were 66 kt. on the FDR and 57 kt. on the DAR, prior to the ADRs being selected off when the data became invalid. These recorded airspeeds were consistent with the pitot probes being covered.

Preliminary analysis of the available groundspeed and AOA data indicated that the aircraft was flown within operational limits. However, determination of the airspeed indications and related warnings and cautions being displayed to the flight crew during the takeoff roll was not available for the initial report.

A lot of this recorded data left me confused. If the covers were still on, how was airspeed recorded at all? I included the data because I'm sure how and why the readings were obtained with the covers in place will be explained in the final report. Nevertheless, none of that is germane to the problem at hand. Specifically, why were the pitot covers not removed?

Buzzing at Brisbane

There have been multiple reports of insect activity disrupting aircraft systems at Brisbane Airport. These included blocked pitot probes, mainly from nests built by mud-dauber and other wasps, resulting in airspeed discrepancies and other effects.

A preliminary review of the ATSB database indicated that from 2008 to 2018 there were at least 15 incidents involving high-capacity transport aircraft departing from Brisbane in which one of the pitot probes had a partial or total blockage, at least four of which were identified as insect nests. These resulted in three

Accidents in Brief

February 13 — At 1125 EST, a Mooney M20J (N1149T) was heavily damaged when it crashed while on approach to Bartow Executive Airport (BOW), Bartow, Florida. The private pilot and a passenger were killed. The airplane was registered to and operated by OR & WIL LLC under Part 91 as a personal flight. It was VFR and no flight plan was filed for the cross-country four-airplane formation flight that originated at 1045 from Spruce Creek Airport (7FL6), Daytona Beach, Florida.

According to flight-lead of the four-airplane formation flight, the accident pilot and his wife joined the flight at the last minute and were assigned the No. 4 position in the formation. The four airplanes (RV-9, RV-6A, RV8 and the accident airplane) flew in formation to BOW. Approaching BOW, the BOW tower controller instructed the formation flight to enter the right downwind leg of the traffic pattern for Runway 23. The formation flew about 3 mi. northwest of BOW and the flight-lead instructed the other pilots in the formation to "go extended trail."

All complied and were in-trail behind the flight lead. The formation flight was cleared to land on Runway 23 shortly after the lead airplane entered the downwind leg of the traffic pattern, and the other airplanes entered the traffic pattern in trail. The lead airplane made a short base turn and it was expected that each airplane would make a later turn onto the base leg than the previous airplane, thereby further increasing the spacing between the airplanes.

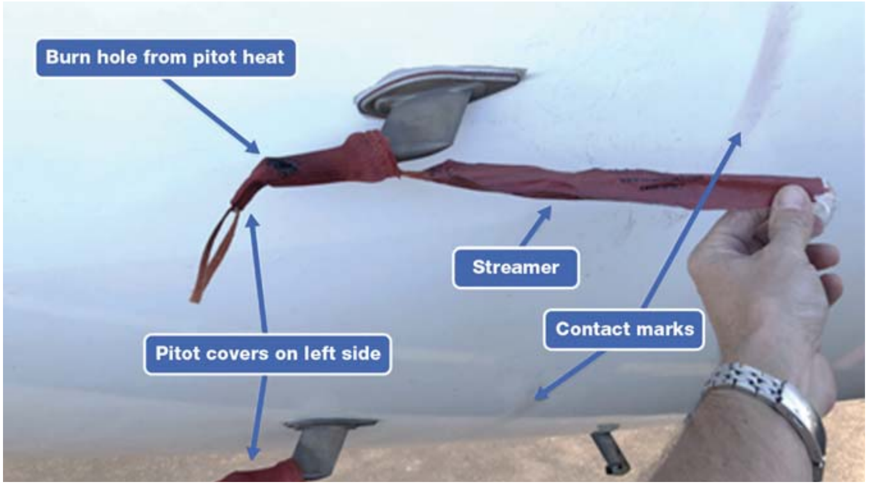
Airplanes No. 1, 2 and 3 made turns to the base and final legs of the airport traffic pattern. The pilot of airplane No. 3 stated that he maintained 70 kt. on final approach. The three airplanes landed and waited for the accident airplane, which had already impacted terrain unbeknownst to them.

A witness working the ground control position at the BOW tower at the time of the accident reported that she looked up from her station and saw airplane No. 1 on short final, and airplanes Nos. 2, 3, and 4 (the accident airplane) were "very close" also on short final. From her perspective, airplanes No. 2, 3, and 4 appeared to be in a triangle formation; however, the accident airplane was inverted and descended straight down to the ground.

A dashcam video from a vehicle traveling toward the final approach path of runway 23 captured airplane No. 3 established on final approach and the accident airplane in trail, in a right bank then steep left bank before it entered a nose down attitude and descended toward the ground.

A witness who resided near the accident location stated that she was inside her residence when she heard an airplane that "sounded different" and too low. She stated that the engine made "no noise, then sputtered twice," then "revved up" before she heard the impact. **BCA**

Figure 5: Reconstruction of pitot probe covers on 9M-MTK, showing pitot cover damage and rub marks on aircraft skin from the streamer



rejected takeoffs, four aircraft returning to Brisbane after continuing the takeoff and one aircraft that continued to its destination.

In May 2015, the Civil Aviation Safety Authority (CASA) issued Airworthiness Bulletin 02-052 Wasp Nest Infestation — Alert to "urgently advise operators, maintainers and pilots of the dangers associated with undetected wasp infestation in aircraft, and the circumstances under which they can occur." It stated that wasps could build nests in aircraft that are stationary for more than 20 min. with uncovered pitot probes.

From November 2015 onward, the Airservices Australia-produced publication "En Route Supplement Australia" entry for Brisbane Airport included a note that stated:

"Significant mud wasp ACT WI AD VCY [activity within aerodrome vicinity] affecting pitot tubes [probes]. Pitot tube covers recommended."

Similarly, the Jeppesen aeronautical information publication "Australia Airport Directory," used primarily by international pilots operating into Australia, also had the following in the Brisbane Airport information section:

"Significant mud wasp activity within apt [airport] vicinity affecting pitot tubes. Pitot tube covers recommended."

Some operators using Brisbane use pitot probe covers for routine turnarounds.

Ground Handling at Brisbane

On the day of the occurrence, aircraft turnaround duties were shared between:

▶ A maintenance technician from the operator who was rostered to return to

Kuala Lumpur as a passenger on the departing aircraft.

▶ Two non-certifying technicians from the engineering support provider.

▶ Four ground handlers from the ground-handling service provider.

The operator's personnel and the ground handlers were both responsible for conducting pre-departure checks.

Use of Pitot Probe Covers

The pitot probe covers were fitted on the aircraft's three pitot probes by one of the engineering support personnel, as it was his understanding this was normal practice. He later reported that he advised the operator's maintenance technician that pitot probe covers were fitted during a brief exchange discussing turnaround tasks, but that the technician did not directly respond. The technician later reported that he did not recall hearing the advice, and he did not make an entry in the aircraft's technical log to record that the covers had been fitted.

The presence of the pitot covers was not detected by the operator's maintenance technician or captain during separate external aircraft inspections. The maintenance tech boarded the aircraft during turnaround, and the engineering support personnel left the bay to attend to other aircraft. The pitot covers were not detected by ground handlers during pushback.

The flight crew and operator's maintenance tech later reported that they would not routinely use pitot probe covers on a turnaround. They advised that the operator did not normally fly

Sound Ground Procedures

Any reading of the two incidents cited in this month's *Cause & Circumstance* to a group of aviation professionals would likely result in the same outcome. Be they flight crew, ground, safety or management personnel, each would be displaying a 100-mi. stare and be thinking, "You're kidding."

You have all the facts. Since they come from preliminary reports, we don't have a probable cause for either occurrence. Still, it would be instructive to develop theoretical protocols among ourselves that might have prevented them. Thankfully, no one was hurt in these incidents, but let's task ourselves to develop a plan that would prevent and/or catch lapses in preflight activities that have the potential to cause serious harm.

In the simplest sense they both followed a failure to perform a very important step in making the airplane ready for flight and the failures were not caught in at least one other follow-up check.

I would suggest the first step in building a procedure to prevent these type of slips would be to look at the required acts that must be performed before a flight can safely depart. Which of these items are critical?

Once the critical duties are identified, to whom do we assign them and to whom, if anyone, do we assign the checking of the performance of the first person? Should a "leading hand" have responsibility for ensuring that all ground operations are complete in accordance with a checklist? Would we task that person with final safe dispatch reliability? I don't think that would be fair since the person is primarily a ground technician and wouldn't know, for example, the potential pitfalls of a leaving a pitot tube covered. Keep in mind that whatever jobs we assign this person would probably appear on a checklist, which would most likely wind up on a clipboard. Should it instead be pocket-sized and laminated? Should metallic clipboards even be allowed around the exterior of the airplane in our new procedures?

The dispatcher performed what is called a "duty of care" walk-around and actually saw the clipboard in the engine nacelle yet did nothing. In our system would the dispatcher have the responsibility to remove any potential problems, or just report them? How would that dispatcher handle a much bigger, much heavier object like a jack pad, wheel, tire assembly or vehicle too close to the airplane for safe pushback? Should we have the dispatcher, after ensuring the area and plane are safe, be in direct contact with the crew?

Then there are the flight crews involved in the two incidents. Often pilots perform their preflight inspections as they arrive at the airplane. There is still a lot of work to be done before the pushback and the timing of various checklists is such that they are usually accomplished as the passengers are loading. Yes, the PIC is always responsible, but can we hold someone else responsible for making sure an area is clear if it's possible to foul it after the pilots check it? In both cases, were lines of authority clearly delineated or could the pilots have seen both problems yet thought they'd be handled by another person?

The clipboard was seen in the nacelle by as many as three people: the person who left it, the dispatcher and possibly the crewmember performing the preflight inspection. Additionally, it was in the field of view of numerous ground personnel working around the airplane during loading and pushback.

The AAIB (Australian Aviation Investigation Board) offered a quick update of suggested revised dispatch procedures:

(1) Don't place items in the cowling.

(2) Improve details around checks and responsibilities.

(3) Develop emergency and non-normal procedures.

(4) Have methods to re-establish communications with flight crews via radio or ground signals.

The devil is in the details of No. 2, if you ask me. Specifically, it is in the word "responsibilities." While designating one person as the final decision maker can stifle communication, that person should ensure the team is actively engaged in the operation and realizes acknowledgement and satisfaction with the tasks being accomplished.

to airports where the use of pitot probe covers was standard. Security video recordings of the operator's three previous turnarounds at Brisbane Airport showed that pitot probe covers were not used.

Examination of the three covers fitted to the aircraft following the occurrence found that each had a hole burned through where the cover folded around the probe in the airstream. The streamers were damaged by contact with the aircraft skin during the flight. **(See Figure 4 on page 30 and Figure 5 on page 31.)**

Proactive Safety Measures

Whether or not the ATSB identifies safety issues in the cours we of an investigation, relevant organizations may proactively take steps to reduce their safety risk. Indeed, the Safety Bureau has been advised of the following actions in response to this occurrence.

▶ The operator notified all of its technicians and flight crews of the need for pitot covers to be fitted to aircraft at Brisbane Airport during turnarounds or when parked, as well as the required procedures for their removal.

▶ The operator and maintenance support provider clarified and formalized more detailed service level arrangements.

▶ The maintenance support provider improved its procedures for conducting turnarounds, including improved inspection, documentation and tool control.

▶ The ground-handling service provider gave all employees a "read and sign" bulletin emphasizing its arrival and departure inspection procedures. **BCA**

As to the pitot covers being left in place, that was certainly not the first time. I was in the left front seat of a C-5 Galaxy for a promotion film being directed by our public affairs officer for the Air National Guard. We were supposedly leaving on a mission, but we weren't going anywhere. It's worth noting that the pitot covers for the big airlifter were about 15 ft. off the tarmac and required a lift or some fancy maneuvering from the cockpit to remove them. Our big scene involved the sounds of engines — not ours — starting, interphone chatter and my head on a swivel inside the cockpit. When the film debuted to the wing, there were the covers firmly affixed to the pitot tubes of our supposedly mission-bound aircraft, for all the world to see. I heard about that for a long time.

But I've heard of those covers being left in place for different, hard-to-believe reasons. In one instance some of the pitot tubes were high up on the side of the airplane. This particular operator always installed pitot covers when the airplane was to be left for overnight or even if the crew left to go to lunch for just an hour or so. The lower and upper covers were interconnected with an elastic bungee cord so that pulling on the flag on the bottom cover pulled it off the lower pitot.

The bungee cord would then extend and eventually snap the pitot cover off the top tube. When that happened, the hyperextended bungee cord would snap the entire assembly toward the pilot holding its other end. It was customary for the person doing this to turn their head when they snapped the cover as it usually flew back toward their face. On the incident I heard about, the pilot pulled the bottom cover off and extended the bungee cord. That time, when the cord snapped back, it pulled out of the top pitot cover and left it on the tube. The person pulling the cover had the lower cover in his hand when he turned his head. He felt the top cover "let go" and put the bottom cover, along with the bungee cord, but not the top cover, into the covers bag. The results were similar to what this incident described, but far less dramatic as only one of four systems was affected. In that case, one person was held responsible and paid some very serious consequences.

Whenever a safety lapse occurs, we have to look at what was different in that particular instance. In the pitot cover incident, it was the overnighting of the airplane at a place with known wasp nesting problems. While it was a good idea to install the covers, it is a known fact that this was not an SOP for this operator.

Would it be better to always install the covers, so that they always had to be removed? That's a good idea as it would negate the reasoning to check and see if there were circumstances at a transient location that required covers to be installed.

Note also that the incident implies there was a company technician booked on the plane and two more employed by a local vendor on scene at the time of the occurrence. Again, it is assumed a PIC has the responsibility for everything that happens to or in the airplane, but did he see the covers and assume the engineers would get them when they did their preflight? How many ground personnel were within 5 or 6 ft. of dangling red flags, waving in the breeze, when the airplane was pushed back?

As I noted previously, accident chains of events usually begin with "One Little Difference." In the two incidents covered in this Cause & Circumstance the one difference in the first was the placing of a clipboard in a non-standard location and in the second it was the installation of pitot covers as an exception to SOPs.

How do we build a safety management system that would prevent such events? I say we must have one person in charge of the "final" preflight inspection. No one else should be able to access the airplane after that inspection is completed and, further, that person should be charged with reporting and removing any inappropriate items and should be the last to leave the area and signal the pushback crew. **BCA**

▶ **ASK FRED**
Send your questions about this article to:
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Performance Plateaus

Are **0.935 MMO** and **51,000 ft.** hard limits?

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

Faster cruise speeds and higher cruise altitudes have been key market drivers in business aviation for more than half a century. Operators now expect new aircraft to fly efficiently at 490 to 500 KTAS and soar into the mid- to upper forties. Maximum operating speeds now exceed Mach 0.90 and certified cruise altitudes extend all the way up to 51,000 ft., enabling new aircraft to fly above most headwinds and weather.

The Citation X+ set a new record for civil aircraft in mid-2014 when Cessna Aircraft (now Textron Aviation) earned approval for its 0.935 MMO, equivalent to a top speed of 548 KTAS at 31,500 ft. This edged out Gulfstream's feat of attaining a 0.925 MMO for its G650 in 2012. Both of these aircraft are certified to fly as high as 51,000 ft., a record high cruise altitude set by Learjet in the mid-1970s that has yet to be topped by any civil subsonic aircraft.

Older business jets still in production top out at Mach 0.80 to 0.90, enabling them to economically cruise at Mach 0.76 to 0.82, or 435 to 470 KTAS in the stratosphere, assuming standard day temperatures. The fastest current production commercial jetliners typically have 0.89 to 0.92 MMO redlines. Long-range jetliners most often cruise at Mach 0.83 to 0.86. When heavily loaded, they usually level off below the tropopause where warmer temperatures yield 490 to 500 KTAS.

The highest performing business jets typically fly 5,000 to 10,000 ft. higher, well above the tropopause where it's colder. Thus, their slightly higher 0.85 to 0.87 cruise Mach numbers yield about the same 490- to 500-kt. cruise speeds of jetliners at lower altitudes. Some of the newest business jets may have a slight cruise-speed edge over jetliners, but the actual time savings is negligible on a 10- to 12-hr. transoceanic flight.

Most of the large-scale travel time savings associated with business aircraft comes from eliminating airport hassles and other ground delays. No business aircraft passenger was ever told to show up at the airport 2 to 3 hr. before an international departure to afford enough time to check-in, handle baggage and wade through a mile-long security queue. General aviation airports hosting international flights seldom have 20 to 30, or more, waiting in line for takeoff.

> Most of the large-scale travel time savings associated with business aircraft **comes from eliminating airport hassles and other ground delays.**

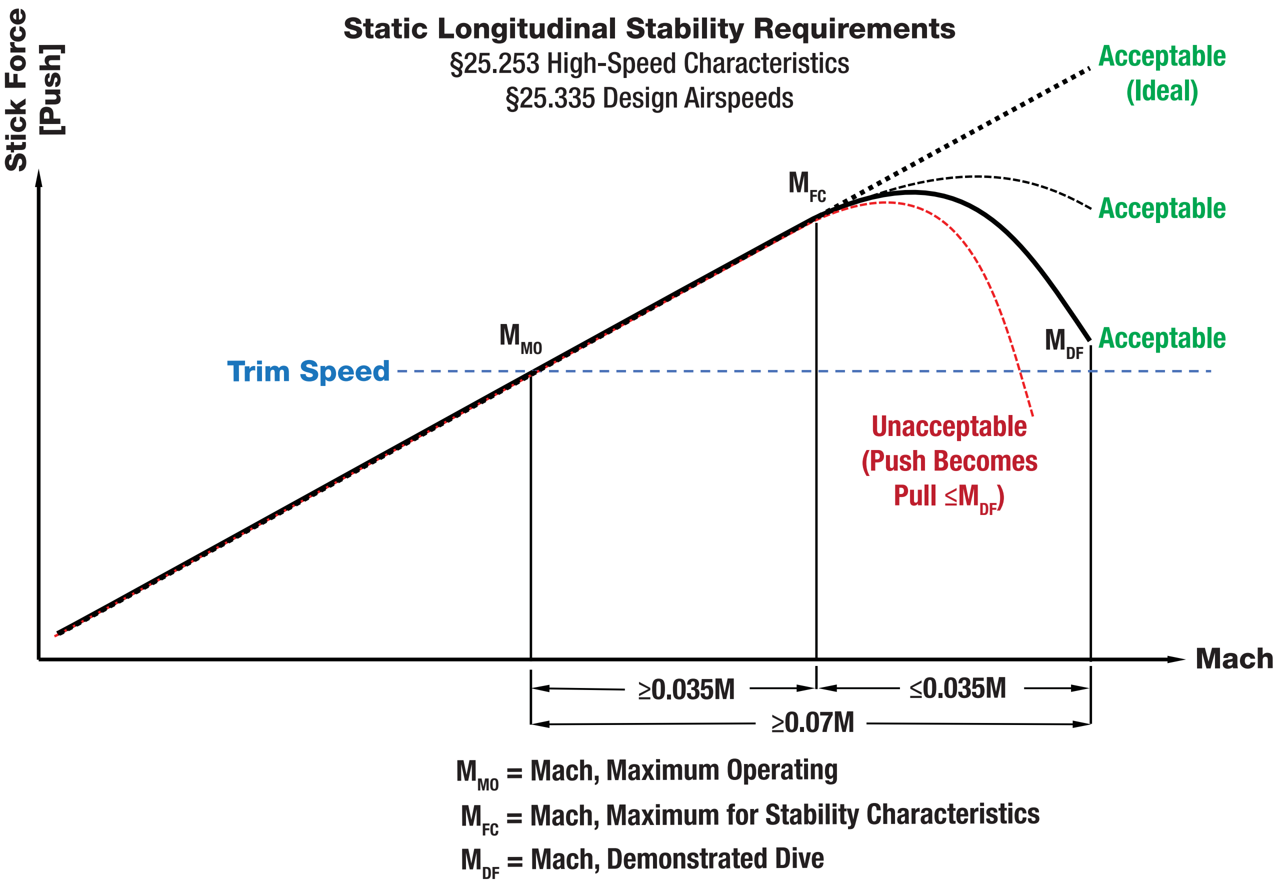
Yet, if history serves to predict the future, a couple of ticks higher max operating Mach, or a few thousand feet higher cruising altitude, would seem to be strong sales incentives for new models. The first OEM to offer an uber-jet with a 0.95 to 0.99 MMO and a 55,000- to 60,000-ft. max cruising altitude might garner a sizable number of orders based on boardroom bragging rights alone.

A young pilot on social media recently asked if civil aviation speed and altitude had reached their top limits, and if so, why. So, we dived into the FAR Part 25 transport category aircraft certification regulations, along with Advisory Circulars AC 25-7D, which is the flight test guide for Part 25 aircraft certification, and AC 25-20, dealing with pressurization, ventilation and oxygen systems, to find some answers.

The FAA has honed these regulations and Advisory Circulars over the years to incorporate lessons learned from aircraft accidents, high-altitude upsets, systems malfunctions, fatigue analyses and pilot errors, says Arthur Barth, a former DER and freelance experimental test pilot with 40+ years of flight test experience. The upshot was a tightening of Part 25 certification regulations starting in the mid-1990s.

Dive! Dive! Dive!

Historically, some of the most challenging tests for aircraft with conventional flight controls, either manual or hydraulically powered, have been the upset and overspeed checks. Test pilots must push aircraft to demonstrated dive speeds and Mach numbers well above VMO and MMO to prove the



Source: BCA

aircraft is safe and controllable in the event of inadvertent pilot error, a runaway trim condition, jet stream turbulence and cold front penetration, among other anomalies.

As speed increases, especially at higher Mach numbers, compressibility effects become more prominent. Mach-induced shock waves can cause pitch force and control reversal, they can excite flutter, they can cause severe buffeting and even render the aircraft uncontrollable. That's why test pilots probe the edges of the flight envelope very carefully and in very small increments.

One particularly challenging test requires that the aircraft start a 7.5-deg. dive at VMO, hold that pitch for 20 sec. and then pull up at 1.5 G. The speed achieved during the dive maneuver is used to determine demonstrated dive speed (VDF). Alternatively, dive speed also may be calculated "if reliable or conservative aerodynamic data is used."

In addition, the margin between MMO and demonstrated Mach dive speed (MDF) must be Mach 0.07. Applicants may apply for a lower margin using "rational analysis" of the effects of automated systems, such as Mach trim systems or stick pullers. However, the margin between MMO and MDF may not be reduced to less than Mach 0.05.

Most applicants just dive test to Mach 0.07 above the intended MMO to demonstrate required stability and control characteristics. Gulfstream, for instance, dive tested the G650 to 0.995 MDF to validate the aircraft's 0.925 Mmo redline. Cessna pushed up the Citation X's MMO redline from Mach 0.92 to Mach 0.935 mostly by using previous dive-speed and aeroelasticity engineering analyses coupled with some new flight test data. Insiders believe the Citation X reached Mach 0.99 during dive tests.

Positive pitch stability, known in the regulations as static longitudinal stability, is required through most of the flight envelope, including defined speeds above VMO/MMO. It's defined as requiring a stick (or wheel) pull to reach and maintain speeds lower than the trim speed and a stick (or wheel) push to reach and maintain speeds higher than the trim speed.

The bottom limit for static longitudinal stability is reference stall speed (VSR) and the top limits are maximum speed and Mach number for stability characteristics (VFC/MFC). The stability characteristics speeds and Mach numbers may not be less than halfway between VMO/MMO and VDF/MDF.

Assuming there is a Mach 0.07 spread between MMO and MDF, if you accidentally exceed redline by Mach 0.035 and you have the aircraft trimmed, it should require more push on the yoke or wheel to maintain any speed up to MFC. Above MFC, and up to MDF, static longitudinal stability stick force must remain positive. But it's acceptable for stick forces to lighten between MFC and MDF as long as you don't have to start pulling back on the stick to prevent the nose from pitching down. The upshot is that it's highly unlikely that you'll ever exceed VDF/

> If one of the yaw damper channels fails, **the aircraft may be grounded.**

MDF in normal operations because of static longitudinal stability.

Assuring positive pitch stability throughout the flight envelope, though, is but one of many hurdles that new and faster aircraft must clear.

Stability and Control, Flutter and Buffet

While VMO/MMO redlines assure safe controllability and buffet-free margins, the regulations also require aircraft to be immune from aeroelastic flutter, defined as unstable structural oscillation excited by the airstream, all the way out to 15% above VDF/MDF. The FAA, though, caps the 15% margin at Mach 1.0 as long as MDF is less than Mach 1.0.

Thus, as the minimum acceptable spread between MMO and MDF is Mach 0.05, it's reasonable to assume that any proposed MMO of Mach 0.95 or above would require a demonstrated dive Mach of 1.0 or above. This would trigger the need for a comprehensive aeroelasticity analysis to at least Mach 1.15 to meet the MDF + 15% requirement. Such analyses are expensive and time consuming.

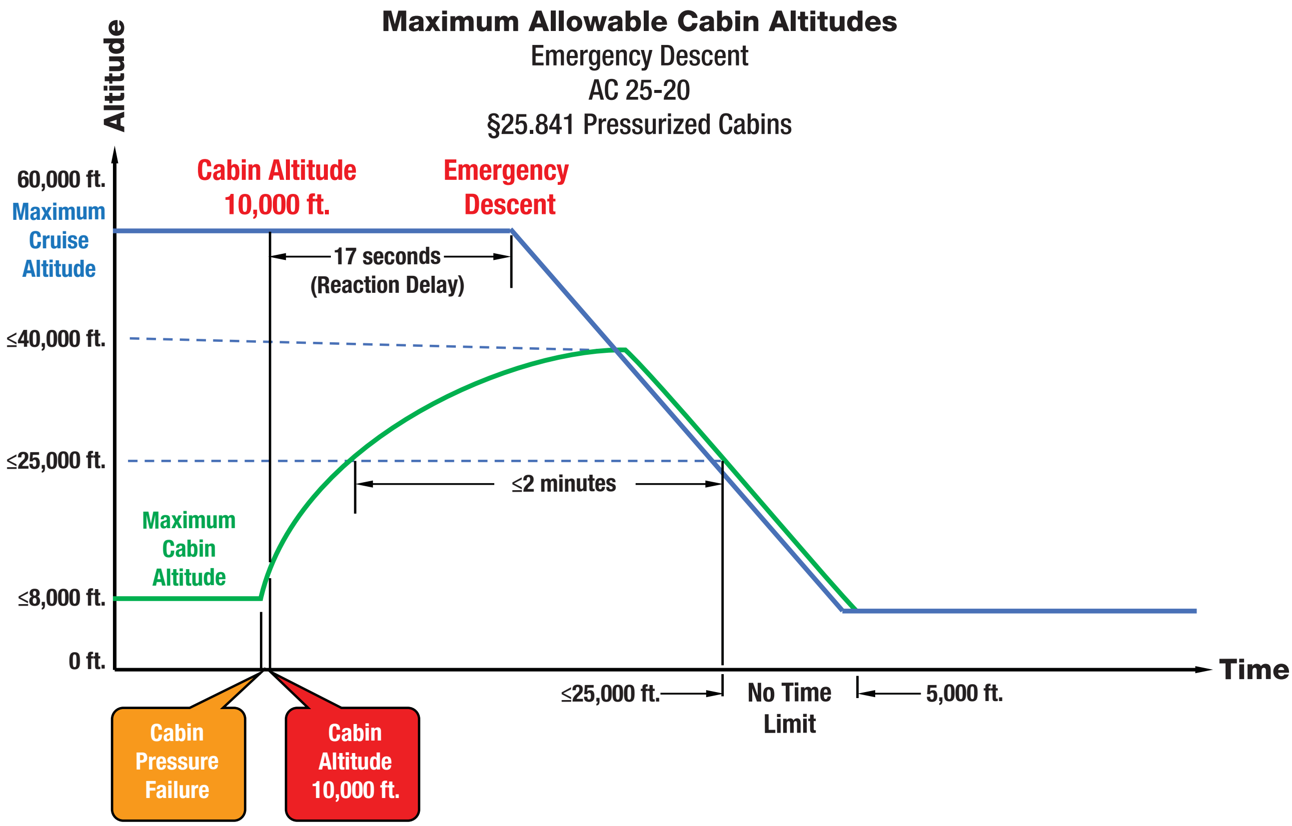
The aircraft also must be directionally stable from 13% above stall speed up to the VFC/MFC maximum flight stability speed and Mach number. The aircraft must positively recover from a skid after a rudder input is released. Some aircraft with conventional flight controls require dual, triple or quad redundant yaw dampers to meet this requirement. If one of the yaw damper channels fails, the aircraft may be grounded.

Similarly, the aircraft must be laterally stable, meaning that it tends to raise a low wing in a sideslip all the way up to VFC/MFC. The regulations allow mild divergence between VMO/MMO and VFC/MFC, providing that it's gradual, easily recognized and easily controllable.

Lateral-directional oscillations, or "Dutch roll," must be positively damped all the way to VFC/MFC stability characteristics speed and Mach number. Many aircraft with conventional flight controls require artificial yaw dampers to meet this requirement at high speed.

Directional and lateral stability often becomes weaker, or even negative, at high indicated airspeeds and Mach numbers, thus, increasing VMO and MMO can create potential certification challenges that require artificial stability augmentation systems.

When the aircraft is flown up to VDF/MDF demonstrated dive limits, there must not be any buffet or vibration that would interfere with safe flight, that would hamper control of the aircraft. Up to the VMO/MMO max operating limits, there must no discernible buffet



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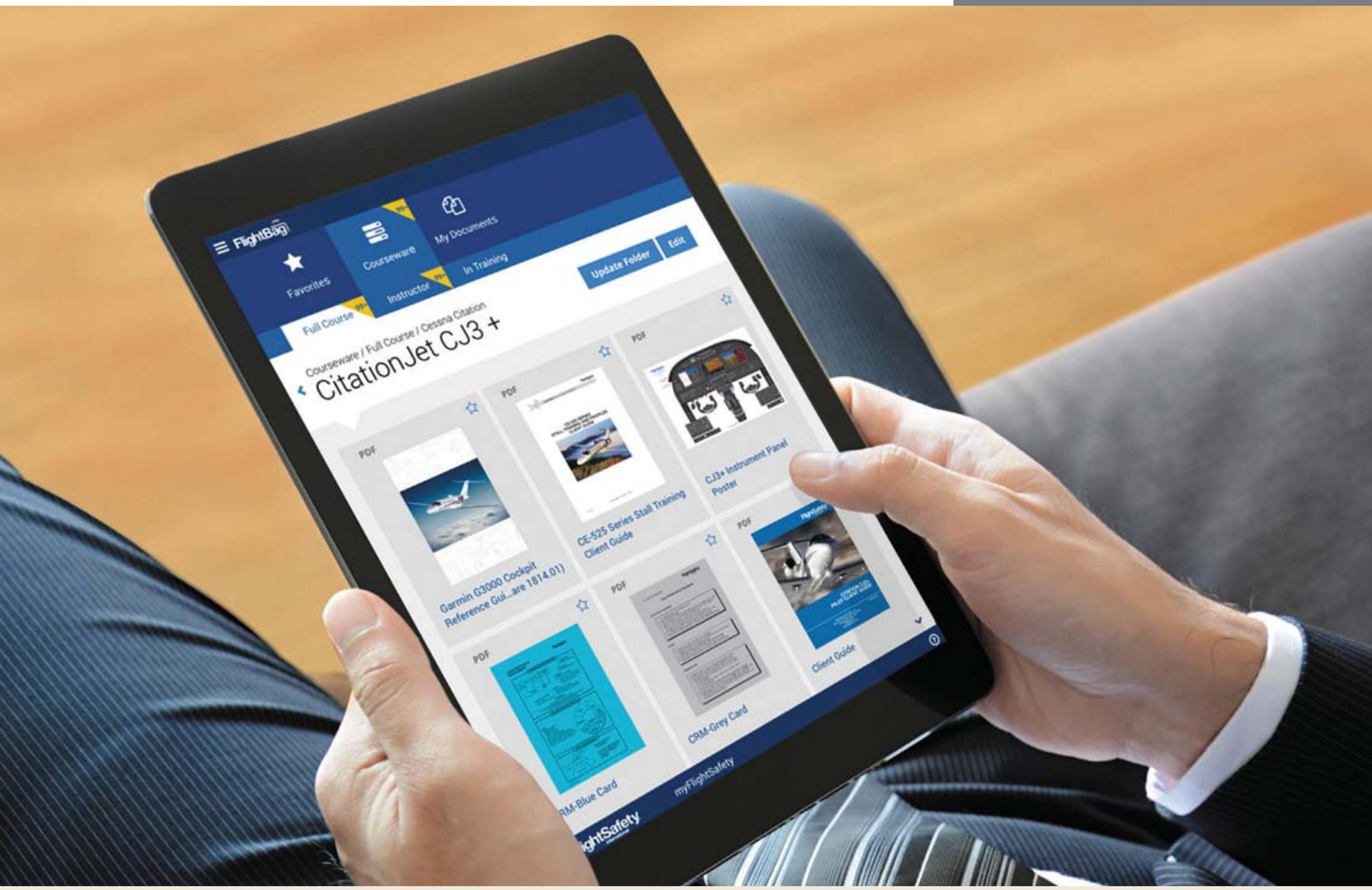

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at all in the clean configuration, except for extension of drag devices. The objective is to prevent excessive pilot fatigue and to prevent unnecessary fatigue on the airframe.

Cabin Pressurization . . . and Depressurization

Transport category aircraft must provide cabin pressure altitudes of 8,000 ft. or lower at the aircraft's maximum cruise altitude. Thus, an aircraft cruising at FL 510 must have at least a 9.32-psi pressurization system. In practice, most business aircraft that fly that high have considerably higher pressurization, resulting in lower cabin altitudes. The latest long-range Gulfstreams, for instance, have 10.7- psi pressurization systems.

The cabin pressure vessel must be tested to 67% above maximum design pressure differential for aircraft certified for 45,000 ft. and above. For the new Gulfstreams, that required testing the pressure vessel to 17.9 psi. And those aircraft also had to be designed and flight tested to withstand sudden depressurization at maximum cruise altitude caused by a hole of a specific size in the pressure vessel defined by regulations.

Windows are critical parts of the pressure vessel, so they must have primary and fail-safe panels and be virtually immune to fatigue failure. They must be capable of withstanding 150% full cabin pressure coupled with external aerodynamic pressure loads.

Any probable failure of the pressurization system may not expose occupants to a cabin pressure altitude in excess of 15,000 ft. If the aircraft suffers sudden decompression due to an extremely improbable (10-9) failure and the crew executes an emergency descent, the cabin pressure altitude must never exceed 40,000 ft. or exceed 25,000 ft. for more than 2 min.

Use of emergency oxygen masks by passengers may help prevent their losing consciousness at up to 34,000 ft. The cabin altitude caps are designed to prevent permanent brain damage or other long-term physiological harm.

The FAA requires a 17-sec. delay from the time sudden cabin decompression occurs until the crew begins the emergency descent to allow for crew recognition of the anomaly and donning of crew oxygen masks. The delay time is based on U.S. Air Force research of crew reaction times during altitude chamber tests.

The emergency descent begins at maximum cruise altitude and ends with a level-off at 5,000 ft. Some aircraft have an automatic emergency descent function incorporated into their autopilots, triggered by sudden cabin pressure loss, that enables them to meet these requirements.

These standards pertain to civil subsonic airplanes certified for flight up to 51,000 ft., according to Advisory Circular AC 25-20 published in 1996. The Advisory Circular also envisions the need for special conditions to be satisfied for flight above 51,000 ft.

> Windows are critical parts of the pressure vessel, **so they must have primary and fail-safe panels and be virtually immune to fatigue failure.**

Barth and other test pilots tell *BCA* that the biggest obstacle to achieving cruise altitudes above 51,000 ft. isn't likely to be meeting the FAA's stability and control standards. It will be demonstrating emergency descent following sudden cabin decompression without exceeding the maximum cabin pressure altitude duration limits in Advisory Circular AC 25-20.

Faster and Higher Means More Cost and Complexity

Three-axis digital flight controls, so-called fly-by-wire systems, will be a virtual must for a new generation of aircraft that fly faster and higher than today's business jets. Digital controls both tame stall characteristics and assure positive stability at high speeds and cruise altitudes.

All major large-cabin business aircraft OEMs are using fly-by-wire controls for their latest generation of long-range aircraft. Aircraft such as the Bombardier Global 7500, Dassault Falcon 7X/8X and Gulfstream G500/600, G650/650ER and G700 all feature three-axis digital flight controls. Hand-flying these aircraft at their maximum 51,000-ft. cruise altitudes is no more challenging than hand-flying older models in the mid-thirties.

These aircraft also have robust cabin pressurization systems, emergency oxygen masks and automatic emergency descent functions that enable them to meet the latest safety standards.

For new models to fly above 51,000 ft., they will need steeper emergency descents to 5,000 ft. to meet the regulatory requirements for maximum cabin altitudes in the event of sudden depressurization.

All these technological hurdles are solvable. But at what cost? And for what benefit? An aircraft that cruises at Mach 0.95, about 545 KTAS assuming standard day temperatures in the stratosphere, might shave 30 min. or so off a 7,000- to 8,000-nm trip, compared to a jet flying at Mach 0.90.

However, airframe drag increases steeply above Mach 0.90 as localized shock waves build in intensity. The 29-kt. faster cruise will require considerably larger fuel tanks, higher operating weights and more powerful engines, assuming a Mach 0.95 jet would cruise at the same altitudes as today's fastest business aircraft.

If designers elect to push the next generation of high-speed subsonic jets above 51,000 ft. to reduce drag and thus save fuel, meeting the pressurization and emergency descent regulations will be substantially tougher and more costly.

For now, it appears that subsonic business aircraft have reached virtual speed and altitude plateaus because of the cost and complexity of pushing those two limits.

Future supersonic business jets, though, are likely to fly well above 51,000 ft. NASA's X-59 quiet supersonic research aircraft (QueSST) will routinely cruise at 55,000 ft., says NASA's J. D. Harrington. Supersonic aircraft could fly as high as 60,000 ft., or higher, to conserve fuel and reduce sonic boom.

Yet, SSBJs will have to meet the same or tougher FAA standards for stability and control, pressurization, cabin altitude and emergency descent as subsonic aircraft. So, price of admission to the Mach 1.4 to 2.0 club could be double or triple that of today's jets that cruise at Mach 0.85 to Mach 0.90. **BCA**

Is It Airworthy?

Damage from turbulence and upsets can evade inspections

EXTREME-PHOTOGRAPHER/ISTOCK

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

Severe turbulence is an ongoing reality and problem. According to "Turbulence Related Accidents & Incidents" by Donald Eick, senior meteorologist in the NTSB's Office of Aviation Safety, airline pilots report 5,500 severe or greater turbulence encounters annually — that's 15 per day — and they're tough on crews, their passengers and the airframe. In addition, flight control system failures, upsets and pilot-induced maneuvers can also produce excessive stress.

These inflight events should be followed by a logbook entry by the captain and a proper inspection by a maintenance technician. Nevertheless, the NTSB has discovered that the resulting structural aircraft damage can be substantial and yet evade post-flight visual inspections by pilots and maintenance technicians, thus allowing unairworthy aircraft to fly again.

On Nov. 17, 2002, a Canadair CL-600-2B19 operated by Comair from Atlanta to Washington, D.C., encountered severe turbulence during its descent near Rockville, Virginia. About 3 hr. before takeoff, the dispatcher approved the flight release, which contained SIGMET Whiskey 8 for occasional severe turbulence from 14,000 ft. to FL 280. The turbulence box overlaid the departure airport and planned en route climb to altitude; however, the top of descent (TOD) and destination airport were clear of the turbulence.

When the pilot later printed the flight release, SIGMET Whiskey 8 had been replaced with SIGMET Whiskey 9. The turbulence box had moved east of the departure airport, and the TOD and destination airport remained clear of the turbulence box. The flight release also contained a single pilot report of severe turbulence from a Boeing 737 at FL 240, within the defined area of turbulence. Prior to departure, but after the flight release was signed by the pilot, the release was updated again, this time with SIGMET Whiskey 10. The turbulence box moved farther east to cover the TOD and destination airport. Nearing his destination, the pilot descended into the turbulence box.

The airplane was not equipped with an aircraft communications addressing and reporting system (ACARS). Rather, weather updates were accomplished by direct radio contact between the dispatcher and pilots, or by the pilots accessing FAA facilities while en route. Although the operator had about 100 flights operating in the turbulence box, none were canceled due to forecast turbulence, or reported to have encountered severe turbulence.

The pilot turned on the seat belt sign, asked the flight attendant to be seated, and made an announcement for the passengers to remain seated as they were within 30 min. of the destination airport. While descending through 17,800 ft., the flight encountered heavy turbulence. Fortunately, there were no injuries to the crew or passengers. Upon landing, the jet was visually inspected for damage in accordance with the Canadair Regional Jet (CRJ) Aircraft Maintenance Manual (AMM) and returned to service.

One of the certification criteria for transport aircraft dealing with structural integrity is 14 CFR 25.301(a), which states, "The structure is required to be designed to sustain the highest loads expected in service ['limit load'] without detrimental permanent deformation and any deformation may not interfere with safe operation."

Subsequent evaluation of the flight data recorder by Canadair revealed large vertical accelerations ranging from +4.3 to -1.9 negative during the turbulence encounter. These load factors were outside the certificated design envelopes for the wing, pylon and horizontal stabilizer attachment to the vertical stabilizer. The inspection procedures in the CRJ AMM define a minimum positive G threshold depending on the airplane's weight (+2.5 G's in this event), above which a visual inspection for damage is required. No inspection criteria were provided for negative G or lateral G excursions. Canadair subsequently performed an engineering assessment and determined that inspections in addition to those already specified in the CRJ AMM were required to ensure the airplane's structural integrity.

On May 12, 1997, an Airbus A300-600 operated by American Airlines as Flight 903 experienced a stall warning system activation followed by extreme bank angles left and right, and a rapid loss of more than 3,000 ft. One passenger sustained serious injuries. Upon landing, the aircraft was visually inspected for damage in accordance with the Airbus A300-600 AMM, which specifies threshold criteria for positive and negative accelerations in the vertical axis, but does not specify lateral G excursions. Damage to the engine pylons and engines was noted and repaired before the airplane was returned to service.

Subsequent analysis of Flight 903's FDR revealed lateral accelerations in excess of 0.4 G, resulting in internal loads well in excess of the certificated ultimate loads for the vertical stabilizer attachment structure. The stabilizer was removed and the composite attachment lugs were subjected to ultrasonic nondestructive inspection. The results of the right-hand aft attachment lug inspection indicated a delamination. Delamination of a composite structure can severely compromise its strength. The NTSB wrote that this type of damage can be caused by extreme loading conditions such as those associated with the upset. The vertical stabilizer was permanently removed.

In both of these events, the operators performed the required inspections as specified in the applicable AMM. However, at the time neither the CRJ nor the A300 AMM included inspections for damage caused by high loads due to extreme lateral accelerations, such as those encountered by American Flight 903, and the Canadair AMM did not include inspections for damage caused by extreme negative vertical accelerations, such as those encountered by Comair Flight 5109.

AIR21's Pilot Protection

As Capt. Roger Luder of Continental Airlines was preparing to fly from Miami to Houston on Sept. 15, 2007, he learned that the aircraft had encountered significant turbulence. In particular, he was informed that the turbulence almost "ripped the wings off," sent a flight attendant to the medical clinic for treatment, and appeared "pink" on the airplane's weather radar.

Luder checked the logbook and found no documentation of the turbulence. So, he noted it and contacted the airline's Operations Control in Houston to order an inspection. Under 14 CFR 91.9, a pilot must comply with the airline's Flight Operations Manual, which in such cases required that pilots log severe turbulence encounters and order the aircraft be inspected.

However, Operations Control ordered Luder to board passengers for the flight. He refused and received a call from Continental officials, including the assistant chief pilot on duty, who said an inspection was unnecessary because the turbulence had been "moderate." The captain hung up and when the assistant chief pilot called him back, Luder threatened to contact the FAA.

Continental inspected the aircraft, which delayed takeoff by over 30 min. Shortly thereafter, Continental suspended Luder without pay for 21 flight hours and threatened him with termination for any improper conduct in the future.

Luder's case eventually was taken to the Administrative Review Board of the Department of Labor (Luder *v.* Continental Airlines). Under the AIR21 Whistleblower Protection Program, protected whistleblowing includes providing information relating to any violation or alleged violation of any FAA order, regulation or standard. The court found that by logging the severe turbulence, Luder engaged in protected whistleblowing. In particular, by so doing, it entailed reporting a violation by the previous pilot for failing to log the encounter. It found that by challenging Continental's refusal to conduct an inspection of the aircraft, Luder was reporting Continental's attempt to cause Luder to violate FAA regulations by not complying with the Flight Operations Manual.

AIR21 prohibits a wide range of retaliatory employment actions, including any action that would dissuade a reasonable worker from engaging in the protected conduct. The court found that suspension without pay is a way to dissuade employees from engaging in protected conduct, and thus, Continental's suspension of Luder for two weeks without pay was an adverse employment action.

Continental asserted that it suspended Luder because of his heated telephone conversation with the assistant chief pilot. But the court found that the real reason was his refusal to agree with his supervisors' directive to forego the aircraft inspection. The court noted that under 14 CFR 91.3, Luder had the authority to decide that the plane was unsafe to operate and had final authority as to the operation of the aircraft. Therefore, he acted appropriately by insisting that Continental inspect the aircraft. **BCA**

Looking for Post-Turbulence Over-Stress

The following is extracted from the Boeing 767 Aircraft Maintenance Manual (AMM) recommendations for structural inspections after an aircraft has been written up for a turbulence encounter. These instructions are spelled out for all the areas of the aircraft.

When the conditional inspection tells you to "examine" a component, look for these conditions (replace or repair the components, if necessary):

- *(a) Cracks.*
- *(b) Creases or cracks in the skin or web.*
- *(c) Skin wrinkling that crosses a line of fasteners.*
- *(d) Pulled apart structure.*
- *(e) Loose paint (paint flakes).*
- *(f) Twisted parts (distortion).*
- *(g) Bent components.*
- *(h) Fastener holes that have become larger or longer.*
- *(i) Loose fasteners.*
- *(j) Fasteners that have pulled out or are gone.*
- *(k) Delamination.*
- *(l) Misalignment.*
- *(m) Interference.*
- *(n) Other signs of damage.*

The AMM spells out where to look, and any specific things to look at in those areas. The following is an example for inspecting the internal areas of Section 48:

(7) Examine all of the internal structure of the fuselage, Section 48 that you can get access to. Look at the structure from the rear pressure bulkhead to the aft end of the airplane. Look for distortions, paint that has flaked and cracks. Also look for fasteners that have pulled out or are not there.

- *(a) Look at the areas that follow:*
  - *1. The aft fuselage bulkheads.*
  - *2. The fin attach fittings.*
  - *3. The horizontal stabilizer center section.*
  - *4. The stabilizer hinge fittings.*
  - *5. The stabilizer jackscrew-mechanism mount fittings and support structure.*
- *(b) Look at the jackscrew and hinges for signs of binding.*
- *(c) Inspect the horizontal-stabilizer-to-body rubstrips. Look for signs of movement of the structure against the rubstrips. Such movement shows distortion of the structure.*


ANDRESR/ISTOCK

Pilot Control Inputs

Inappropriate control actions by pilots can exacerbate an upset recovery or turbulence encounter, putting additional loads on the aircraft. Remember that flight at high speed and high altitude produces considerable changes on an aircraft's stability and handling qualities. Since air density decreases at higher altitudes, an aircraft's aerodynamic damping decreases and it becomes more responsive to control inputs. Flight in the high-speed regime creates high control power, which if used improperly, can over-stress aircraft components.

Over-controlling is a distinct threat at high altitude. For the same control surface movement at constant airspeed, an airplane at 40,000 ft. experiences a higher pitch rate than an airplane at 5,000 ft. because there is less aerodynamic damping. Therefore, the change in angle of attack (AOA) is greater, creating more lift and a higher load factor. It takes less force to generate the same load factor as altitude increases. Erratic and large pitch inputs, possibly from a startle/surprise effect, can quickly bring the aircraft into an upset. It is imperative that pilots refrain from overreacting with large and drastic inputs. Rather, they should smoothly adjust pitch and power to keep the aircraft within the center of its maneuvering envelope.

Aircraft are not built to endure an infinite number of combinations of control inputs. The structural integrity of an aircraft is intended to withstand a predefined stress load induced by "normal" control inputs. At speeds higher than maneuver speed (V_A), a single large deflection in pitch or roll has the potential to generate structural damage or even failure. At any speed, large aggressive control deflection reversals can exceed structural design limits. Also, certification flight tests involve control input in a single axis and single direction. Control reversals will amplify the loads on the aircraft's structures.

The Airbus document "Managing Severe Turbulence" provides additional guidance to flight crews of fly-by-wire (FBW) aircraft based upon in-depth analysis of severe turbulence events. Airbus engineers discovered that pilots who followed the prescribed recommendations for FBW aircraft to keep the autopilot and autothrottles engaged were able to minimize the loads on aircraft, as opposed to flight crews who took over manually.


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BusinessAviation
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'. . . Should Never Have Flown'

The ground crew at North Philadelphia Airport was trying to be helpful to the crew of a Cessna Citation by providing a ground power unit (GPU) to assist with air conditioning as well as the engine start. The understaffed ramp crew had another incoming aircraft to park and was scrambling to cover that as well. In the doing, no one noticed that the GPU was still attached to the Citation as it started to taxi out, its power cord firmly attached to the aircraft's power receptacle until the aircraft turned and it snapped free.

A ramp worker ran in front of the Citation to signal a stop. The pilots shut down the engines and after examining the bent sheet metal around the power receptacle, the FBO's lead maintenance technician phoned the maintenance department of the aircraft's owner. Photos were sent to the maintenance service desk and the maintenance director consulted with the operator's FAA PMI. The three concurred that the aircraft was safe to fly. The operator was issued a ferry permit to allow the aircraft to be flown to the Cessna Service Center at Greensboro, North Carolina, with no additional restrictions.

EXTREME-PHOTOGRAPHER/ISTOCK

A non-routine flight operations captain was assured by the maintenance director that the damage to the jet was "merely external and basically cosmetic," and thus it was safe to fly. The pilot conducted a preflight, looking carefully at the damaged skin around the power receptacle, and using a flashlight while leaning into the auxiliary bay as far as possible to determine if any additional damage was visible. Satisfied, he ferried the aircraft to the service center without incident.

However, roughly 60 min. later, the maintenance service director approached the pilot and said, "Captain, you might want to come look at this." Technicians had removed some of the adjacent external skin and were shocked to see internal load-carrying structures significantly bent.

They immediately sent documentation to Cessna engineers in Wichita who specialized in stress analysis. Using tools such as finite element analysis, the mechanical engineers determined the permanent deformation in the underlying structure required complete replacement of the internal load-bearing structures.

The maintenance service director grimly passed along a message from the engineers to the captain of the ferry flight: "The amount of internal structural damage was substantial. This aircraft should never have flown."

The pilot sat stunned, contemplating how lucky he had been that the structurally compromised components hadn't failed in flight.

He was shaken, I know, because that pilot was me. **BCA**

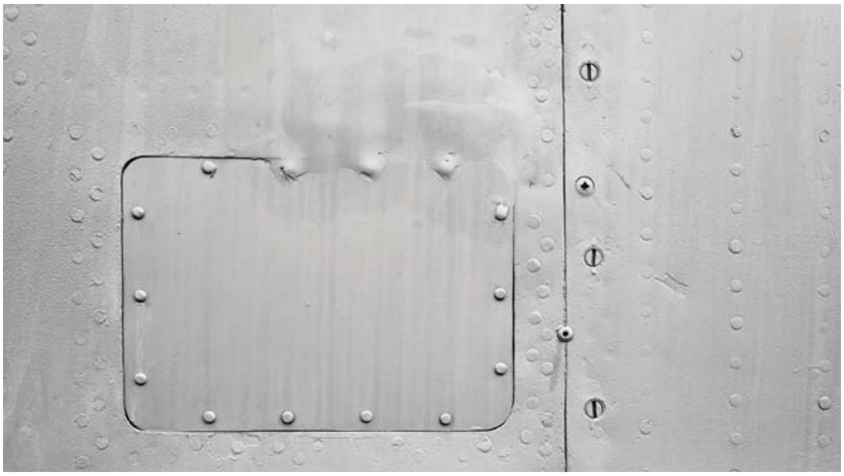
The manufacturer's Flight Crew Operating Manual recommendations are to follow the target speed (which depends on altitude) when turbulence is encountered and keep autothrottles engaged except if thrust changes become excessive and keep the autopilot on. Detailed studies found that the autopilot when combined with the turbulence-induced motions successfully limits the aircraft to smaller reactions. In contrast, they also found that pilot pitch-down reaction to an initial updraft will accentuate the pitch-down effect as the aircraft flies into the downdraft section. This increases the negative load factor and also increases the risk and number of injuries.

A severe turbulence encounter may lead to excessive high-speed or low-speed excursions. This will induce autopilot disconnections and activation of the appropriate flight control law in an FBW aircraft. In the case of a VMO/MMO exceedance, a pitch-up would be commanded to reduce the excursion. If excessive low speed occurs, the alpha protection law would activate and produce a nose-down movement. In order to keep the autopilot engaged as long as possible, flight control software modifications have been developed on FBW aircraft.

Severe turbulence can induce significant altitude excursions because of the turbulence or as a consequence of triggering the VMO/MMO protection or the AOA protection. Without the pilot in the loop these protections will place a priority on protecting the target speed rather than maintaining the trajectory. When either protection law is activated, the autopilot is automatically disconnected. The pilot should apply smooth corrections to manage the aircraft trajectory and avoid sudden corrections fighting the turbulence.

According to the industry's Upset Recovery Manual, if during recovery the application of full lateral control (ailerons and spoilers) is insufficient, it may be necessary to apply rudder in the direction of the desired roll. The manual warns, "only a small amount of rudder input is needed. Too much rudder applied too quickly or held too long may result in loss of lateral and directional control and cause structural damage." After recovering the aircraft, flight crews must assess any damage that may have occurred.

> Due to the risk of reduced structural integrity of an airplane, the NTSB is concerned about deficiencies in inspection procedures. Implicit in **the high-load and inspection formulation was the presumption that the specified inspections would be adequate . . . .**



VLADIMIROVIC/ISTOCK

The NTSB wants to prevent inspected but still unairworthy aircraft from returning to service after events that exceeded the manufacturer's threshold.

Severe atmospheric turbulence and inappropriate flight-crew control inputs can induce significant "multi-axial" loads on aircraft structures. A prime example of this occurred when a Boeing 747 nearing Anchorage, Alaska, on March 31, 1993, was in the vicinity of strong mountain wave turbulence. The jumbo experienced a rapid 50-deg. roll to the left followed by a significant yaw. Then came several pitch and roll oscillations. The severe turbulence created dynamic multi-axis loadings that so exceeded the structural capability of the No. 2 engine pylon that it completely separated from the airplane, taking the engine with it.

What is "multi-axial" loading and why is it important to this discussion? Its impact on an engine pylon illustrates this phenomenon perfectly. Under normal circumstances in flight, the engine is producing a significant amount of forward thrust, thus its pylon endures a direct tensile (pulling) force along its primary axis and is designed accordingly. Now, consider an abrupt rolling input to the aircraft. Suddenly, in addition to the tensile force from the thrust-production, the pylon experiences a sideways shearing force. This places the pylon into a condition of "multi-axial" force . . . tensile stress in one direction and shear stress in another. The combination of stresses acts in a direction that the structural element wasn't originally designed to withstand, and can lead to failure.

Summary

Due to the risk of reduced structural integrity of an airplane, the NTSB is concerned about deficiencies in inspection procedures. Implicit in the high-load and inspection formulation was the presumption that the specified inspections would be adequate to identify and address damage caused by any such event. Canadair and Airbus determined that their published inspection criteria were inadequate to ensure safety after the high-load events encountered by their airplanes, and that additional broader and more-detailed inspections were required to ensure safety.

The NTSB wants to prevent inspected but still unairworthy aircraft from returning to service after events that exceeded the manufacturer's threshold. Furthermore, the Safety Board is troubled that airplanes may be exceeding design and certification standards more frequently than was previously known or expected, and recommends that all such events be tracked and evaluated.

After encountering significant turbulence or any other event that may have exceeded the aircraft's structural limitations, a captain is responsible for annotating the fact in the aircraft's logbook after the flight, triggering a mandatory inspection for structural damage. According to Airbus, turbulence can be considered as excessive when passengers and crew are moved violently against their seat belts and objects move around the aircraft. Inspections that are mandated after flight in excessive turbulence are described in the AMM. In case of severe turbulence it is recommended that the manufacturer be informed as well. Note that in some cases the manufacturers have subsequently determined that limit loads have been exceeded in portions of the airplane, thus requiring additional inspections. **BCA**

Leonardo's AW609

Bringing **tiltrotor technology** to civil aviation

LEONARDO

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

"Man was intended to fly like a bird — not like a bat out of hell," is an aphorism attributed to Lawrence Bell, founder of the eponymous rotary-wing manufacturer and, with inventor and polymath Arthur Young, developer of the first civil-certificated helicopter, the iconic Model 47.

Regardless of the statement's provenance, the sentiment accurately conveys the age-old human dream of being able to rise vertically from the ground and then fly through the air — like a bird. The helicopter, of course, satisfies the vertical takeoff half of Bell's alleged dictum, but to go anywhere must thrash through the air, "beating it into submission," as rotary-wing pilots like to joke. As a result, rotary-wing craft are limited in speed and range and generally confined to lower altitudes.

A Tiltrotor Legacy

As early as the 1950s, Bell began exploring the possibility of combining vertical capability with fixed-wing flight with the XV-3. One of the world's early tiltrotor experiments, the aircraft featured twin wingtip-mounted helicopter-like rotors driven through shafts by a radial engine installed in the fuselage. While dogged by persistent rotor instability (specifically, a variation on whorl mode), the XV-3 nevertheless logged more than 100 hr. flown by Bell and U.S. Air Force pilots, thus proving the viability of the tiltrotor concept.

The XV-3 provided a knowledge base that two decades later led to Bell's development of the NASA-funded XV-15, a fully functional tiltrotor design that established the practical operating envelope for combined rotary- and fixed-wing flight. Featuring unique proprotors characterized by severely twisted, wide-chord blades and pivoting wingtip-mounted engines, the XV-15 laid the groundwork for definition of the JVX tactical transport program in 1981 that culminated in development of the V-22 Osprey tiltrotor for the U.S. Marine Corps, Air Force and Navy. A prototype of the aircraft flew for the first time in 1989, commencing a nearly 20-year refinement program marred by several accidents and consequent setbacks. The MV-22 officially entered service with the Marines in 2007.

In conceptualizing and developing the V-22, Bell partnered with Boeing Helicopters, and in the mid-1990s, the two began discussing the possibility of teaming up to build a commercial tiltrotor. This resulted in the BB609, which was conceived as a nine-passenger, two-pilot aircraft and was more like the XV-15 in size and performance than the V-22. Following its merger with McDonnell Douglas Boeing exited the commercial helicopter business in 1998 to focus on the military rotorcraft market with the CH-47 Chinook, AH-64 Apache and other products.

Meanwhile, Bell, which had a long history of licensing partnerships with Agusta Westland, teamed up with the Italian manufacturer to continue the 609 program, redesignated BA609. This arrangement continued until late 2011, when Agusta bought out Bell's share, and the aircraft's designation was again changed, this time to AW609. Subsequently, in the consolidation of Italy's aviation industry, Agusta Westland was absorbed into Leonardo, a conglomerate that encompasses rotary- and fixed-wing aircraft, aerostructures, electronics and cybersecurity. "This is now a 100% Leonardo program," William Sunick, head of tiltrotor marketing at Leonardo Helicopters, recently told *BCA*.

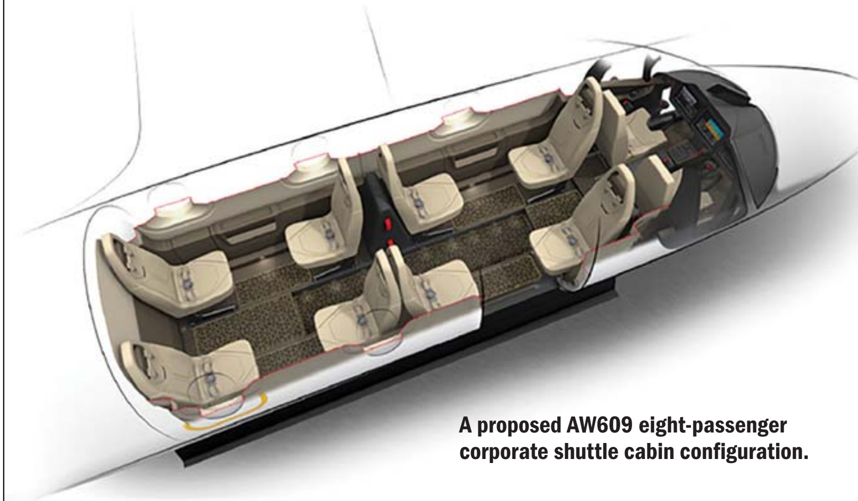
The AW609 is the distillation of thousands of hours of engineering, innovation, testing and refinement, and touched with tragedy. The program has been in progress for nearly 25 years and has yet to achieve certification, although with the fourth prototype now flying at Leonardo's U.S. headquarters and factory in Philadelphia — where the AW609 will be produced — that prize is in sight and perhaps soon.

Tiltrotor Tech Is Mature

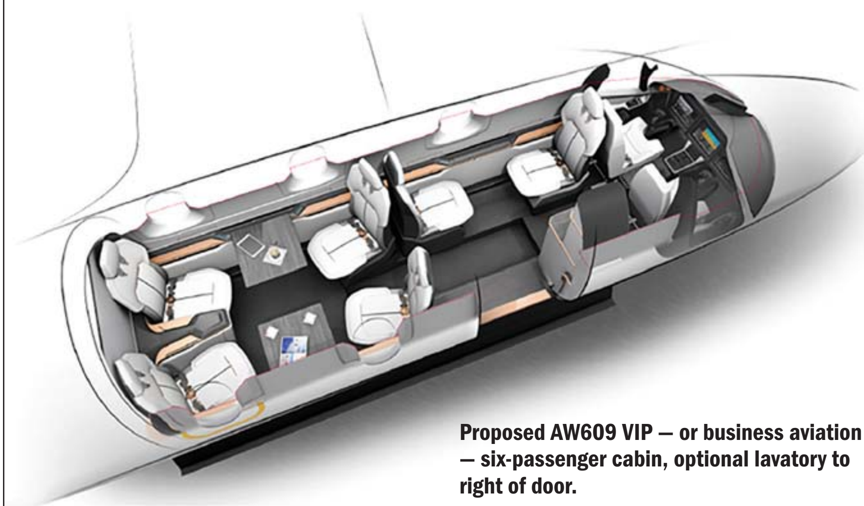
As Sunick points out, tiltrotor technology is well accepted and mature, with more than 500,000 hr. of operational experience, most of it by the V-22 in military and combat ops with the Marines and Air Force; Navy aircraft will begin carrier-on-board (COD) deliveries next year with the CMV-22V variant. Total hours logged in the AW609 testing program stood at 1,600 at the beginning of this year. In addition, thousands of hours of ground testing preceded flight. In Italy, a "run stand" was built on which prototypes are secured so that nacelles can be rotated and dynamic systems tested. Engineering simulators have been installed in Italy and Philadelphia for software development and avionics and actuator testing.

The fourth prototype, built in Philadelphia in production configuration, made its first flight Dec. 21; its first assignment is inflight testing of the Collins Fusion avionics suite that equips the AW609 line. It joins a second machine at Philadelphia currently engaged in aeroelastic stability and engine testing. Meanwhile, an earlier prototype is back on the run stand in Italy for further research purposes. Another prototype was destroyed in a 2015 inflight accident in Italy. In January, the first two customer aircraft were in production at the Philadelphia plant, destined for launch customer Era Aviation.

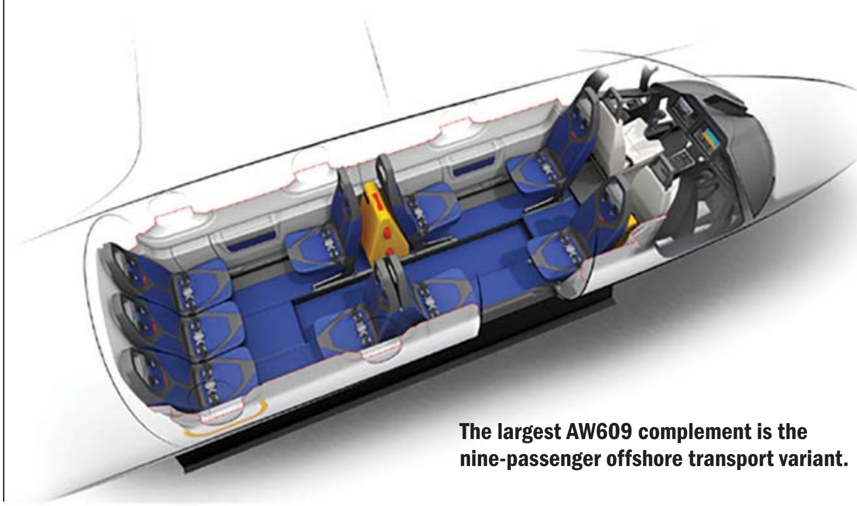
LEONARDO (3)



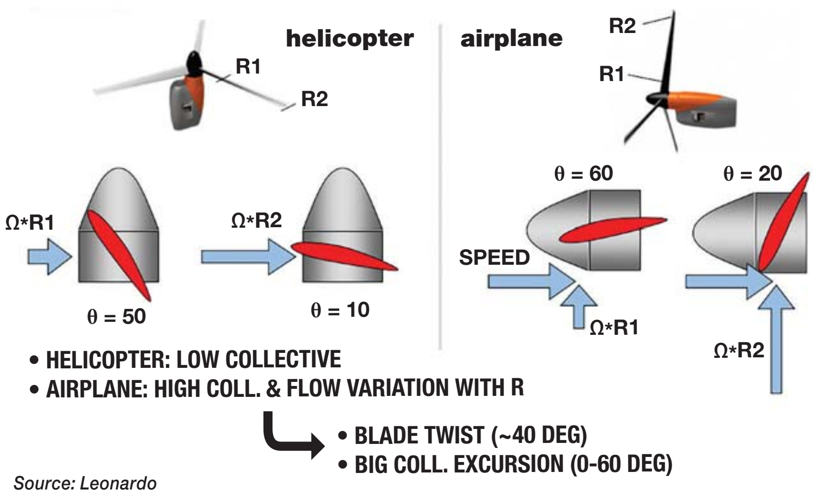
A proposed AW609 eight-passenger corporate shuttle cabin configuration.



Proposed AW609 VIP — or business aviation — six-passenger cabin, optional lavatory to right of door.



The largest AW609 complement is the nine-passenger offshore transport variant.



Source: Leonardo

In the combined rotary- and fixed-wing modes, proprotor blades exercise a collective "excursion" of 0 to -60 deg.

Given that tiltrotor technology was well along when the AW609 was conceived, why did it take so long for the program to reach its present state? "When we acquired the program," Sunick explained, "we took a critical eye on where the program was in development within the context of both emerging technologies and the capability we wanted the AW609 to have at certification. So [in 2012] we embarked on a whole new development program to incorporate the latest technologies."

As a result, the aircraft is "much changed." This includes:

▶ An aerodynamic cleanup reducing drag by 10%, based on flight testing and wind-tunnel analysis.

▶ An engine upgrade to the Pratt & Whitney Canada PT6C-67A turboshaft rated at 1,940 shp for normal operation and 2,492 shp for 30 sec. under one-engine-inoperative (OEI) conditions.

▶ MTOW increased to 18,000 lb. from 16,799 lb. Useful load is 6,000 lb.

▶ Structural changes, including a beefed-up retractable landing gear to accommodate the higher gross weight.

▶ A new, wider cabin door. Measuring 35-in. wide and 50-in. high, it is a clamshell-type design, à la the Learjet 25/35, with segments hinged at the top and bottom, replacing the original, smaller door that was hinged on one side. The upper segment of the door is claimed to be sufficiently robust to serve as a mounting point for a hoist for a proposed search-and-rescue (SAR) version of the aircraft.

▶ A redesigned cockpit based on addition of the Collins Fusion suite.

▶ A new air data system.

▶ An upgraded flight control computer (FCC).

▶ A new environmental control system (ECS).

The last four improvements on the list are said to reduce pilot workload, and the new prototype/demonstrator at Philadelphia incorporates all of them. "All this results in a robust capability and is cutting edge," Sunick proclaimed.

There is a popular misconception that the AW609 was spun off from the V-22 and is a scaled-down version of the military tiltrotor. Nothing could be further from the truth, Sunick insisted. "The tiltrotor concept and technology is shared with the V-22, but this is a commercial aircraft designed to FAA transport category aircraft standards, FAR Parts 25 and 29." In addition, the FAA has conceived a whole new category to accommodate tiltrotors called "powered lift" — so far unnumbered and expressed simply as "Part TR."

Optimized for Comfort

Also, unlike the spartan military V-22, the AW609 is "optimized for passenger safety and comfort," Sunick said. So again, unlike the V-22, its cabin is soundproofed and pressurized to the aircraft's 25,000-ft. ceiling.

Further, in the unlikely event both of the tiltrotor's PT6C-67A engines were to fail, the AW609 can perform autorotational landings, since its proprotors generate much lower disk loading than those of the V-22, and, thus, the aircraft behaves more like a helicopter.

In a 2009 test of a dual engine failure, an AW609 prototype's pilots were able to carry out a successful and safe autorotational landing from cruising altitude. Five years later, Leonardo pilots performed more than 79 power-off conversions from airplane to helicopter mode during autorotation tests monitored by the FAA, concluding that minimum altitude for a successful autorotation is 3,000 ft. and that, if the maneuver is conducted properly, the AW609 can easily maintain rotor rpm above 70%, the minimum for stable recovery.

The procedure is straightforward: Glide to windmill the proprotors; institute "a rapid conversion" to helicopter mode with an airflow inversion with respect to the proprotors; begin the autorotation with descent airflow keeping the proprotors turning; finally, time flare before touchdown.

Technically, the 30,000-lb. V-22 can

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The AW609 will be equipped with a Collins Fusion avionics suite typical of business jets. It includes a sink-rate warning system and nacelle tilt-angle indicator.

autorotate if both of its Rolls-Royce/Allison turboshafts were to fail. However, due to the aircraft's relatively high rotor disk loading, safe autorotational landings are deemed to be "extremely difficult." In order to meet a shipboard requirement of folding rotors for below-deck storage, the aircraft's proprotors had to be truncated by 5 ft. to a 38-ft. span from a size considered optimal for vertical flight, resulting in the high disk loading. During the proving phase of V-22 development, the Pentagon testing directorate pronounced that an attempt to autorotate the aircraft below a 1,600-ft. hover would likely be un-survivable.

Emphasizing the AW609's broad capabilities beyond vertical flight — speed, range, high-altitude cruise avoiding weather — Sunick pointed out that "about 85% of the time the 609 is flying, it will be in the airplane mode, depending on the mission. For example, it may go somewhere and hover, as in the SAR application, then return in the fixed-wing mode. So there would be a takeoff and landing and a mid-point hover for a rescue that will involve vertical lift."

Operating under transport category rules, the AW609 can take off vertically at 16,800 lb. (the aircraft's previous MTOW). Leonardo plans to establish vertical takeoff weight in the normal category this year and expects it to be higher. The AW609 is capable of short takeoff and landing (STOL) performance when the nacelles and proprotors are lowered from the vertical to a diagonal position to facilitate a rolling takeoff. (Nacelle angle is at pilot's discretion but in the neighborhood of 75 deg.) "This will result in less wear and tear on the dynamic systems," Sunick said. It also makes takeoff at the new 18,000-lb. MTOW possible. Run-on landings are also possible with the

LEONARDO

AW609 collective stick, or "power lever," includes a thumb-wheel for tilting the aircraft's nacelles.

VRS and Other Controversies

Tiltrotor technology has been hard won. In its long development, the V-22 Osprey experienced so many accidents and fatalities, Time magazine referred to it in a 2007 report as "A flying shame."

During testing between 1991 and 2006, four Osprey crashes resulted in 30 fatalities. Since entering service in 2007 with the U.S. Marine Corps and Air Force, seven more crashes — including two in combat zones — were responsible for 12 more fatalities, for a total of 42 lives lost since its inception. Several other accidents and incidents have resulted in survivable injuries and loss of aircraft.

In the nearly 25-year development period of the (now) Leonardo AW609 civil/commercial tiltrotor, two test pilots were killed while engaged in dive tests in 2015 when their aircraft experienced uncontrollable oscillations and broke up in the air. (See text of main story for a description of the accident and the conclusion of the Italian investigation team.)

The most costly accident experienced by the Osprey occurred in April 2000 during a Marine training exercise at Marana, Arizona. An MV-22 moving forward at under 40 kt. descended too rapidly into its downwash and stalled its right proprotor, rolled over, crashed and exploded. All 19 on board died. The post-accident investigation determined that the MV-22's descent rate was 100% more than its required limit of 800 fpm at airspeeds below 40 kt., a restriction typical of conventional helicopters. The phenomenon that had brought down the big tiltrotor was vortex ring state (VRS), a condition long known by rotary-wing pilots.

An irony is that subsequent testing of the V-22 and later the AW609 proved that tiltrotors in general are less susceptible to VRS, as the condition is said to be more easily recognized by the aircrafts' pilots than in helicopters and with a "more natural" recovery action, and if altitude is 2,000 ft. or higher, altitude loss is significantly less. (The altitude of the V-22 that crashed in 2000 was only 245 ft. when its right proprotor stalled.)

Leonardo offered this statement regarding a question of whether the AW609's FBW software would "sense" an incipient VRS: "Similar to other rotorcraft, the AW609, while flying as a helicopter, will alert the pilot well in advance of the possibility of entering a vortex ring state condition. Conversely, in airplane mode, the AW609 will alert the pilot well in advance of the possibility to enter a stall, like other fixed-wing aircraft." According to a Leonardo briefing presentation, VRS prediction for the AW609 was based on V-22 data. BCA nacelles set at the appropriate tilt angle.

In the full helicopter mode (nacelles vertical), the AW609 can hover out of ground effect (HOGE) at 6,000 ft. and in ground effect (HIGE) at 10,000 ft., both under ISA conditions.

The load-bearing nacelles' full extent of tilt is 95 deg. vertically to 0 deg. horizontally. For takeoff and hovering, the pilots will choose the optimal slant depending on various factors including weather and space constraints, usually between 87 and 90 deg. However, it is also possible to pivot the nacelles 5 deg. aft (*i.e.,* to the full 95-deg. vertical extent) for braking or rearward flight. For forward flight, nacelles are automatically locked in the 0-deg. position. Conversion is facilitated hydraulically by dual telescopic ballscrews. Hovering, flaperons are automatically dropped to 66 deg. to reduce wing area from the proprotor downwash.

Diameter of the three-blade proprotors is 25 ft., 11 in. Blades are twisted 40 deg., distinguishing them from the flatter rotorblades of conventional helicopters. "By nature it is a compromise design between a rotor and a propeller," Sunick observed, "and walks a fine line between them."

Another difference is that a helicopter rotor is designed to operate in one plane of rotation, and the proprotors must function as both helicopter rotors and airplane propellers in planes 90 deg. apart. In the combined rotary- and fixed-wing modes, the blades exercise a fairly broad collective "excursion" of 0- to 60-deg. pitch. The blades are fabricated of mainly carbon fiber; their useful life is being determined by Leonardo's maintenance review board.

With the nacelles mounted at the wingtips, the proprotors are more than 15 ft. from the cabin for "enhanced ride quality." Also, with the AW609 on the ramp and the nacelles in the vertical position, the proprotors, when turning, are more than 15 ft. above the ground for safe movement of passengers or ramp personnel.

The AW609's 32-ft., 10-in. span wing (measured between proprotor centers) is slightly swept forward and fabricated of carbon fiber. It holds the AW609's entire 2,571 lb. of fuel load, distributed among 10 crashworthy cells. In terms of range, this gets the aircraft — as expressed by Sunick — "700 nm to dry tanks under ISA conditions with no payload." (Apparently, neither FAA nor NBAA IFR range calculations have yet been worked out by the developer's engineering test pilots.) Duration is listed as 3 hr. at maximum cruise speed of 275 kt. In 2015, one of the AW609 prototypes was flown 721 sm (626 nm) from Yeovil in the UK to Milan in 2:18 hr.

Tilting the PT6C-67A

For the Leonardo AW609 tiltrotor application, Pratt & Whitney Canada had to modify its PT6C turboshaft so that it could operate through a 95-deg. arc at high-power settings. The resulting variant was the Dash 67A engine that received reciprocal FAA, Canadian DoT, and EASA certification in September 2017.

The mods included mostly changes to the engine's oil system to keep the oil where it should be in all attitudes, which is to say, out of the air streams. This involved new sealing arrangements and oil scavenge pumps.

To boost the power rating of the engine – the largest in the extensive PT6 product line – the compressor and high-pressure turbine were tweaked. According to PWC, the rating structure is similar to a turboshaft, however, in the tiltrotor application, the engine will be operated as a turboprop most of the time, given the AW609's typical mission curve.

The PT6C-67A's configuration is the same as other PT6s on the high-power end of the product line: four-stage axial, single-stage centrifugal compressor; reverse-flow annular combustor; single-stage high-pressure turbine; and a two-stage low-pressure power turbine. The engine contains no reduction gearbox; instead, output shaft reduction is accomplished through the AW609's drivetrain which includes reduction gearboxes. Leonardo also took responsibility for mating the engine with the uniquely designed proprotors that enable both rotary- and fixed-wing flight and for providing the PT6C-67A's digital electronic control system (FADEC).

The PT6C-67A is rated at 1,940 shp for takeoff but features a one-engine-out (OEI) power reserve of 2,492 shp for 30 sec.

For ground testing of the engine, PWC built a rig replicating the tilt-range of the AW609 application – essentially, 0 deg. horizontal to 95 deg. vertical. The rig continues to be used for test runs of production engines. As of this winter, total test rig and flight testing run time is approaching 10,000 hr.

Configuration of the PT6C-67A is typical of the PT6 line: five-stage compressor, reverse-flow annular combustion, single-stage HP turbine, and two-stage LP turbine.

By the end of March 2020, six production PT6C-67A turboshafts had been completed. Time between overhauls (TBO) of the engine has been set at 5,000 hr. Other maintenance aspects conform to established PT6 procedures. BCA

Leonardo is working on auxiliary fuel tanks that would be externally mounted under the wings, inboard of the nacelles, adding approximately 900 lb. of additional fuel, which would extend range under the same conditions to 1,000 nm. "They look like military drop tanks but are fixed," Sunick said.

Lots of Moving Parts

Much of the AW609's mechanical complexity is contained in the wing and nacelles. In addition to the power transfer shaft in the wing that connects the engines, enabling the operating turboshaft in an OEI situation to drive both proprotors, there is a mid-wing gearbox for the transfer shaft to get it "around the corner" at the apex of wing's sweep. (The shaft is similar to the driveshaft that runs from the main rotor gearbox to the tail rotor in a conventional helicopter and so is well-established technology.) Additionally, two tilt-axis gearboxes for moving the nacelles plus a pair of proprotor reduction gearboxes are contained in the nacelles. That's five gearboxes in all.

The empennage of the AW609 consists of a T-mounted horizontal stabilizer and elevator atop a vertical stabilizer that does not include a rudder. The aircraft is turned in the airplane mode using flaperons and "differential collective" (more on that later).

The aircraft has designed-in proprotor anti-ice and deice capability and is fitted with wing and engine inlet deicing boots and a heated windshield for eventual approval of flight into known icing conditions. Leonardo has tested the airframe with ice forms in flight to determine the effect of icing on the unprotected empennage.

Obviously, hydraulics are an essential component of the tiltrotor, to (among other functions) precisely rotate the nacelles under heavy dynamic loading, so the AW609 is equipped with a triplex (i.e., triply redundant) 3,000-psi hydraulic system. To meet electrical needs, three DC generators, two AC generators and a 28Ah battery are standard. The flight control computer is also backed up with two dedicated batteries. Vapor-cycle air-conditioning augments the cabin pressurization system. The aircraft, at least at present, is not equipped with an APU.

The fly-by-wire (FBW) control system is also triply redundant. "BAe Systems developed the FBW hardware and Leonardo wrote the software code

The AW609 can take off vertically at 16,800-lb. weight. At the 18,000-lb. MTOW, a running takeoff would be necessary with nacelles tilted at approximately 75 deg.

in-house," Sunick noted. Considering that it must govern both rotary- and fixed-wing operation and the transition between the two modes, the software must be among the most complex in civil aviation, and it makes flying the AW609 possible with a claimed minimum of pilot workload. "We are constantly updating it," Sunick said, "just like your iPhone." It is programmed to, in certain cases, "not let you do things," he offered. However, note that this is not exactly like some FBW code in other aircraft that will not allow the aircraft to diverge from the established flight envelope.

One reason why it took so long to develop and perfect the tiltrotor concept is establishing the dynamics and control laws necessary to enable the conversion from vertical to horizontal flight in a seamless and safe manner. According to a Leonardo briefing document, "Flight controls from VTOL conversion to airplane mode are transparent, phased with nacelle tilt angle."

Thanks to flight control system augmentation, constant altitude during the conversion can be maintained (i.e., with no dip in altitude for translational lift) with low pilot workload as a byproduct. Consider that transition must be made starting from a condition where nacelles are vertical and lift is produced in a hover, to a lowering of the nacelles to about 75 deg. where forward speed builds to approximately 60-80 kt., and lift is gradually transferred to the wing. As the aircraft continues to accelerate to about 160 kt., the wing becomes fully loaded, and conversion to airplane mode is complete.

According to Sunick, the Collins Fusion avionics are "pretty much unchanged from what you'd find in a typical business jet other than incorporating a nacelle position indicator."

The suite features three large-format displays with touch-screen interfaces. A sink-rate warning system is also included to maximize allowable descent rates at slow forward speeds with a safety margin to avoid vortex ring state. (See "VRS and Other Controversies" sidebar.) The cockpit is designed for single-pilot IFR operation, although it is likely that in most roles such as in business aviation or offshore transport, two pilots will crew the aircraft.

While many of the functions in the AW609's operation are automated via the FCC and its software algorithms, cockpit controls are designed to replicate those of conventional rotary-wing aircraft to ease transition of pilots into the dual-role tiltrotor. A collective stick is mounted on the left side of the pilot seats — in the AW609, it is called the "power lever" and is equipped with a thumb wheel to change the nacelle positions — with a cyclic stick facing the pilot that doubles as a "joystick" in the airplane mode.

How Does It Fly?

So, from a pilot's perspective, how does the AW609 fly in either mode? The beauty of the FCC software is that it replicates the characteristics of each type of aircraft implicit in the hybridized aerial vehicle.

"As a helicopter, we programmed the fly-by-wire software so it flies in a similar fashion to the Leonardo

LEONARDO

The AW609's cabin is pressurized to the tiltrotor's 25,000-ft. ceiling. Its height and width are, respectively 56 in. and 58 in.

AW139 midsize helicopter," Sunick said. "This modeled the behavior. In the airplane mode, we wanted it to behave like a twin-engine turboprop, so it is modeled like one of those — for example, the Beech King Air 250. By design we had to make it easy and intuitive for both kinds of pilots to fly.

"It doesn't have a rudder, so when in airplane mode, we use differential collective — the yaw effect — to turn," he continued. "Differential collective and flaperons enable the coordinated turn — all managed by the FCC. From the pilot's perspective, though, nothing has changed. The flight control computer takes the pilot's input and moves the proper control surface to get the desired result. The AW609 can autorotate and you have maximum compatibility so that a conventional helicopter pilot would feel no difference in how it handles. Same for fixed-wing pilots."

In what configuration would a crew fly an IFR approach in the AW609? "Easy," said Sunick: "You transition to rotary-wing to fly the relevant IFR approach. This offers greatly reduced speed for maneuvering, unlike a fixed-wing aircraft." (How this will come down with air traffic controllers at high-density airports under pressure to get as much traffic on the ground as quickly as possible remains to be seen.)

VNE (never exceed speed) is 283 KTAS at the aircraft's ceiling of 25,000 ft. In the 2015 mishap in Italy that occurred during dive tests, the country's accident investigation board, Agenzia Nazionale per la Sicurezza del Volo (ANSV), determined that the test aircraft achieved a maximum airspeed of 306 kt. before uncontrollable oscillations (similar to Dutch roll) forced the proprotors to deform and strike the leading edges of the wings, severing fuel and hydraulic lines and culminating in an in-flight breakup. Test pilots Herb Moran and Pietro Venanzi died in the crash.

ANSV also concluded that neither the control laws programmed into the FCC

AW609 Dimensions and Footprint

How much ramp space does the Leonardo AW609 need? At first glance, it might seem like a ramp hog, but actually, it has about the same footprint as midsize turboprops and helicopters such as the Beech 200/250 King Air and Leonardo's hugely successful AW139 (1,150 orders by 280 operators over the last 15 years).

The AW609's span from proprotor tip to tip is 60 ft. while the King Air 250's wingspan is 57 ft., 11 in. The AW139 gets a pass here, as its main rotor diameter is only 45 ft., 3 in. and the width of its fuselage is 10 ft. But in terms of length, the helicopter leads the pack at 54 ft., 8 in. (from tail rotor tip to main rotor tip) while the AW609's length is 46 ft. and the King Air's is 43 ft., 10 in.

AW609 Comparison

Aircraft	Length	Span	MTOW	Cabin	Capacity	Max Cruise	Vne	Ceiling	Range	Endur	ROC	HIGE HOGE
AW609	46 ft.	60 ft.	18,000 lb.	4 ft. 8 in. H 4 ft.10 in. W 13 ft. 5 in. L	2+9	275 kt.	283 kt.	25,000 ft.	700 nm.*	3 hr.	1,500 fpm	10,000 ft. 6,000 ft.
AW139	54 ft. 8 in.	45 ft. 3 in.	14,110 lb.	4.7 ft. H 6.6 ft. W 8.8 ft. L	2+12	165 kt.	—	20,000 ft.	573 nm.	5 hr. 13 min.	2,140 fpm	15,360 ft. 8,130 ft.
KA250	43 ft. 10 in.	57 ft. 11 in.	12,500 lb.	4 ft. 9 in. H 4 ft. 6 in. W 16 ft. 8 in. L	2+7	310 kt.	—	35,000 ft.	1,403 nm.**	4.8 hr.	2,437 fpm	N/A N/A

*To dry tanks; aux. fuel extends this to 1,000 nm. to dry tanks, ISA
**NBAA IFR, 100 nm. alternate, 291 kt., ISA (Beechcraft lists max range as 1,720 nm.)
Source: Leonardo/Pratt & Whitney

nor the project's engineering simulator could predict the possibility for the oscillations and the ensuing event that destroyed the aircraft. As the investigation report stated, "Therefore, the [simulator] was not really able to properly carry out the role as test bench for the control laws and risk reduction."

Leonardo declined to comment on the accident for this report pending litigation. But one visual result of the mishap was a redesign of the AW609's vertical stabilizer and the tail end of the fuselage (the difference can be noted in before-and-after-2015 photographs of the aircraft). And it would make sense for Leonardo to reprogram the engineering simulator to provide cues of an incipient Dutch roll condition when maneuvering at high speed.

helicopters and turboprop airplanes.

Also in abeyance is pilot certification for the crossbred tiltrotor category of aircraft. "We are still defining pilot licensing," Sunick said, "and discussing with the FAA the requirements, number of hours, and so forth. Certified helicopter pilots will need to obtain fixed-wing qualifications, and vice versa." It would seem that the unique nature of the tiltrotor would require an equally unique pilot certificate.

Which brings up the subject of training. This summer at Leonardo's Philadelphia Training Academy, the manufacturer will commission a "full-flight" six-axis motion-base Level D simulator to be built by Canada's CAE and able to interchange between Leonardo's AW139 and AW609 rotary-wing products. Jointly developed by Leonardo and CAE and based on the latter's 3000 series, the simulator will be managed by Rotorsim, a joint venture between the two companies. The simulator is complemented by an AW609 procedures trainer featuring panels from the actual aircraft as well as other devices designed to prepare students for its operation.

Meanwhile, FAA and EASA reciprocal type certification of the AW609 awaits. "We can't provide a date, but we are laser-focused on certification," Sunick said. With the production prototype now flying at Philadelphia and some 25 years of engineering, development, millions of dollars and blood behind it, one might speculate that 2020 will be the year that a civil tiltrotor will receive production approval.

Other questions waiting to be answered are the AW609's unit price, operating cost and number of orders Leonardo has accepted for production aircraft.


LEONARDO

The AW609 is expected to spend 85% of its flight time in the airplane mode. Its maximum cruise speed is 275 kt.

Concerning the first, Leonardo executives decline to reveal a range of purchase prices for AW609s or an average. At the beginning of the century, when the project was approximately five years old, price numbers between $8 million and $10 million were touted by the then developers. More recently, speculation holds that price may have escalated to as high as $30 million.

Whether the utility of the tiltrotor can offset such a unit price remains to be seen. The company has said only that "The AW609's price has not yet been set, though from a total operating cost perspective, the AW609's point-to-point capability will be very competitive with legacy mixed-fleet transportation options."

Leonardo is holding its operating-cost cards close to its corporate chest. However, given the high cost of operating helicopters, the dual personality of the AW609 and the consequent complexity of the tiltrotor, one can assume the aircraft's DOCs will go even higher.

As for orders, Leonardo is equally mum. Early in the program — that is, when Bill Clinton was still president — orders totaled in the 70s. As program ownership changed hands and development dragged on, projective purchasers canceled their delivery positions and the order book thinned.

Leonardo has lofted several configurations for the AW609. These include:

▶ Utility/offshore, nine passengers, two crew.
▶ Search and rescue (SAR), up to four attendants, one-two litters.
▶ Emergency medical service (EMS), up to four attendants, one-two litters.
▶ Corporate shuttle, eight passengers, two crew.
▶ VIP/business aviation, six passengers, two crew and an option for a lavatory.

Whether the AW609 will find acceptance by business aviation remains to be seen. For flight departments with a need to service a corporate territory with a 700-nm radius and a paucity of airports, it could offer a solution. As could the ability to operate from an urban heliport or rooftop pad, an attractive convenience for the time-driven executive in an environment where surface transportation is abysmally restrictive.

While the AW609 offers new levels of flexibility to a variety of applications, it remains to be seen if the market is ready for this unusual aircraft. **BCA**

Unanswered Questions

The AW609 is constructed primarily of carbon-fiber composite skins and aluminum frames, mechanically fastened. As noted, final assembly will take place in the Philadelphia plant from subassemblies made in Italy. Composites are fabricated in Leonardo's Brindisi, Southern Italy, works. (Leonardo's rotary-wing division is headquartered in Milan, while the corporate headquarters is located in Rome.)

Maintenance, or how the immensely complex AW609 will be inspected, maintained and overhauled, is yet to be determined. According to Sunick, Leonardo's Maintenance Review Board is working out inspection intervals. Given its mechanical complexity, the tiltrotor's maintenance costs will likely exceed those of comparable helicopters and turboprop airplanes.

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Part 91 Department Inspections

The FAA **is coming**

FOR YEARS NOW, THE FAA'S DELAYED FUNDING HAS DICTATED cutbacks on "non-essential travel" to places like, well, airports. Budget cutbacks have also resulted in Flight Standards Offices (formerly known as FSDOs, or GADOs if you are older) migrating from convenient, but expensive, airport office buildings to cheaper office parks that are nowhere near an airport. And of course, many inspectors now "telecommute" from home on many days.

One result has been a suspension of random ramp checks for FAR Part 91 operators for many years. Ramp checks never went away for Part 135 and Part 121 pilots, but even those encounters have become less random because the inspectors don't want to drive out to the airport only to discover there are no pilots to surprise.

AVID CREATIVE/ISTOCK

So, why are inspectors now visiting Part 91 flight departments? The 2018 FAA Reauthorization had two provisions that bear on the change: (1) Congress mandated that the comptroller general study the effectiveness of the FAA's 2015 Compliance Philosophy, and (2) Congress mandated that the secretary of transportation report on "follow-up" (or lack thereof) on illegal charter complaints. These studies are underway, and they have resulted in increased scrutiny of aircraft leasing and reimbursements in the business aircraft community.

What will the FAA look for when inspecting a Part 91 flight department? The agency recognizes that the recordkeeping rules of Part 135 do not apply. But the inspectors are advised: "Even though recordkeeping is not required of an executive/corporate operator, many do maintain training records. The inspector should encourage all operators to keep and maintain records to verify compliance with 14 CFR §§ 61.55 and 61.58." The guidance goes on to instruct the inspectors to examine such records if they are maintained.

If you are operating an aircraft subject to a lease under Part 91, make sure that you have a copy of the lease and that you, and everyone in the flight department, understands the lease. If the aircraft has a max gross takeoff weight over 12,500 lb., then a copy of the lease must be kept in the aircraft.

But once the FAA is in the hangar, the inspection won't stop at training and lease records. If you have a Minimum Equipment List, the inspectors will check to see if the Master Minimum Equipment List has been subsequently revised. If you operate a large or turbine-powered multiengine airplane, you are required to have an emergency checklist, one-engine inop climb performance data and a two D-cell flashlight (Part 91.503). Expect to show where each of these items can be found in the cockpit, and make sure that the flashlight works. Passenger briefing cards are not required, but if they are used to supplement an oral briefing, then they must be available to all passengers and must refer to the specific type and model of airplane (Part 91.519).

Will they inspect your aircraft, or just the records? Inspectors are advised: "When an inspector checks the aircraft for general airworthiness, he or she should keep in mind that the inspection should not resemble a 100-hr. or annual inspection. Rather, it is similar to a preflight inspection to check for obvious discrepancies that could affect the safety of flight (§§ 91.403 and 91.405). For example, some obvious discrepancies to check for include fuel or oil leaks, damaged tires, prop seal leaks, broken exhaust hoses, etc."

Ramp checks: The FAA is also ramp-checking business aircraft operators as part of the current effort. Are you ready? At some point in your flying career, you probably memorized "ARROW" so that you would be ready for an inspector visit: Airworthiness Certificate, Registration Certificate, Radio Station License, Operator Handbook, Weight & Balance. These are the aircraft's required documents, and this is still a pretty good acronym to jog your memory, but the ARROW requirements have evolved. Your aircraft needs an FCC Radio Station License if you will fly internationally. And if you do, you also need to carry a Restricted Radiotelephone Operator Permit. The FAA will also be checking to see if each pilot has "a photo identification." (Part 61.3 lists all of the acceptable forms of ID. A state-issued driver's license will do nicely.)

What are the rules of a ramp inspection? You must "present" your airman and medical certificates. Don't play games. Smile. Hand them to the inspector. If the inspector wants to make a copy, ask for the certificates back and tell him that you can get a copy for him at the FBO.

Who determines when a ramp check is over? You do. An inspector has no right to detain you. You do not have to speak with an inspector at all. However, if you are rude, the inspector may question your compliance attitude and begin an investigation. On the other hand, this is not a social engagement. Don't drag it out. Smile and excuse yourself politely as soon as the inspector has verified that you and the aircraft have the required documents. **BCA**

Fred George
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Embraer Phenom 300

Strong hold on first place in light jet

WHEN THE $7 MILLION PHENOM 300 first entered service in late 2009, Embraer almost instantly redefined the value proposition in the light jet segment. More than 440 first-generation units were delivered through 2016. Historically, only about 5% have been on the resale market.

EMBRAER

No wonder. This is one of the roomiest aircraft in its class. Excluding its shorter lavatory, the dimensions of the main passenger seating area compare favorably with Learjet 70, including maximum height because of Phenom 300's 4-in. dropped aisle. Its 66-cu.-ft. aft baggage compartment is the largest its class and there is another 10 cu. ft. of luggage storage split between the nose compartment and lavatory. Its runway performance is closely matched with Citation CJ4. When flown at the same cruise speeds as CJ3, its fuel efficiency is almost identical. Typically equipped with 200 lb. of options and other gear, it can fly 4 passengers 1,800+ nm and land with 100-nm NBAA IFR reserves.

Up front, Phenom 300s delivered between 2009 through 2013 have Embraer Prodigy cockpits using Garmin G1000 avionics with three, 12.4-in. displays. In 2013, cockpits were upgraded with Prodigy Touch, based on G3000 with touchscreen controllers in the center console. Both versions are approved for single-pilot operations. Embraer is working with Garmin to develop a G1000NXi upgrade for early aircraft.

Cabin layouts usually consist of a central four-chair club section, two forward facing chairs in the aft cabin and a full-width aft lavatory with optional belted potty seat. Most aircraft have short galleys with a two-place divan on the right side. But legroom is tight on the flight deck with only 9.6 in. of seat track available.

The cabin windows are the largest in the light jet class, with two in the lavatory that flood the compartment with daylight. Notably, the toilet is externally serviced. However, the fresh water tank for the optional lavatory sink must be internally replenished.

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

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

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

This aircraft is rugged, having a 28,000 cycle/35,000 hr. design life. The aircraft also is comparatively easy to maintain, being a fully validated MSG 3 design with 600 hr./12-month basic inspection intervals. Major inspections come due at 5- and 10-yr. intervals. Landing gear overhaul at 120 months runs $150,000, plus parts. Aerospace Turbine Rotables is closing on approval of overhaul that will slash the cost by more than 40%, says Dustin Cordier a light jet resale specialist with JetAviva.

For aircraft older than 5 yr., Embraer Executive Care coverage for parts averages $482/hr. TBO for the twin PW535E turbofans is 5,000 hr. Pratt & Whitney ESP Silver coverage costs about $398.70/hr. for both engines. Operators say Embraer's product support is strong and the firm is committed to ongoing product improvements.

Average utilization is 300 hr. per year for owner/operators. Fractional fleet operators fly up to 1,000 hr. per year, or more. Asking prices for early aircraft average near $5 million, says Cordier. Late model aircraft, up to 2017 when the Phenom 300E made its debut, command $7.5 million, depending upon options, age, flight time and condition.

Prime competitors include CJ3 and CJ4 with smaller cabin cross-sections and slower cruise speeds; the two-pilot Learjet 70 with a flat-floor, slightly more range and higher speed, but needing longer runways and having significantly higher operating costs; and Nextant 400XTi with a flat-floor, a slightly smaller cabin, but having competitive range and better fuel efficiency, though needing longer runways.

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

On Duty

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

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

▶ **Asian Business Aviation Association (AsBAA),** Hong Kong, named **Jeff Chiang** chief operating officer. He most recently served as senior sales manager for Hong Kong Jet and Asia Jet.

▶ **Avinode Group,** Gothenburg, Sweden, named **Alex MacRae** to lead the newly created customer experience team, in addition to serving as head of marketing. MacRae, who leads 12 marketing and customer experience specialists at Avinode, has served with the company for nearly three years and before that spent more than a decade in marketing, digital strategy, account managing, and brand advising.

▶ **Beep,** www.go-beep.com, announced that **Racquel Asa** has joined the company as chief marketing officer. Asa previously served as a transportation journalist and anchor. Most recently, she was lead transportation reporter for WFTV in Orlando.

▶ **Bye Aerospace,** Englewood, Colorado, announced that **Mark Armstrong,** has joined the Strategic Advisory Board. Armstrong is a software engineer and entrepreneur. He is currently a corporate advisor to high-tech organizations. **Rod Zastrow** has been appointed to the Strategic Advisory Board of Bye Aerospace. Zastrow is chief operating officer and president of Spartan Air Academy Iraq.

▶ **C&L Aerospace,** Bangor, Maine, announced that **Edmund Tan** has joined the company as regional sales manager and will lead the marketing activities for the commercial and regional airline segments for Asia. Tan most recently served as senior manager of sales and marketing for Flightparts.

▶ **Cutter Aviation,** Phoenix, Arizona, announced that **Peter Hokanson** was named CFO, managing the company's accounting, human resources and information technology organizations. Hokanson has more than 30 years of senior management experience with companies such as Honeywell, Garrett Aviation and General Electric.


JEFF CHIANG


DON DWYER

▶ **Duncan Aviation,** Lincoln, Nebraska, appointed **Dennis Kruse** as avionics installation sales representative for its Provo, Utah facility. Kruse has spent seven years with the Duncan avionics sales team in Lincoln, and before that served in the U.S. Marine Corps.

▶ **Elliott Jets,** Moline, Illinois, hired **Eric Hammer** as executive sales director. Before joining Elliott Jets, Hammer served as a regional sales director for Embraer Executive Jets and has also led sales efforts for Atlantic Aero and Cessna Aircraft.

▶ **Guardian Jet,** Guilford, Connecticut, named **Gabriel Bastos** vice president. Bastos, who formerly was with Embraer Executive Jets, is Guardian Jet's first executive representative in South America, Central America, Mexico, and Southern Florida. **Don Dwyer,** managing partner, was appointed to the Advisory Council for the NBAA.

▶ **Passur Aerospace,** Stamford, Connecticut, named **Brian Cook** chief executive officer. Cook will retain his position as a director of the company. **Jim Barry,** president and CEO, will continue as president and a member of the board of directors. Cook most recently served as CEO and a board member at CyFIR, a cybersecurity software and services company.

▶ **PrivateFly,** United Kingdom, named **Robert Shaplen** senior vice president of sales for the West Coast. Shaplen most recently served at Gama Aviation and was formerly with XOJet.

DON MILUM

DAN PRIEU

▶ **Nordic Aviation Capital,** Billund, Denmark, named Patrick de Castelbajac CEO. De Castelbajac most recently served as Airbus Asia-Pacific regional president and head of Asia-Pacific commercial aircraft sales. He will join Nordic in the third quarter of 2020.

▶ **Universal Avionics,** Tucson, Arizona, appointed **Don Milum** U.S. senior sales manager, and is based in Kansas City, Missouri. Milum joined Universal in 2019 as regional sales manager for the Midwestern U.S.

▶ **West Star Aviation,** East Alton, Illinois, promoted **John Brummel** has been promoted to avionics technical sales manager at East Alton facility. Brummel joined the company in 2007. **Jeffrey Sneden** quality assurance manager at its Chattanooga, Tennessee facility. Sneden brings more than 37 years of aviation experience to his new role, previously serving with Miller Aviation, Flight Options, and Embraer. **Dan Prieu** has been promoted to senior project manager at West Star's facility in Chattanooga. Prieu has 28 years of aviation experience and previously held positions with SAAB and Bombardier.

▶ **Wheels Up,** New York, New York, named **Gail Grimmett** chief experience officer responsible for overseeing event programming, marketing, public relations, social, digital and member benefits.

JEFF MULDER

▶ **Women in Aviation International,** West Alexandria, Ohio, named **Allison McKay** CEO. McKay previously served as vice president of the Helicopter Association International Foundation. She also held positions at Safran USA and B/E Aerospace.

▶ **Gulfstream Aerospace,** Savannah, Georgia, promoted **Sheryl Bunton** to senior vice president and she is now a member of the company's senior leadership team. Bunton most recently served as chief information officer.

▶ **Farnborough Airport,** Farnborough, U.K., named **Richard Wittels** business development manager.

▶ **Woolpert,** Dayton, Ohio, announced that **Jeff Mulder** has joined the company as a senior consultant. Mulder most recently served as director of airports in Florida, Oklahoma and Wisconsin.

▶ **National Air Transportation Association (NATA),** Washington, D.C., announced that **Keith DeBerry** is the new senior advisor for regulatory affairs maintenance and liaison of NATA's Aircraft Maintenance and Systems Technology (AMST) Committee. He assumes the position from Carol Giles. DeBerry previously served as Academy Director for the FAA. **BCA**

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Flight image courtesy of
FlightAware (flightaware.com)

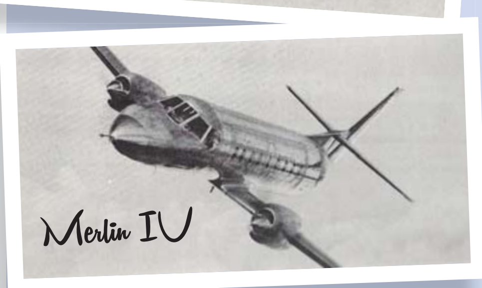
BCA 50 Years Ago

April 1970 News

As a result of the **golden years** in general aviation from **1966 to mid-1969,** new models of airplanes and equipment have been surfacing at record rates. (Aviation has probably progressed further in those years than in any 20 previous.) – *BCA Staff*

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

Never in the short history of aviation has so glowing a near-future been predicted. The way in which general aviation has been forecasted to grow in the seventies is analogous to the initial climb of an under-gross overpowered bizjet.



Marking Time: A 10,000 mi. delivery flight from Oakland to Singapore has been completed by a 17-place Volpar Turboliner in 37 hr. 32 min. In so doing, the stretched and modified Beech 18 has apparently set speed records for all legs of the flight for this class of airplane. Block speeds of up to 269 mph were recorded.

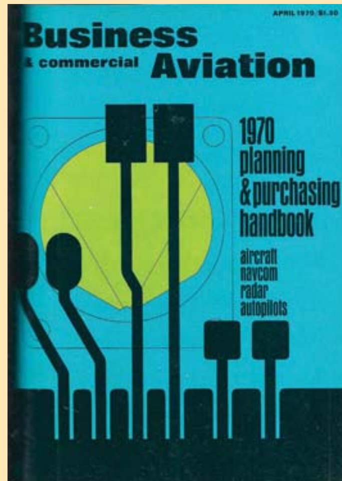
Swearingen's Merlin III and IV, the newest additions to corporate turboprop line, are due at dealers this summer. Eight-place Merlin III is basically a Merlin IIB with Metro wings, empennage and systems changes. Price of the Merlin III is $550,000 less avionics. Merlin IV is basically a Metro (commuter liner) with corporate interior and systems. The aircraft will carry 10 passengers plus two crew. It's powered by two TPE-331s rated at 840 shp ea. Price of the IV is $615,000.

The year 1969, which had been predicted to deliver some 15,900 airplanes from U.S. manufacturers, came up with only 12,471, nearly 10% lower than 1968's total of 13,698 delivered units. The bizjet category looked good from reports of 203 deliveries in 1969 but the view turns bleak when lone looks for actual sales made during the last half of 1969 and the first part of 1970.

Gulfstream II simulator has been installed at FightSafety's New York base. The simulator, made by Redifon, Ltd., of England, cost some $1.5 million and features full motion. Hourly rate if $230. Block of 100 hr. brings the hourly cost down to $195.

Inventories on the Falcon and the Sabreliner are reportedly running high. Pan Am is negotiating with AiResearch to take over all sales of the Fan Jet Falcon. **BCA**

THE ARCHIVE



The April 1970 Planning & Purchasing Handbook cover (It began life as the April issue of BCA, it changed to May for many years and it's now in the June issue. — Ed.) was illustrated by freelancer John Kane under the art direction of BCA staffer Ralph Kellner.

The all new STARS — Sperry Three Axis Reference System. First deliveries are going to Learjet and to Association Radio for Swearingen Merlin IIBs.