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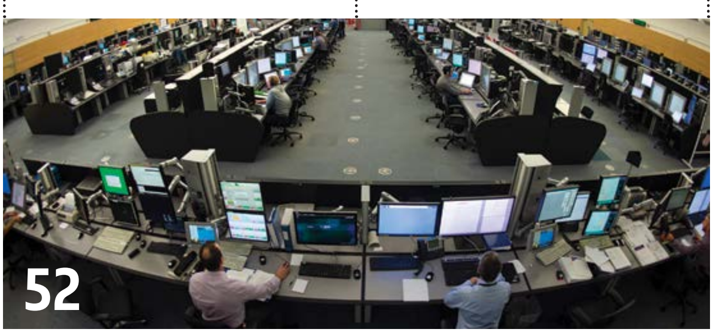

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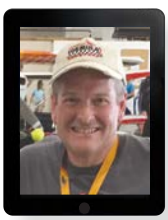

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Editor-in-Chief	**William Garvey** — william.garvey@informa.com
Executive Editor	**Jessica A. Salerno** — jessica.salerno@informa.com
Senior Editor/Chief Pilot	**Fred George** — fred.george@informa.com
International Operations/ Features Editor	**David Esler** — david.esler@comcast.net
News Editor	**Molly McMillin** — molly.mcmillin@informa.com
Art Direction	**Lisa Caputo** — lcaputo@aviationweek.com
Art Department	**Thomas De Pierro, James Miller, Rosa Pineda, Colin Throm**
Associate Producer	**Theresa Petruso** — theresa.c.petruso@informa.com
Copy Editor	**Scot Greenan** — sgman124@gmail.com
Contributors	**Richard N. Aarons** — bcasafety@gmail.com **James Albright** — james@code7700.com **Mal Gormley** — malgormley@gmail.com **Kent S. Jackson** — kjackson@jetlaw.com **Ross Detwiler** — rossdetwiler.com **Patrick Veillette, Ph.D.** — jumprsaway@aol.com **Ringston Media** — info@ringstonmedia.com
Editorial Offices	520 Folly Rd., Ste. 238, Charleston, S.C. (520) 638-8721 • (843) 718-2458

Publisher	**Frank Craven** — frank.craven@informa.com Phone: (913) 967-1729
Managing Director, Business Aviation Intelligence/ Data Services	**Anne McMahon** — anne.mcmahon@aviationweek.com Phone: (646) 291-6353
Director of Sales, Business Aviation	**Elizabeth Zlitni** — elizabeth.zlitni@informa.com Phone: (913) 967-1348
Production Manager	**Fran Vaughn** — fran.vaughn@informa.com Informa, 22701 W. 68th Terrace, Ste. 100, Shawnee, KS 66226-3583 Phone: (913) 967-7293 • Fax: (913) 514-7303
SeniorAudience Development Manager	**Tyler Motsinger** — tyler.motsinger@informa.com Phone: (913) 967-1623
Head of Business Aviation Fleet Data	**Nigel Prevett** — nigel.prevett@aviationweek.com Phone: (407) 314-7403
Head of Valuations, Business Aviation	**Chris Reynolds** — chris.reynolds@informa.com Phone: (913) 967-1956
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President, Aviation Week Network	**Gregory Hamilton** — hamilton@aviationweek.com
Managing Director—Civil Aviation	**Iain Blackhall** — iain.blackhall@aviationweek.com
Administrative Offices	605 3rd Ave., New York, N.Y. 10158

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Business & General Aviation Conference

Strategy ✈ Program Updates ✈ Supplier Opportunities

NOVEMBER 18, 2020

Jonathan Club
Los Angeles, CA

This Conference is designed for leaders and decision-makers from OEMs to suppliers in the Business & General aviation industry, including strategic planning and business development leaders, supply chain executives, market analysts, investment bankers and financial institutions.

Delegates at the **Business & General Aviation Conference** will meet and interact with industry experts and manufacturers who will provide updates on the state of the industry, recovery trajectories within the market, and technology advancements. Various networking opportunities throughout the Conference will enable you to connect with colleagues, and develop valuable relationships with peers, influential decision makers and even competitors.

The THREE MAIN PILLARS of the Conference are:

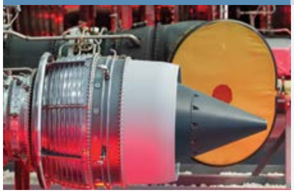
Strategy, **Program Updates** and **Supplier Opportunities**. Knowledge gained from each pillar is actionable — enabling delegates to effectively secure significant and sustainable growth opportunities.

Strategy

Supercharge Your Business Strategy

Delegates at Business & General Aviation Conference engage with top industry analysts who offer their views of the industry, provide forecasts for business planning, long-term strategies around products, consolidation and restructuring, and OEM initiatives.

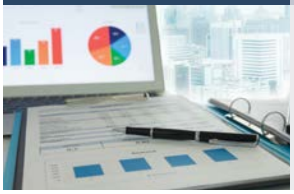
Program Updates



Grow Your Business or Organization

The Business & General Aviation Conference shows suppliers how to make their mark with top programs and clear the fiscal realities and the deal-making models that contractors are utilizing today. Delegates discover how the supply chain is reshaping itself to create winning positions on major programs.

Supplier Opportunities



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Discover program breakthroughs and technological innovations as speed and disruption become increasingly important factors. Gain visibility into the processes and systems that enable suppliers and decision makers to reach the highest levels of success.

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- Trends in business and general aviation
- OEM product strategy and market developments
- Trajectories within the supplier market
- Forecasts within current market

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- Analysts and investment/financial community members
- Information and technology specialists

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18 Tyler Motsinger, Sr. Audience Development Manager — Date 9/30/20

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ADVERTISING SALES

Publisher
Frank Craven – frank.craven@informa.com
(202) 517-1061

Director of Sales
Elizabeth Zlitni – elizabeth.zlitni@informa.com
(913) 967-1348

NORTH AMERICA ADVERTISING SALES

Pacific Region
Miguel Ornelas – miguel.ornelas@aviationweek.com
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(949) 481-4519
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Florida, Georgia, South Carolina
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FBO ADVERTISING SALES

Jodi Espinoza – jespinoza@acukwik.com
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WORLDWIDE ADVERTISING SALES

Michele Markarian – michele.markarian@informa.com
+1 (617) 649-0420

Europe
Robert Springthorpe – robert.springthorpe@aviationweek.co.uk
+44 (207) 017 7627
Andrea Prudente – andrea.prudente@aviationweek.com
+44 (207) 182 4524

Israel
Tamir Eshel – invision@netvision.net.il
+972 (9) 891-1792

William Garvey
Editor-in-Chief
william.garvey@informa.com

Gee Whizzery Welcome

Reaching forward is a given

FOR MANY YEARS, SUMMER'S ARRIVAL FOR AV JUNKIES WAS signaled not so much by Memorial Day speeches, All-Star games or the season's first surfside sunburn. Rather, it was marked by Art Scholl standing and waving as he flew overhead in his Super Chipmunk; by Bob Hoover looping, landing and rolling out in his Twin Commander-turned-glider; by the Wasp radials of Skytypers' SNJs blatting their way down to Runway 13 at Carl A. Spaatz Field.

I've no idea how or why the annual air show came to be in Reading, a middling town in southeastern Pennsylvania, whose previous claim to fame was as Daniel Boone's birthplace. But attending was a must among business and general aviation's grandees, movers, pitchmen and, yes, lowly scribes.

Over there's Bill Lear holding court; attorney/pilot/Enstrom owner F. Lee Bailey is searching for another spotlight; Jim Bede's pitching his mini BD-5; and the stranger soliciting my utterly uninformed opinion on the viability of upgrading the GII turns out to be Allen Paulson, the millionaire, one-time TWA mechanic who had just bought Gulfstream American from Grumman. Oh, and entering the press trailer is Dave North, another business aviation scribbler and furloughed Pan Am pilot destined to become editor-in-chief of Aviation Week. What fun.

The Reading show was my indoctrination to big-time aviation gatherings and got me hooked on showy, newsy, tech-focused, av celebration/showcases that happen to also serve as reunions for those attending the world over. In addition to the tire kicking, aerobatics and glad-handing at Reading, there was much to see about new gear and services promoted at the booths set up in the main hangar.

One that caught my attention was a weather radar display from Bendix, as I recall. There, a fellow standing in front of the table owned an Aerostar or 310 and was saying his current radar worked great and he saw no need to replace it. Then the fellow on the other side of the table switched on a unit next to the one featuring the then-standard green miasma and suddenly a multi-colored display popped to life; there was a red blob near the center. The visitor was taken aback by the unexpected technicolor display and asked what the red represented. "That's where you don't want to fly," the radar man explained. That sealed the sale.

I've witnessed countless such exchanges in the decades since, all underscoring the fact that business and general aviation operators will readily adapt new technologies and services if they provide additional utility and security, a behavior not shared by the airlines. After all, the air carriers fly for profit so any equipment that involves additional cost to acquire, install and maintain must be deemed essential. And then they have to buy for the whole fleet, meaning its operation and benefit must be proven. By contrast, most private operators need only buy and install one or two of whatever.

As a result, manufacturers look to business and general aviation as a primary and proving market. And they typically unveil their newest gee whizzery at large av gatherings, which is part of what makes them so interesting and why I was so disappointed with this year's cancellation of the big business aviation shows in Geneva and Orlando, let alone Farnborough and Oshkosh. Who knows what magic we missed?

BCA

To provide some perspective, I offer an introduction to a recent webinar led by *BCA*'s Fred George: For decades, we've witnessed business aviation pioneer new flight-deck technologies that make flying safer, more comfortable, more reliable and more efficient. Among these are GPS en route and approach guidance, LPV precision approach, data-link weather, glass cockpits, enhanced flight vision systems, terrain awareness and warning boxes, even enabling pilots to do all preflight tasks on their tablets and transfer the data to the FMS.

To that list, let me add: ADS-B In, flight phones (my predecessor, the one and only Archie Trammell, had one in his Cessna 182 nearly 50 years ago), along with the whole-airplane parachute, fractional aircraft ownership, active-control sidesticks, electric propulsion, empty-leg charter, the extraordinary emergency autoland and autonomous passenger flight, among other things. And looking way, way back, while Boeing's 707 may be credited with truly launching the jet age, the Lockheed JetStar took flight three months prior. Just saying.

My point is that for business and general aviation, technological and operational innovation is very much a part of its DNA. And I expect further evidence of that would have been displayed at this year's canceled shows. But the gee whizzes are coming regardless — step right this way for Mach+ or hydro flight, folks — and I'm sure the old Reading show's denizens would applaud. **BCA**

In-Personal Preferred

I really enjoyed "Being There" (Viewpoint, October 2020, page 7), and in transitioning the NBAA Business Aviation Convention and Exhibition to a virtual safety week, I agree wholeheartedly that we need to be in-person. I forecast that once a vaccine is available, we'll be going hog-wild to travel and socially interact as before.

Tom Huff
NBAA Safety Committee Chairman
Aviation Safety Officer
Gulfstream Aerospace
Savannah, Georgia

In Decline, Sadly

I concur with your observations and conclusions in the September Viewpoint. As an aviator of your approximate vintage, I have also witnessed the alarming decline of personal flying.

I took a close look at the problem in my book *A Personal Flyers Guide to More Enjoyable Flying.* I also suggest a strategy for reversing the trend.

Dave Koch
Former military, airline, corporate and general aviation pilot

Expensive Training

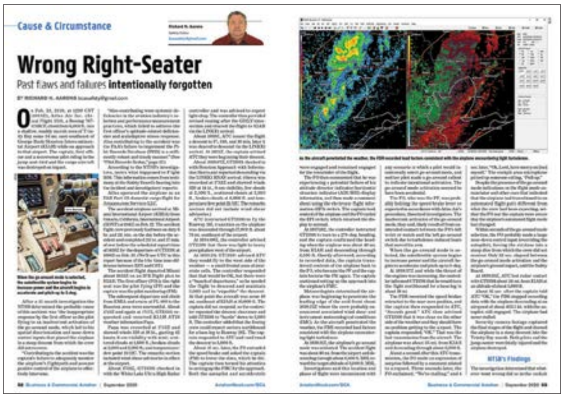
Regarding "Middle-Age Muddle" (Viewpoint, September 2020, page 7), I've some thoughts on why single-engine general aviation aircraft have an average age of 46 years.

I was hired by TWA in 1966 with exactly 200 hr. in my logbook and a temporary Commercial pilot certificate. The airlines were hiring then, but the Vietnam war kept military pilots from signing on. As a result, the carriers were accepting low-timers, which drove many of us to take flying lessons. TWA hired over 600 pilots in 1966 and the same amount for the next three years, finally stopping in 1970.

In the 1970s I owned a training business with four locations in Southern California. Our weekend ground training ramped up from 15 students on a good weekend to 120. And in 1974, I started a Learjet training program that was 90% funded by education benefit payments for flight training from the Veterans Administration (VA). And get this — the entire fee was tax deductible!! The IRS eventually put regulations in place to allow only 10% to be deductible, which removed all those Korean/Vietnam war vets from the training rolls. And then the VA got on board to diminish flight-training reimbursement.

The airlines hiring low-timers along with tax-deductible flight-training money from the VA combined to produce a lot of pilots. And pilots buy airplanes. But stop making pilots, and you stop making airplanes, which causes those made and sold during the heyday to age.

Meanwhile, the Boeing 767 accident near George Bush Intercontinental Airport (KIAH) detailed in September's Cause & Circumstance (page 52) is an



example of the failure of the training chain. In the end, you get what you allowed to pass muster.

As for the NTSB's findings, do its members really believe that merely accidentally engaging the go-around mode can produce a "startle" effect? Please. Startle results from an explosive decompression. A bird strike. A lightning strike. From something for which you are not trained.

Then, too, there's the complexity of today's flying environment in which air traffic controllers think that they are the PIC and the pilot is unaware of FAR Part 91.3(a) — to wit: The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft — and how to act under it.

I am still a practicing CFI and the lack of fundamental pilot knowledge I encounter is disappointing.

Bob Pastore
Via email

It's the Cost

From my point of view, "Middle-Age Muddle" missed probably the two biggest factors for the dearth of new pilots and light general-aviation airplane purchases.

Student loan debt is one. I would love to take lessons and buy a plane. Can't do that with a $500 student loan payment. It would also be unfair to my family to indulge with such a debt load hanging over my head.

Boomers had Pell Grants and the older generations had the GI Bill. My education is on my dime. No airplane for me.

My generation, Gen X, grew up during conditions of chronic underemployment, unemployment and government shut_downs.

As a professional degreed individual, I could walk into a middle-class job a generation or two ago. Today, it's a brutal cage fight for those jobs. I am surplus labor.

I am certain you understand that as a journalist.

Lawrence Necheles
Pontiac, Illinois

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INTELLIGENCE

EDITED BY **WILLIAM GARVEY, JESSICA A. SALERNO AND MOLLY MCMILLIN**
william.garvey@informa.com
jessica.salerno@informa.com
molly.mcmillin@informa.com

NEWS / ANALYSIS / TRENDS / ISSUES

A FOURTH TEST AIRCRAFT JOINED THE GULFSTREAM G700 certification program in early October. In its inaugural flight of nearly 2 hr. the G700 reached an altitude of 41,000 ft. and a speed of Mach 0.89. It will be used for testing of its avionics, environmental control system, electrical power, hydraulics and mechanical systems. The flight test program launched Feb. 14 and the test fleet has logged more than 600 hr. aloft during which the aircraft have reached a speed of Mach 0.99 and altitude of 54,000 ft. Additional aircraft are being readied to join the test and certification program and will include at least one that's fully outfitted. The four-section G700 is powered by two Rolls-Royce Pearl 700 turbofans and is designed to have a high-speed cruise of Mach 0.90 for 6,400 nm, or a long-range cruise of Mach 0.85 for 7,500 nm. It features a touchscreen Symmetry flight deck and active sidestick controls.

BUSINESS AIRCRAFT MANUFACTURERS WORLDWIDE ARE PROJECTED to deliver 7,404 new business jets and 2,590 new turboprops from 2021 to 2030, **valued at a total of $236.5 billion at list prices, with demand for maintenance, repair and overhaul services expected to total $102 billion,** according to a new forecast by the Aviation Week Network's 2021 Business Aviation Fleet & MRO Forecast. Deliveries of jets and turboprops are expected to reach 612 and 185, respectively, next year, growing to nearly 1,100 by 2026 — that's down nearly 20% from previous projections. Going forward, deliveries are expected to take until 2024 or later to return to 2019 levels, the forecast says. Meanwhile, the world's business jet fleet is expected to expand at a 1.3% compound average growth rate from 2021 to 2030, with large jets growing the most at a compound annual growth rate of 2.3%, followed by small jets at 1.1% and medium jets at 0.7%. In contrast, the fleet of turboprops is expected to decline at a compound annual rate of -0.8%, largely due to the number of older aircraft in the fleet, the forecast says. At the same time, business jet retirements are projected to rise slightly compared to the previous 10-year-period, with a total of more than 8,000 retirements. Said Brian Kough, the Aviation Week Network's senior director of forecasts and aerospace insights, "Although business jet deliveries were down severely in the first half of 2020, the effects of the global pandemic are anticipated to have a lessening impact by late 2020 and 2021" with operators adjusting to a "new normal." Looking forward, Cirrus Vision Jet deliveries are expected to total 919 units over the next decade, followed by the Pilatus PC-12 at 657, Pilatus PC-24 at 526, Bombardier's Challenger 350 at 476 units and Embraer's Phenom 300 with 475 aircraft. North America is expected to accept new business jets and turboprops valued at $150 billion at retail prices, followed by Western Europe at nearly $40 billion.

EMBRAER HAS RECEIVED APPROVAL BY THE FAA AND Agencia Nacional de Aviacao Civil of Brazil (ANAC) for the Synthetic Vision Guidance System (SVGS) for its Praetor 500 and 600 jets. The system, a result of a partnership with Collins Aerospace, provides pilots with perception of position, trend and motion, which aids in the transition to visual references and allows for the safe completion of more missions during inclement weather and during approaches in lower ceilings. It allows pilots to descend to a decision height of 150 ft., rather than the typical DH of 200 ft., and can be used with or without the HUD. SVGS is also available as a retrofit on Legacy 450 and 500 aircraft as well as previously delivered Praetor 500s and 600s.

MEBAA Postpones Annual Convention to February 2021

As has been the case with so many other aviation events this year, The Middle East Business Aviation Association (MEBAA) has postponed its annual convention originally scheduled for December to Feb. 22-24, 2021, because of increased concerns related to the COVID-19 pandemic. MEBAA said the decision was made upon "careful consideration" and feedback from attendees, exhibitors and others.

Vista Global Teams With Ferrari for Private Transport

Vista Global has partnered with Ferrari to provide private jet transportation to all the Ferrari drivers competing in the international GT races and the Prancing Horse monobrand championships. The new service will allow professional and amateur Ferrari drivers to fly with VistaJet and XO aircraft as they travel globally to compete in the races.

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

FAA Certifies Beechcraft King Air 360/360ER

Textron Aviation has received type certification from the FAA for its newest flagship twin-turboprop Beechcraft King Air 360/360ER aircraft, paving the way for customer deliveries to commence. Announced in August 2020, the Beechcraft King Air 360 demonstrates the company's commitment to ongoing product development, bringing the latest innovations to the aircraft and providing added value for customers.

Airshare Earns IS-BAO Stage 3 Certification

Airshare, a Lenexa, Kansas-based private aviation company offering fractional ownership, jet cards, aircraft maintenance and charter services, has been awarded International Standard for Business Aircraft Operations (IS-BAO) Stage 3 Certification from the International Business Aviation Council (IBAC). The company received the certification following an audit of its operations that includes flight operations, maintenance, safety management systems, owner services, flight control, emergency planning, accounting and marketing.

DAHER RECENTLY ROLLED OUT THE 1,000TH TBM TURBOPROP from its final assembly line in Tarbes, France. The aircraft, a TBM 940, was purchased by James Hislop, an American investment banker who also is a volunteer pilot with Mercy Flights Southeast, Angel Flights Northeast and Patient Airlift Services. **"The Daher group and its employees take particular pride in reaching the TBM's 1,000 mark," said Didier Kayat, Daher's CEO.**

"We have made significant investment since integrating the TBM into Daher's business portfolio, and now it is a major asset for our overall industrial activity." Daher acquired the product line 10 years ago. When the TBM 700 was introduced by Socata in 1980, skeptics questioned the viability of a pressurized, single-engine turboprop and the company's goal of delivering 600 of them. However, the market responded favorably and thanks to continuous improvements to the aircraft, has continued to do so for four decades. The TBM 900-series is the sixth iteration of the TBM family, with the TBM 940 incorporating Garmin G3000 avionics, HomeSafe emergency autoland, autothrottle and touchscreen controls, and the TBM 910 with Garmin G1000 NXi avionics.

THE FAA HAS ANNOUNCED ITS POLICY FOR APPROVING DRONE designs as a special class of aircraft. Published on Sept. 18 in the *Federal Register,* the policy statement confirms a notice the agency released in February. The earlier notice informed the public of its plan to treat drones as a special class of aircraft under its FAR Part 21.17 for very light airplanes when assessing if the design of a model complies with airworthiness standards. The agency will now issue type certificates, or design approvals, for unmanned aircraft systems under a Part 21.17(b) process. It said it may still tailor design approvals for some drones, where appropriate, using airworthiness criteria from other categories of airplanes and helicopters under Part 21.17(a). **And, in an apparent reference to urban air mobility vehicles, the agency added: "Future FAA activity, through either further policy or rulemaking, will address type certification for UASes carrying occupants."** The FAA is currently managing 30 UAS type certification projects, according to Earl Lawrence, executive director of the agency's aircraft certification service. Of those applicants, 44% are seeking to fly drones under Part 91 operating rules that apply to general aviation pilots and 32% under Part 135 for commercial air carrier services.

TEXTRON AVIATION AVOIDED A STRIKE BY ITS HOURLY WORKFORCE when members of the International Association of Machinists and Aerospace Workers accepted the company's final offer of a new four-year labor contract on Sept. 19. The agreement, which

took effect Sept. 21, includes increased job security language that ensures final assembly of its new Cessna 408 SkyCourier and Cessna Denali turboprops will remain in Wichita for the length of the agreement. Both aircraft are under development. The contract also adds a no-deductible health-care plan option, general wage increases, a voluntary retirement plan for employees 55 years and older with five years of service and additional contributions to the health savings accounts. The agreement covers 4,560 hourly workers represented by the Machinists union's Local Lodge 774. Of those voting, 64% voted to ratify the contact. It was the first full negotiation of a contract following Textron's purchase of Beechcraft and its merger with Cessna Aircraft.

Jet Aviation Delivers Upgraded VVIP Cabin on ACJ319neo

Jet Aviation's Completions Center in Basel, Switzerland, has completed the upgrade and redelivery of its first ACJ319neo. The aircraft is the quietest VVIP cabin that the company has completed to date. Driven by customer demand for lighter, quieter cabins, the aircraft was designed by Jet Aviation Design Studio, in collaboration with the customer's interior designer, to showcase a VVIP level of elegance and attention to detail, the company says.

IATA Expects Slower-Than-Expected Air Travel Recovery

IATA

IATA is now forecasting a slower-than-expected recovery of air travel for this year and into 2021, highlighting the need for further financial assistance from governments and urging the introduction of broad testing that would allow a quick reopening of borders. IATA says air travel will still be down 68% in December compared to last year and overall demand for the full year will have contracted by 66% in terms of RPKs. That compares to the July forecast in which IATA expected demand to be down 55% at year's end and 63% for the full year.

THE THIRD AND FINAL CESSNA 408 SKYCOURIER test aircraft completed its first flight on Sept. 28 and is joining the company's flight test program. It along with the prototype are configured in a passenger variant. The second aircraft is configured as a freighter. The newest aircraft will be used to focus on avionics, flammable fluids, and cold and hot weather testing. Its first flight lasted 1.5 hr. and reached a speed of 210 kt. and an altitude of 15,000 ft. Textron Aviation will soon begin SkyCourier line production at its factory in Wichita as it moves closer to certification and first delivery, which is anticipated to occur in 2021. The high-wing SkyCourier is powered by two Pratt & Whitney Canada PT6A-65 engines and equipped with Garmin G1000 GXi avionics. It's expected to have a maximum cruise speed of up to 200 kt. and maximum range of 900 nm. **The aircraft can accommodate 19 passengers or in a freighter configuration carry three LD3 shipping containers.** Its single-point pressure refueling capability is intended to facilitate quick turnarounds and its rugged landing gear enables it to use unimproved strips. In 2017, FedEx Corp. launched the SkyCourier program when it placed a firm order for 50 SkyCourier 408s, plus options for 50 more. Deliveries were to begin this year.

BOMBARDIER PLANS TO ESTABLISH A COMPANY-OWNED service center in Berlin through an agreement with Lufthansa Technik AG and ExecuJet Aviation Group, as the company grows its customer support network. **Under purchase agreements with the two companies, Bombardier will acquire all of the issued and outstanding shares of Lufthansa Bombardier Aviation Services that it does not currently own.** The transactions are expected to close before year's end. The service center is located at Berlin-Schonefeld Airport, which has been providing services to Bombardier business aviation customers since 1997. The 160,000-sq.-ft. center employs 240 workers.

SIGNATURE FLIGHT SUPPORT AND FUEL SUPPLIER NESTE have partnered to offer permanent supplies of sustainable aviation fuel (SAF) to operators at San Francisco International Airport (KSFO) and London-Luton Airport (EGGW). The move is part of an initiative called Signature Renew, a company-wide plan to help achieve the industry goal of net-zero carbon emissions. The FBO chain committed to purchase 5 million gal. of SAF and NetJets has signed on as the launch customer for fuel supplied at KSFO. Up until now, FBOs have been able to provide only a few thousand gallons of SAF at one time by request or for a one-time event. "For us, it's been a long time coming," said Tony Lefebvre, Signature COO. "We've been wanting to be in the space with a sustainable amount of sustainable aviation fuel where we wanted to provide it on a consistent basis, but it hadn't been easy to do up to this point." As demand grows, Signature said it plans to offer SAF to other locations in its network. It said the per-gallon price for SAF will be higher than for traditional Jet-A. Neste has been producing SAF for almost 10 years, with plans to have the capacity to produce 515 million gal. a year by 2023. Its SAF is made from waste and residue materials, such as used cooking oil gathered from places such as McDonalds, Wendy's and other businesses. Before use, the fuel is blended with fossil jet fuel and verified to meet ASTM jet fuel specifications. Once blended at a 35% ratio, Signature expects a more than 35% reduction in direct net-life-cycle greenhouse gas emissions from fuel from the two airports.

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Embraer Delivers 250th Business Jet in Latin America

Embraer has delivered its 250th business jet in Latin America following Phenom deliveries to two first-time jet buyers, the company says. Embraer delivered a Phenom 100EV entry-level jet to an undisclosed industrial company, which will use the aircraft for business operations during the COVID-19 pandemic. It also delivered a Phenom 300E to AgroJem, an agribusiness company, which transitioned from a turboprop.

Clay Lacy Aviation Secures 35-Year Lease for KSNA FBO

Clay Lacy Aviation has been awarded a 35-year lease at John Wayne Airport (KSNA) in Orange County, California, for its FBO from the Orange County Board of Supervisors. The facility will serve as a business gateway for the county, the company says. Clay Lacy Aviation was awarded a 15-acre leasehold to design, build and operate the FBO, with 11,000 sq. ft. of hangar space, 42,000 sq. ft. of office space and a private terminal. The FBO will create 180 jobs.

AVIATION START-UP ZEROAVIA COMPLETED THE FIRST FLIGHT of its hydrogen-fuel-cell-powered Piper M350 test aircraft when it flew an airport pattern on Sept. 24 in Cranfield, England. The brief flight is a first step toward the company's Project HyFlyer goal of performing a 250-mi. flight from an airfield in the Orkney Islands, Scotland, before the end of this year. "While some experimental aircraft have flown using hydrogen fuel cells as a power source, the size of this commercially available aircraft shows that paying passengers could be boarding a truly zero-emission flight very soon," ZeroAvia CEO Val Miftakhov said. The powertrain on the Piper testbed was producing 230-240 kw and the company is looking to increase this to 260 kw to support longer flights. However, it plans to develop a 600-kw powertrain that could power an 19-20 seat commuter aircraft including Cessna's new twin-engine SkyCourier, Viking's Twin Otter and the Dornier 228. The company says it has received 10 letters of intent from aircraft operators and airlines showing in interest in its technology, while discussions are underway with seven aircraft manufacturers.

WHEELS UP IS EXPANDING AGAIN. THE OPERATOR HAS FORMED Wheels Up Aircraft Management, a new group created after its integration of recent acquisitions Delta Private Jets and Gama Aviation Signature, giving it a fleet second only to NetJets. Wheels Up says the new entity is "one of the largest and most efficient aircraft management platforms available today," offering clients and aircraft brokers customized services whether involving a single aircraft or a fleet. "With our acquisitions of Delta Private Jets and Gama Aviation Signature, we gained a dedicated team of experts who are in position to lead Wheels Up Aircraft Management and deliver a best-in-class, bespoke service to our members and new clients," said Kenny Dichter, Wheels Up founder and CEO. The services include full aircraft management for primary users, select access for those wanting to gain savings by leveraging the company's purchasing power, charter outsourcing for customers wishing to place their aircraft on Wheels Up's certificate as well as maintenance management. Each client can receive guaranteed access to Wheels Up's King Air 350i fleet and "as-available" access to Citation Excel/XLS and Citation X jets.

FLIGHT SERVICES PROVIDER DRONEUP HAS ANNOUNCED a pilot program with Walmart and Quest Diagnostics to deliver COVID-19 test sample collection kits by drone in North Las Vegas, Nevada. Flown under operating requirements of FAR Part 107 for small commercial drones, the service delivers kits that contain a device for taking nasal swabs to single-family houses within a 1-mi. radius of a Walmart store. Residents can schedule the free service through a website. DroneUp, based in Virginia Beach, Virginia, has developed a payload and drop mechanism for the DJI Inspire 2 quadcopter that lowers a bag containing small items by tether to the ground. The system uses a Skyzimir Stork drop system and adds an optional DJI Zenmuse X5S camera and gimbal to improve the pilot's view of the drop area. Upon receiving a kit, residents take their own nasal swab sample, then ship the sample to a Quest Diagnostics lab using a prepaid shipping envelope. They can check their test results for exposure to the novel coronavirus that causes COVID-19 through the company's "MyQuest" web portal, which is available as a mobile application.

▶ **BYE AEROSPACE IS LOOKING TO ADVANCES IN BATTERY** technology for future six-place eFlyer X and nine-seat Envoy all-electric aircraft that it plans to follow the two- and four-seat eFlyer 2 and 4, respectively, now in development. The Broomfield, Colorado, company is working with the U.K.'s Oxis Energy to test lithium-sulfur battery packs with higher energy density than the lithium-ion system used in its first eFlyers. That's key to offering greater range in the planned eFlyer X and Envoy, according to CEO George Bye. The eFlyer 2 is aimed at the flight school market, the two-seater optimized for typical training sorties of up to 1.3 hr. with 20-min. recharging between flights. Its slim nacelle encloses a 90 kw Rolls-Royce RRP70D electric motor, and the 37.8-ft.-span wing houses a 75 kwh battery pack. The eFlyer 4 is essentially a stretch of the two-seater, sharing common aerodynamic and structural DNA, and uses the same battery technology with roughly a doubling of the pack size. Both have fixed landing gear. The planned eFlyer X will fly higher and faster as a "lightly pressurized" six-place single seater designed to cruise at 25,000 ft. The aircraft will have retractable gear. Illustrating an advantage of electric propulsion, Bye notes the eFlyer 2 developmental prototype has the same climb rate at 9,000 ft. as at sea level. "There's no combustion, just electrons to torque. The bottom line is electric loves to fly high and the calibrated airspeed to true airspeed benefits are fully realized — and the ability to get there, the climb rate all the way up, is not diminished." The planned twin-motor, nine-seat Envoy will also fly higher and faster. But, as with the eFlyer X, battery energy density is a consideration that could impact a formal program launch. "There's great promise for the eFlyer X, that six-seater lightly pressurized retractable, but most of the people who buy an airplane of that type like to have longer range," Bye says. The same goes for the Envoy that would follow.

▶ **BUSINESS AVIATION MANUFACTURING VETERAN DAVID COLEAL** has vacated his position as president of Bombardier Aviation following a senior management reorganization as the Canadian planemaker closed on the sale of its rail train division. Apparently, Eric Martel, the president and CEO of Bombardier, is assuming those responsibilities as well. "Our goal is to create a leaner, more agile and customer-centric company to better capture the growth opportunities with our industry-leading business jet portfolio," Martel said. "This includes simplifying our corporate leadership structure." Martel thanked Coleal for "his many contributions" and wished him well. The company expects to close on the sale of its Bombardier Transportation to Alstom, a French multinational conglomerate with interests in the power generation and transport markets, during the first quarter of 2021. At that point, Bombardier will be focused entirely on business aviation since it previously divested all De Havilland Canada assets as well as its commercial jet businesses. Coleal was appointed president of Bombardier Aviation in May 2019 after leading the business aviation division, which began in 2015.

▶ **ACCORDING TO JETNET IQ PULSE, SMALL JET ACTIVITY** has remained the strongest in business jet flight operations during the COVID-19 pandemic. From July 1 to Sept. 21, it reported FAR Part 135 on-demand charter operations by small jets were down 2% from a year ago, which it deemed "an impressive performance to say the least." Meanwhile, it reported Part 135 medium jet activity for the period declined 5%, while large jet activity was down 17%. Part 91 activity by small jets declined 24% for the period, while fractional ownership activity by small jets declined 17%.

328 Support Services Adds German-Based Dornier 328 Sim

328 Support Services GmbH, a division of the Sierra Nevada Corp., has opened a new simulator facility for the Dornier 328 turboprop near Dusseldorf, Germany, at Velbert/Essen. An EASA-certified Level DG simulator is now available for training, it says. The simulator received certification from the German Federal Aviation Office and will be operated in partnership with Simulator Training Solution GmbH.

FlightSafety Begins G280 Training in Wilmington

FlightSafety International is now offering training for the Gulfstream G280 business jet at its Learning Center in Wilmington, Delaware. FlightSafety will offer operators a wide range of training programs for the G280 at the facility, it says. The location will offer the fourth G280 simulator. The other three are in service in Savannah, Georgia, and Dallas. The simulator is equipped with Rockwell Collins Pro Line Fusion PlaneView 280 avionics, dual FMS, integrated flight information system and other features.

Kent S. Jackson, Esq.

Founder & Managing Partner
Jetlaw LLC, Washington, D.C.
www.jetlaw.com

Considering his family history, Jackson was predestined for a career in law. His great, great grandfather was a John Brown abolitionist who traveled west to Kansas to help combat pro-slavers in neighboring Missouri. He fought and was severely wounded in the Civil War and for that service was named a justice of the peace. His son went on to become attorney general of Kansas and then a congressman as a member of Teddy Roosevelt's Bull Moose Party. His son, in turn, became a member of the Kansas Supreme Court, and his son — Kent's father — served as a district court judge. "So, by that standard," Kent says, "I've not really done much." Oh? He's a 7,000-hr. ATP and CFII, has flight instructed, flown checks at night, owned an FAR Part 135 operation, built his own Lancair, competes in air races and is known nationally for his mastery of aviation legal matters. Accordingly, he is a sought-after speaker and heads an FAA rulemaking committee. Oh, and he's been writing *BCA*'s Point of Law column since 1998.

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

Questions for Kent S. Jackson, Esq.

1

Why aviation law? After all, it's pretty specialized and narrow.

Jackson: When I was an infant, my parents went to a drive-in movie with me in the back seat. At one point, an airplane appeared on the screen, and I exclaimed, "Airplane!" Mom and Dad turned in amazement. It was my very first spoken word. As a kid, I knew I was going to be a fighter pilot. I was an Eagle Scout at 13, an Aviation Explorer at 14, soloed at 16, got my Private at 17 and drove to the Air Force Academy in Colorado Springs to announce my availability. They were unimpressed, especially since I had 20/200 vision uncorrected. I was crushed. But my father said I could end up as chief counsel for TWA. Meanwhile, I was doing research for Dad during summers and came up with the idea for a book connecting statutes with aviation regulations, figuring no one had ever done such a thing. After all, by legal history, aviation law was essentially brand new.

2

Did you write it?

Jackson: Eventually. First, I completed bachelor's and law degrees at the University of Kansas, did an internship and staff work at the Kansas DOT and then joined Jim Cooling's well-regarded practice in Kansas City. While there I finally wrote the book, which a legal publisher turned down, but suggested I approach Jeppesen. I really liked the idea and did just that. Well, although I was 29, I looked about 12 and they said I'd need a co-author with a bit more gravitas. I invited Joe Brennan, a friend and veteran FAA lawyer, to join me and that really worked out. Joe was not a pilot — in fact, he called all pilots "cowboys" — so I learned how non-pilots at the agency think, and how to combine operational reality with abstract regulation. The FAA purchased the entire 5,000-copy first printing of FARs Explained and more than 100,000 copies followed. It's still in print and available electronically through Amazon. Its success helped spur me to open my own firm.

3

How did a tiny law practice in Kansas gain a national clientele?

Jackson: I flew to see my clients wherever they were. I can't count how many times I crossed the Rockies or flew to Washington or other East Coast destinations. Business aviation made my practice, along with my flying experience and a lot of research.

4

What are the most common legal mistakes made by pilots?

Jackson: Remember, flying is a privilege, not a constitutional right. And if you fly for a living, you're married to the FAA. So, be polite and respectful, but don't say anything stupid. You have the right to remain silent, yet many pilots don't have that ability and get themselves in trouble talking to inspectors, some even bragging about things they shouldn't have done. And if someone lies on a federal form such as an FAA medical application, they could end up spending years in jail.

5

You ever going to win at Reno?

Jackson: Were it not for its cancellation because of the pandemic, I just know this would have been the year for my team to take the gold at Reno. The airplane was ready and we were ready. But I promise we'll still be ready in 2021. **BCA**

Adjusting Approach Speed

When VREF isn't enough

PHOTOS AND CHARTS BY JAMES ALBRIGHT/B&CA

A GVII-G500 at minimums, flying a 13-kt. gust additive.

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

In "Enterprise," one of the most underrated of the Star Trek television spin-offs, future Capt. Jonathan Archer repeatedly crashes his model airplane because a turn of the winds found his craft without the necessary lift. His father reassures him, saying, "You can't be afraid of the wind, learn to trust it."

As a pilot, this scene troubled me for some reason. Did I fear the wind? Except for a towering thunderstorm parked on the end of a runway threatening a microburst, I didn't think so. But I certainly did not trust it. I've had too many landings in windy conditions where something (not me!) happened at the last minute to rob my wings of the lift they needed. When my flight manuals gave me the opportunity to adjust my approach speed, I did so, and those surprises seemed to happen less often. In most of those manuals, that additive was recommended but not required.

Until you were burned a few times, you might have been tempted to forgo the additive. "I never needed it before." This begs the question: How large is your margin to an angle of attack (AOA) limit on short final? If that convinces you to include the speed additive on your next flight on a gusty-wind day — and I hope that it does — there are still two more questions to answer. First, on what wind will you base the additive; i.e. all or part of the headwind or crosswind, and what about a gust? Second, once you've added the necessary margin, do you hold that to the runway threshold or get rid of it? And if you elect the latter, when and how?

How Large Is Your Stall Margin at Approach Speed?

When flying a transport category aircraft, your approach speed cannot be lower than reference speed, VREF, which may not be lower than 1.23 times the reference stall speed in the landing configuration, Vsr. Moreover, 14 CFR 25.143 further specifies that when landing, the aircraft must be maneuverable and free of stall warning or other characteristics that might interfere with normal maneuvering up to 40 deg. of bank with symmetric thrust while flying a -3-deg. flight path angle. While we all think of stalls as occurring at certain airspeeds, we know that stalls actually happen at particular angles of attack, what an aeronautical engineer calls the "alpha."

But how do we translate that 40-deg. bank angle to G? We are taught early that a level 60-deg. bank turn requires 2 Gs. The math behind that is:

$$G = \frac{1}{\cos 60} = 2.00$$

A 40-deg. bank turn requires:

$$G = \frac{1}{\cos 40} = 1.31$$

So, all of that provides us with two concepts when trying to understand how close to a stall we can come, but how can we turn that into practical knowledge in the cockpit? For most of us, our only G-meter is the "seat of our pants." But we do have attitude indicators and keeping to less than 40 deg. of bank in coordinated flight should keep us safe, provided we maintain a healthy margin above the stall angle of attack. If you have an AOA indicator, you have an advantage. But just what is angle of attack?

Most of us learn early on that the AOA is the angular difference between the chord line of the wing and the relative wind of the aircraft cutting through the air. That isn't precisely correct, but it is close enough. We can change the effective chord line of the wing with leading- and trailing-edge devices, such as slats and flaps. The shape of the aircraft itself may create lift and the angle upon which the wing is mounted versus the reference provided to you on your attitude indicator, the "angle of incidence," will also alter the wing's AOA to your perceived AOA. But for we pilots, thinking of AOA as a function of the relative wind and the wing is good enough.

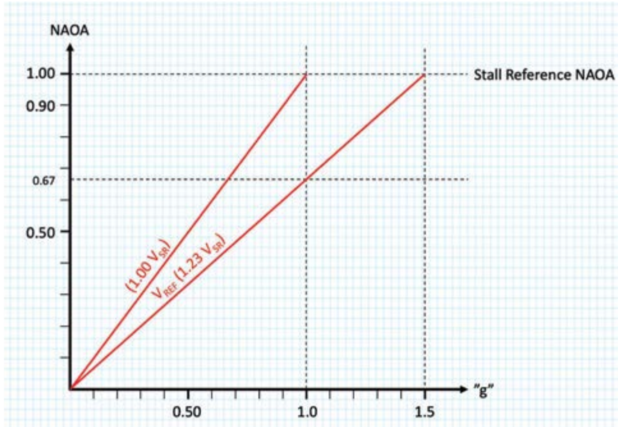
Left unsaid is that an angle is something you measure in units, usually degrees. It is a number, such as 15 deg. We also learn that the wing stalls at a particular AOA. Here again that is given in degrees, such as "the wing stalls at 18 deg. angle of attack." As pilots, we don't use AOA measured in degrees because that measurement varies too much with flight condition and aircraft configuration.

Airplanes that do display "AOA" are usually showing us "normalized" AOA. That is just a fancy way of saying they are giving you a ratio of the actual AOA (in degrees) divided by the stall reference AOA (in degrees) to give you a number between 0.00 and around 1.00. Yes, the number can actually exceed 1.00 as the wing still produces usable lift, but for us pilots, thinking of 1.00 as our upper limit helps our understanding of the concepts. The maximum allowable isn't necessarily the maximum achievable. A fly-by-wire airplane may use a lower AOA to prevent overshoots. An airplane with a conventional stick pusher may do the same to ensure the system activates early enough. In either case, your avionics do the math for you, but a common formula for normalized AOA (NAOA) is:

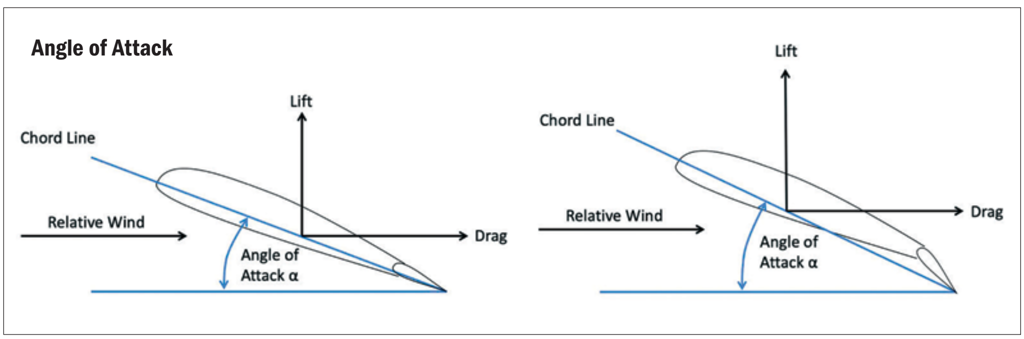
$$NAOA = \frac{AOA_{\,Current} - AOA_{\,Zero\ Lift}}{AOA_{\,Stall\ Reference} - AOA_{\,Zero\ Lift}}$$

Where each AOA term is measured in units of degrees, the resulting NAOA is a ratio and has no units. We typically think of 1.00 NAOA as the stall AOA, but the real value is usually a bit higher. An example of that could be 1.06 for the stall reference AOA and 1.10 where the wing actually stalls. While far from universal, most aircraft in my logbook flew final approach at an NAOA around 0.60 and would give you a stall warning (limiter, stick shaker or pusher) between NAOA = 0.85 and 0.97.

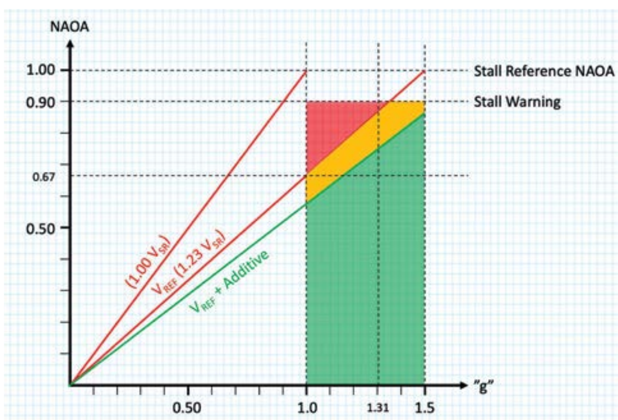
We can make all of this truly useful if we look at what an engineer would call a "notional," or hypothetical, aircraft. The charts and graphs that follow may not precisely reflect your airplane and ignore things like ground and Mach effect, but they serve to illustrate the concepts that you can apply to your aircraft to better understand the principles. Stall reference speed, Vsr, is determined at 1.0 G and the stall speed varies with the square root of G loading. Plotting NAOA versus G for these two conditions proves very useful.



NAOA versus G of a notional aircraft plotted at VSR and VREF



Notice that the intersection of our VREF line and 1.0 G comes to 0.67 NAOA. This would make a good target NAOA on approach for our notional aircraft. If the notional aircraft has an alpha limiter or stick pusher that activates at 0.90 NAOA, we can draw an envelope to indicate an area of operation where the airplane is maneuverable without stalling. Of course, we don't want to operate below VREF, but this area is available to us in the event of wind shear or another non-normal condition. This becomes useful to us, realizing that if we see an NAOA greater than 0.67 on final approach — because of turbulence, for example — we are "eating into" our stall margin.

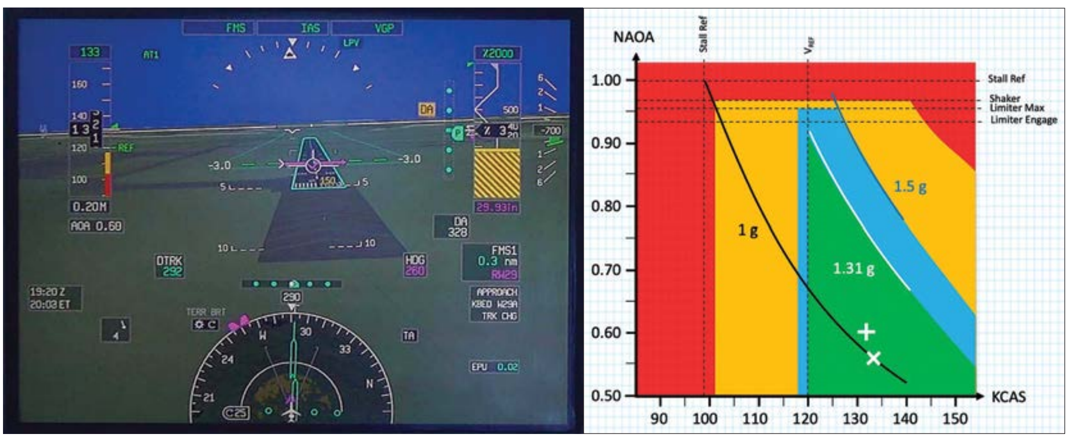


Stall margin of a notional aircraft plotted at Vref plus an additive on an NAOA G graph

Many manufacturers add 5 kt. to VREF, or even more if wind conditions dictate. This results in a lower line on the NAOA G graph and expands our stall and maneuver margins. Imagine yourself flying at 1 G at VREF. You are given a margin before stall warning (the red zone above the line) as well as a maneuver margin. That margin was determined by allowing for a 40-deg. turn on a 3-deg. glidepath, which comes to 1.31 G. These margins can be "eaten" by a sudden gust of wind or turbulence. We certainly don't want to find ourselves flying this slowly low to the ground when a sudden loss of airspeed activates a stick pusher! Fly-by-wire aircraft could find themselves nearing an "alpha limit," limiting pitch authority. In either case, it would be wise to avoid high angles of attack.

The Impact of Sudden Gusts on NAOA, G Loading and Stall Margins

Most pilots are primarily focused on airspeed even if presented with an indication of NAOA. The NAOA-KCAS chart shown for our aircraft is from a recent flight where VREF was 120 kt. (at an AOA of 0.67) and the winds were at 10 kt., gusting to 18, making our target approach speed 120 plus half of 10, plus 8, for a result of 120 + 5 + 8 = 133 kt. (at an AOA of 0.57).



The pilot's synthetic vision display (left) and NAOA-KCAS chart (right) of a high-technology aircraft at decision altitude on a gusty-wind day.

JAMES ALBRIGHT/BCA

Of course, nothing is ever static on a gusty day and just as we expect the airspeed to bounce around, so too does the NAOA. We can see from the photo of the pilot's synthetic vision that a gust has increased the NAOA to 0.60 and that on the chart our target approach airspeed (shown by the "X") moves up and to the left (shown by the cross). Our green zone is defined by VREF on the left and the G loading that equates to a 40-deg. bank turn in level flight (1.31 G) to the right. The manufacturer of our notional aircraft has provided us a margin, shown in blue, before we enter a zone of "low speed awareness," which provides an additional margin before stall warning, even at 40 deg. of bank, shown in red. Passing the threshold and entering the flare, it will be OK to go below VREF (in calm conditions) since we no longer need all of the maneuver margin for the design parameter of 40 deg. of bank.

So, it should be apparent that getting below VREF is not a good idea and that when it gets windy, you need to add to your approach speed to avoid doing that. But by how much?

Half of What Wind and How Much of What Gust?

Some aircraft manuals say you should add half the steady wind and the full gust increment to your approach speed. But that is far from universal. Looking at several aircraft from the smallest Challengers and Falcons to the largest Airbus and Boeing jets reveals the breadth of the variation. You might add a half, a third or none of the steady wind, or the headwind. Most will have you add all of the gust. Most will limit you to a 20 kt. total additive, but some lower this to 15 and even 10 kt.

The reasons for variation may seem arbitrary but might be more strongly corelated to aircraft design and recommended landing technique than one might suspect. All aircraft should be concerned with at least the headwind component because of the nature of winds low to the ground. The wind normally decreases as you near the runway, particularly below 50 ft. Adding at least 5 kt. or half the headwind is a way to mitigate that decrease. An airplane that lands in a crab may only be interested in the headwind, since sideslip is not a factor. An airplane that lands in a sideslip (the so-called "wing low" method) or a de-crab will have to consider all of the wind, regardless of direction.

The reason for including a wind additive to your approach speed is clearly designed to prevent landing with too little stall margin should the winds change. But landing with too much speed presents its own set of problems.

If you land with that extra speed, will you still be able to stop on the runway available? Many manufacturers recommend you lose any additive prior to crossing the runway threshold. (More on that later.) But that will require considerable judgment.

Will this extra speed throw you into a higher approach category? Some aircraft circle at their final approach speed and an extra 20 kt. could very well result in the next higher approach category. This could require a higher circling altitude as well as higher weather minimums.

Will the extra airspeed create problems with tire groundspeed limits? Even if your aircraft manufacturer has not posted such limits, the tire manufacturer most certainly has. These limits can be a factor at higher pressure altitude airports, especially on a day with a low headwind component. On a gusty-wind day an additive might bring tire groundspeed limits into play even at lower pressure altitudes.

Will the lower deck angle make it possible to contact the runway nosewheel first? If your airplane flies its final approach in a relatively nose-low attitude, touching down too fast could result in a nosewheel-first landing with the risk of a nosewheel landing gear collapse. Thus the limits to the approach speed additive should take this deck angle limit into account.

For these reasons, and maybe others, some manufacturers recommend you get rid of the airspeed additive prior to crossing the runway threshold.

Lose or Keep the Additive?

Here again manufacturers differ. Many Boeing, Airbus and Dassault aircraft leave the additive in until the autothrottles retard for the landing. As noted, some manufacturers recommend the pilot remove the additive prior to crossing the threshold. There are many reasons for caution, but if you decide to lose the additive prior to the runway threshold, how do you do that?

I've tried two methods as the pilot flying and I've witnessed both methods as the pilot monitoring. Both methods work. Sometimes. But not always. For that reason, I consider both methods to be bad ideas.

Bad Idea One — With or without autothrottles, some pilots will try to get a feel for the gust and try to time pulling the throttles so as to arrive over the threshold at VREF. I found this easier to do in the Gulfstream GV with approach speeds near 110 kt., but even then, I got it wrong occasionally. With aircraft requiring higher approach speeds, things are happening too fast for me to time the gust consistently.

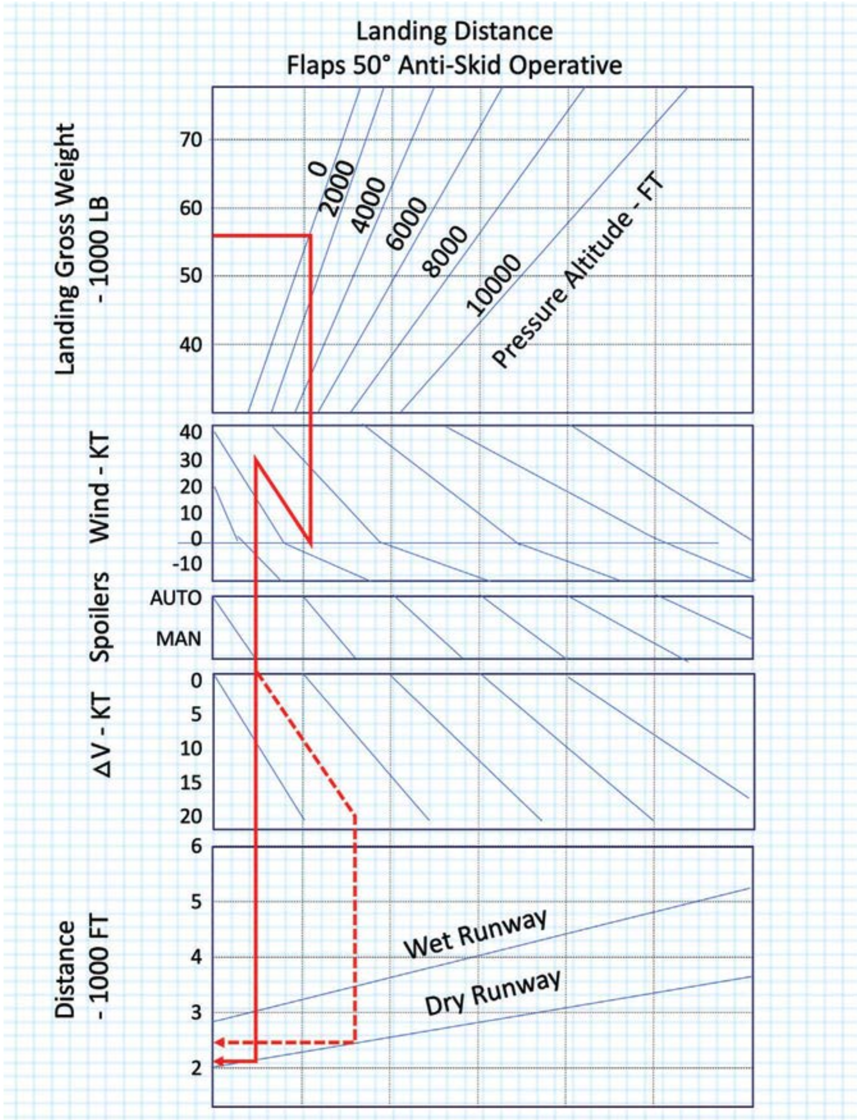
Bad Idea Two — With autothrottles, some pilots will manually insert the targeted speed with the additive and select "auto" mode at a moment when they believe the speed is increasing. Here again, the judgment required at higher approach speeds makes this a hit-or-miss proposition.

I consider these bad ideas because a wind gust cannot be predicted consistently. My solution for the last 10 years has been to keep the additive until the autothrottles retard for the landing flare, and to ensure I have enough runway in case I touch down with all of the additive speed.

Landing Distance Impact

When I suggest holding the speed additive to the runway threshold to other pilots, the first reaction is often to ask about landing distance. The landing performance charts in my current aircraft include a section of up to 20 kt. additional speed crossing the threshold. I've seen other manufacturers with 10-, 15- or 20-kt. allowances.

The next objection will be, "What if the gust hits me at just the wrong time and I end up 20 kt. fast?" Let's look at another hypothetical.



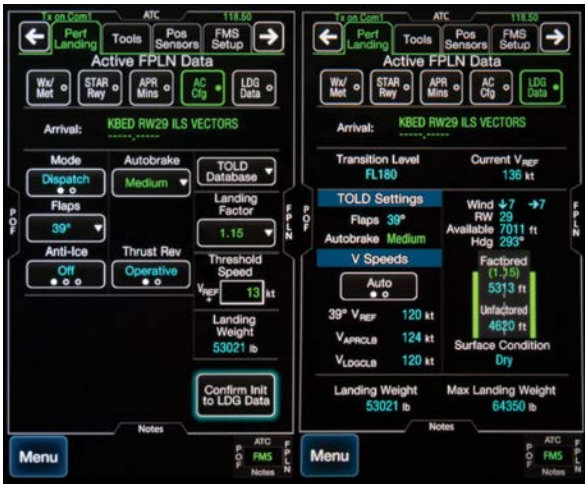
Example landing distance chart with wind adjustment.

Let's say you have a VREF of 120 kt. and a wind straight down the runway at 20 kt., gusting to 30 kt. Your charts, like mine, have a section for a headwind up to 40 kt. and a speed additive up to 20 kt. You compute your landing distance for a headwind of 20 kt. and a gust of 10 kt. Your manufacturer recommends half the steady and all of the gust as an additive, regardless of direction, so your approach speed is 120 + 10 + 10 = 140 kt. That 10-kt. gust treats you unkindly and you end up at the threshold at 150 kt. airspeed. If your performance data included all of that additional wind you won't have a problem; your groundspeed will still only be 120 kt.

If your flight management system automatically computes landing distances, you will need to ensure you have the right data in, to get the right data out. It may seem to be common sense to reduce the headwind entry as being conservative; however, it paints an inaccurate picture of your actual performance and places a subtle pressure on you to remove the additive.

My usual method is to precompute the maximum additive for my normal landing weights at a sea-level airport. I use Teterboro Airport (KTEB), New Jersey, because (a) we go there often, and (b) it is usually gusty. In my current aircraft I find that even landing 20 kt. fast never increases my landing distance by more than a third on a dry runway and that is good enough for the shortest runway there. If the actual conditions are worse than that, I know I need to dig into the Airplane Flight Manual charts. If I can't make the numbers work with the additive, my plan is to find someplace else to land. Over the years, I've had to do that twice.

In my current aircraft, a Gulfstream GVII-G500, the chore is handled automatically by the avionics, giving me a graphic representation of the resulting landing distance. If I elect to keep my speed additive to the runway threshold, I will know how that will impact my stopping distance.



The landing performance and data pages from a Gulfstream GVII-G500's touch screen controller.

Keep the Airplane Flying Until It's on the Ground

Unlike the young Jonathan Archer in "Star Trek: Enterprise," we don't need to be afraid of the wind nor do we have to trust it will behave as we expect. We can simply allow for it to misbehave and plan our approach speed accordingly. On a gusty day, flying an approach speed without a wind additive risks running out of flying speed prior to the landing flare. Your only options may be to add to your approach speed or to divert. An additive may be required, recommended, forbidden or not mentioned at all.

I recommend you research your manuals, see what flexibility you have, and fly the additives if you can. If the resulting landing distance or threat of running out of speed is too great, find another place to land. **BCA**

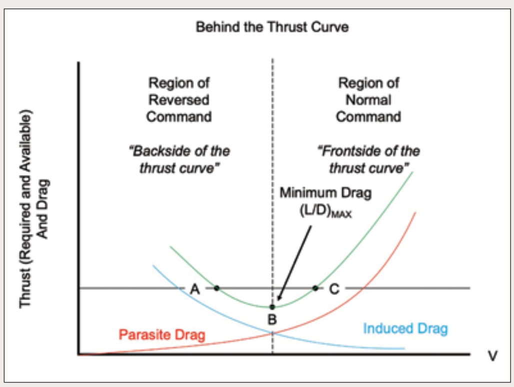
Another 'No' to Below VREF

You may have heard of the hazards of operating "behind the power curve," but what does that actually mean? The question is more than academic because some aircraft have a VREF that can be said to be in what is more properly called the "backside of the thrust curve." The concept of thrust, power, and even horsepower can get messy, and perhaps a bit of a history lesson can start to clean things up.

Scottish inventor James Watt (1736-1819) needed a way of comparing the power of his steam engine to something his customers could relate to, and thus was born the unit of horsepower. He computed the pulling force of a horse attached to a mill wheel to determine the measure of 1 hp. Piston engines use a concept called "brake horsepower" from a standard used to measure engine performance by wrapping a cord or belt (the brake) around a shaft. Thrust, on the other hand, is simply the force or "push" in reaction to an engine.

You can plot the parasite and induced drag of a jet airplane against airspeed and equate that to the thrust required to maintain steady, unaccelerated flight. (These curves are different for piston-driven propeller aircraft; we will limit our discussion to jet aircraft.) The point of minimum drag is known as L/D-max, or "L over D, max." It is simply the point where the ratio of lift over drag is at its maximum. (Somewhat paradoxically, that is the lowest point on the curve.)

We transport category aviators spend almost all of our lives "ahead of the thrust curve" where it takes more thrust to fly faster. In the chart shown, for example, Point B is L/D-max. If you are at Point C and wish to fly at some higher speed, you will need to add thrust, accelerate and then reduce thrust to a point higher than your original thrust. This seems normal and hence is called the "region of normal command." The airplane tends to maintain a selected speed here. If a gust of wind accelerates you, you don't have sufficient thrust to maintain the higher speed and you tend to fall back to your original, desired speed. The same holds true for something that decelerates you. You will have excess thrust and the airplane will accelerate back to your original, desired speed.



Thrust versus velocity and the resulting "thrust curve".

When operating slower than L/D-max we are operating in the region of reversed command. If you are at Point A in the chart, for example, and wish to pull it back a few knots, you reduce your thrust as before. But now, once you've achieved the lower speed, you will need more than your original thrust setting to maintain the lower speed. The aircraft does not hold speed as easily. If a gust of wind slows you down 5 kt., for example, your new speed will require more thrust than what you have so you will tend to slow down even further unless you take positive action by adding thrust.

Aircraft with approach speeds on the backside of the thrust curve will not have a tendency to return to targeted airspeeds without active addition of thrust. If a gust of wind slows the airplane down at a constant thrust setting, the speed will continue to decrease until the pilot takes positive action to reverse it. Aircraft with approach speeds on the frontside of the thrust curve will be more forgiving but still bear watching. **BCA**

Corporate Angel Network CAN

Fund an Angel Virtual Auction

The Fund an Angel Virtual Auction raised significant funds in support of Corporate Angel Network (CAN). Proceeds from the event will ensure CAN is able to continue helping cancer patients, like Scarlett, in critical need during the pandemic and long after. Thank you to all who generously contributed.

Scarlett, an immune compromised pediatric cancer patient, was in need of transportation to a specialized treatment center. CAN was able to transport the family just before Scarlett's 5th birthday.

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Stop. Look. Think.

Timeless lessons from Berlin

BY **ROSS DETWILER** rossdetwiler.com

A Gulfstream GIV-SP of the Swedish Air Force with four crewmembers and four passengers on board was parked on the northern apron of Berlin-Tegel Airport (EDDT) on Jan. 12, 2007. An IFR flight plan from Tegel to Bremen, Germany, had been filed and was ready for the crew when they showed up at the airplane.

The crew completed normal preflight procedures and called for engine start. They simultaneously requested to use Runway 26R for the later takeoff. To help understand the situation that followed, know that there were two parking places involved, the northern and southern aprons. The two ramp areas are separated by dual east-west (8-26) runways. Of the two, 26R is the longer runway at 9,918 ft., while 26L is 7,966 ft. Both runways are 151 ft. wide.

In this incident, airplanes eventually are cleared from both parking areas to the line-up end of Runway 26R and 26L.

The terminal buildings for civil aviation are located to the south of the two runways. The airport tower is also located to the south of the runway. Military aircraft generally use the northern apron and from there Taxiway NE goes in an easterly direction. Initially parallel to the runway, it then turns to the southeast and eventually due south as it approaches the dual runways. From the southern apron, Taxiway SE goes in an easterly direction to Runway 26L and 26R.

The weather on that winter day was not a factor. Even though a light rain was falling, the cloud bases were basically few at 1,000 ft. with scattered to broken at 2,700 and 3,200 ft. Visibility was 10+ kt. The temperature was a crisp 45F and the dew point was 37C with an altimeter of 1014.

In command of the Gulfstream was a military rated 54-year-old pilot, typed in the GIV-SP for over 12 years. He had more than 6,000 hr. experience in the airplane and in the previous 73 days had flown 73 hr. and performed 20 landings.

The 40-year-old copilot had been in the Swedish Air Force for four years. He held a military pilot license and had been typed in the GIV for over two years

Well Done, Gentlemen

I found this incident report while surfing the German Federal Bureau of Aircraft Accidents Investigation (BFU) website. When I finished reading, I felt I'd come across a gem in the rough.

The performance of the crew was completely routine, yet, to me, beautiful in its professionalism. I was so impressed that I've taken certain liberties to show what I think may have been going on during the time they were taxiing. Whether the incident was reported by the crew through some SMS that the Air Force had or was caught by the safety bureau due to a report or routine review, the outcome was not affected by the late reporting nor will it be by my conjecture.

Given that this was, relatively speaking, a small military transport aircraft, the crew did not have all the distractions and time-consuming events involved in getting a large transport crewed and ready for a long international trip. This was more of an inter-city business aviation-type operation.

I included much of what was written in the report since the details serve to better highlight what might have been. Every angle of the operation was considered by the BFU and duly reported. As I read through all of it, I had to remind myself, "Nothing happened."

So often, when reviewing reports just like this, the outcome involves many injured passengers and crew — or worse.

Nothing happened.

All the reviews and details shown read just like they would if this hadn't ended so well.

Nothing happened.

All the fault was apportioned and ways of improving processes delineated.

Nothing happened.

Why did nothing happen?

Simple. The crew was paying attention. They arrived at the plane after a comfortable crew rest or after having been off the field for a few hours while waiting for the passengers to return. The passengers arrived and the crew ensured they were boarded, belted and briefed.

Yes, it was the same briefing the cabin attendant had given all the hundreds of times he'd flown passengers. He knew it by heart, but he still held the checklist that contained the briefing in his hand and he referred to it when he was done to confirm he had missed nothing. When that process was complete, he reported to the cockpit, "We're ready in the back." The "pax briefed" portion of the checklist was complete. The passengers were offered a cup of coffee (it's the military, folks). The engines were started and the after-start checks complete, the takeoff brief completed, the most likely taxi at the time of the incident. He had over 3,500 hr. in the airplane and had also flown 73 hr. and 20 landings in the previous 90 days. (Apparently, to their credit, the Swedes take the crew concept seriously. — RD)

The ground controller had held a controller license for well over 16 years at the time of the incident.

All of the conversations between ATC and the crew were recorded and are available through German Federal Bureau of Aircraft Accidents Investigation (BFU) records. The airfield surface movement radar recordings were not available to the BFU. According to the air navigation service provider, the radar data had been recorded but was deleted 10 days after the incident due to storage capacity reasons.

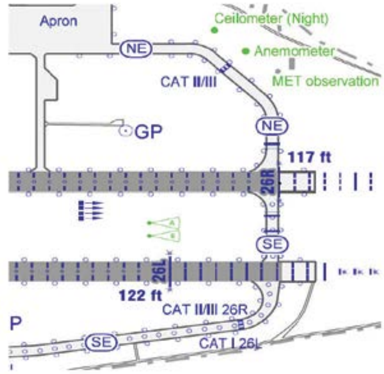
The 12-year-old aircraft was equipped with an FDR and CVR.

Debriefing of the crew showed that the PIC was also to be the PF on this leg, while the copilot was the monitoring pilot and handling PNF duties. Darkness had settled when they started their taxi, with the copilot talking to the controller. While taxiing to the lineup end of the runways, the controller asked the crew if they would like to use 26L for departure as she would be able to get them off quicker from that runway. Naturally the crew accepted that proposal.

As the Gulfstream was approaching the hold short area on the north side of the runways, the pilots were instructed to contact Tegel tower. Later, when the ground controller was debriefed, she stated that there had been no coordination discussion between her and the tower controller concerning the Gulfstream. This coordination discussion was standard procedure for aircraft coming from the northern apron. Due to an incorrect assumption by the ground controller that the GIV was on the south side of the runways, this discussion did not take place. As a result, the ground controller passed on her confusion and lack of situational awareness to the tower controller.

After the transfer took the traffic away from the ground controller, she shifted her attention back to some activity that was occurring on the southern side of the airport.

Due to the lack of coordination, the ground controller was not aware the tower had cleared another airplane to



GERMAN FEDERAL BUREAU OF AIRCRAFT ACCIDENTS INVESTIGATION

Berlin-Tegel Airport (EDDT)

land on 26R. She later assessed the air traffic volume prevailing at her workstation at the time of the incident as "low." She further stated that the workload for the previous few hours had been what she would describe as "medium." Taped conversions confirmed that in the time between when the Gulfstream taxied and when it came to a stop to clear up the confusion, the tower had talked to seven airplanes through 29 radio transmissions. The tower controller stated that she considered the traffic situation

route discussed on one of the screens. When the pilots felt completely comfortable and ready, they contacted the tower.

The copilot may have been the only one to initially note that the clearance included crossing a runway and that he was not authorized to do that in the first place. Nevertheless, that "bridge" wouldn't come into play for a while. Good for him, though, for what seemed to have been a "that can't be right" suspicion.

We can almost see the captain sensing the confusion on the part of his fellow crewman, with the CVR capturing, "Did they clear us to 26L?"

"Yeah, but they didn't actually clear us to cross the right and it looks like there's traffic lined up inbound for that side."

"Yeah, OK, give her a chance. We'll stop up here anyway before we cross any runway."

"Good idea."

"Tower, Swedforce, we're approaching CAT three holding runway two six right."

"She'll probably hold us here."

"Line up two six left."

"What? Confirm we can cross [cockpit internal]."

"Ah, tower, ah, roger line up 26L. Please confirm cleared to cross the right side."

"No need for clearance to cross, just line up on the left side."

And then, in my dream here of the perfect cockpit, the PIC says, "That's all screwed up. Going to stop here and I'll talk to her."

"Tower, you understand that Swedforce is on the north side of the runways and that to get to 26L, we have to cross in front of visible traffic approaching 26R."

"Ah, Swedforce . . . I am sorry. . . ."

Accident avoided.

All of the blame came down on the ATC personnel for making assumptions that were not justified based on incomplete understanding of the situation. But they're human beings and thus try and make every action they take into something routine, whether or not they know they're doing so. While that's human nature, routine can be a killer.

What the crew was doing here was just plain paying attention. They were talking to each other. They were setting barriers ahead of their position to ensure that nothing dangerous would happen before they had a clear understanding of "the plan."

After doing this column for six or seven months and after reading Dick Aarons' submissions for the last 30 years, it just felt good to point out crewmen who were paying attention, doing their jobs, on top of their game and keeping themselves and their charges safe. They turned potential disaster into boring routine.

Well done, gentlemen. Well done, indeed. **Ross Detwiler** "rather complex." There was also a seam or pillar in the tower's glass glazing that blocked the visibility of the NE CAT II/III holding position.

Subsequently it was confirmed that at the point of initial contact, the tower controller assumed the Gulfstream calling was the aircraft taxiing to the end of 26L from the southern parking area. In fact, that airplane had already been transferred to tower control. It was "usual operating procedures" for aircraft coming from the south side for takeoff on 26L be transferred to the tower without coordination.

It was later determined that the controller could have assumed by the call sign "Swedforce" that the airplane was coming from the military apron on the north side of the runways as this was the customary parking place for military operations. Unfortunately, the controller assumed that the aircraft transmitting as "Swedforce" was on the south side of the complex.

Further review of the tapes verified the GIV crew's feeling that their airplane had been spotted and its position was known to the ATC controllers. The confusion, on the part of the copilot, is assumed by the safety agency as he requested confirmation that their clearance for Runway 26L had not included the permission to cross 26R. In looking around, the crew noticed the aircraft approaching 26R and one of those aircraft requesting a "wind check."

"Tower Swedforce . . . approaching CAT three holding runway two six right." The tower controller then cleared the aircraft to "line up on runway two six left." The copilot answered with "line up, eh, runway two six left . . . and tower . . . confirm cleared to cross."

The controller responded, "There is no need to cross two, eh, just line up runway two six left." The copilot answered "Line up, eh, two six left. . . ."

Less than 4 sec. later, the crew of the airplane on final approach to 26R requested another "wind check." The requested information was passed.

The other airplane, which was taxiing from the southern apron on

Accidents in Brief

Compiled by Jessica A. Salerno

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

▶ **September 15 — The pilot of a Piper** PA46 (N596ST) was performing a straight-in approach to Runway 35R, and the approach was "bumpy" due to winds and terrain. She reported that about touchdown, a "severe wind event caused what felt like a potential upset." The pilot felt the left wing lift up and an uncommanded downturn to the right. She applied full power to bank left and climb, but the airplane did not climb. The left wing tip scraped the runway, and the airplane was forced to the right. Before the pilot was able to regain control, the airplane impacted a taxiway sign and several runway lights. The airplane then landed and taxied to the ramp. The Piper sustained heavy damage to the rear wing spar and wing root. The pilot reported there were no mechanical malfunctions or failures that would have precluded normal operation.

▶ **September 13 — About 1100 CDT,** an American Champion 8KCAB (N83DH) was heavily damaged when it was involved in an accident near Groton, South Dakota. The commercial pilot and passenger were killed in the accident. The airplane was operated as a Part 91 personal flight.According to a witness, after takeoff, the airplane accelerated down the runway in ground effect before the nose pitched up to an estimated 45-deg. angle. The airplane then rolled right and inverted and exited the roll maneuver in a nose-low attitude prior to impact with the ground. One witness estimated the roll was initiated between 75 and 100 ft. AGL. Two witnesses reported that the maneuver appeared intentional due to the rapid roll rate. Of the three witnesses interviewed, all stated that they did not know of any planned aerobatic maneuvers for the flight. The flight was part of a group of pilots attempting to raise money to help youth gain interest in aviation.

A family member stated that the pilot routinely performed low-level aerobatics in the accident airplane.

The airplane came to rest about 200 yd. south of Runway 15 at Groton Municipal Airport (2E6). The airplane impacted in an upright, nose-low attitude before it came to rest inverted. Both wings, the fuselage and tail all sustained heavy damage in the impact.

▶ **September 13 — At 1432 CDT, a** Cessna 172 (N8488L) was destroyed when it was involved in an accident near Cottage Grove, Minnesota. The pilot and two passengers were fatally injured. The airplane was operated as a Part 91 personal flight.

Radar data showed the airplane depart SGS at 1428, climbing to about 1,800 ft. MSL, and proceed southbound before it turned southeast-bound over Upper Grey Cloud Island. At 1432, over Lower Grey Cloud Island, the target disappeared. Another airplane, inbound for landing at SGS, captured N8488L in a video and still photographs as it descended. Examination of the photographs indicated the airplane appeared to be intact.

Some wreckage was located and recovered on September 14, 2020. The majority of the wreckage (about 90%) was recovered on September 19. The wreckage has been taken to a secure location where it will be further examined.

▶ **September 11 — About 0252 CDT, a** Beech A36 (N74HS) was heavily damaged when it was involved in an accident near McKellar-Spies Regional Airport (MKL), Jackson, Tennessee. The pilot was fatally injured. The airplane was operated as a Part 91 personal flight.

Review of a surveillance video at Dickson Municipal Airport (M02), Dickson, Tennessee, revealed that the accident airplane arrived on September 10, 2020 about 2041. The airplane taxied to the fuel farm. The pilot exited the airplane taxiway SE in an easterly direction, contacted tower at about this time.

"Tegel tower . . . taxiing to the holding point runway two six left." The controller asked, "Please confirm do you request two six right for departure or do you want to depart on the left side?" The situational furball was wound very tight at that time.

The PIC of the Gulfstream realized that the situation was not right and that his copilot was confused by the received clearance and had queried the controller. This caused him to stop the aircraft. When he looked toward the final approach area of 26R he noticed several approaching aircraft. He estimated that the first of them was extremely close and therefore kept his plane motionless as he tried to take in the problem unfolding. Finally, he felt it necessary to take over the communications from the copilot and transmitted.

"This is Swedforce. We are coming from the military apron and to get to the two six left, we need to cross two six right." The controller, after a brief pause, came back with "Ah, Swedforce . . . I am sorry, so I want you to hold short of runway two six right please."

The crew acknowledged the instruction, and in the debriefing made it clear that the pilot in command had brought the airplane to a stop well before the required position on Runway 26R. The tower controller later confirmed that she had assumed the Gulfstream was taxiing from the southern side of the runways.

The BFU later stated that the lack of surface radar recordings prevented determining if the radar had been correctly read by the controller, but they felt that the transmissions made and the positions given should have alerted her to the location and direction of the taxiing GIV on that radar.

The BFU found that the cause of the incident was ATC issuing a clearance on the basis of inadequate situational awareness. It felt that the restricted view from the tower of the area involved and insufficient use of the airfield surface movement radar contributed to what could have been disastrous. **BCA**

and walked to the fuel pump. He then returned to the airplane and taxied to the parking area. The fuel farm was operated by the fixed-base operator and the pump was locked for the night. The next morning the airplane taxied to the fuel farm and the pilot did not exit the airplane. The engine remained running for 3 min. before the airplane departed the airport about 0206.

Review of preliminary air traffic control information provided by the FAA revealed that about 0248 the pilot requested a deviation to MKL. He advised the controller that he was experiencing a fuel issue and needed to land. The controller provided a heading towards MKL and asked the pilot to report when he had the airport in sight. The pilot turned to the assigned heading, started a descent, and cancelled his visual flight rules flight plan. No further communications were received from the pilot. The FAA subsequently issued an Alert Notice (ALNOT), and the airplane was located later that morning about 1.5 mi. west of MKL in a wooded area.

The engine, cockpit and a portion of the right wing had separated from the airframe during impact with trees and terrain. There was no odor of fuel at the accident site. No fuel was found in the intact left-wing fuel tank. The right-wing sustained substantial damage and the fuel tank was breached. The fuel inlet line attached to the manifold valve was removed and was absent of fuel. A trace amount of fuel was found in the engine driven fuel pump inlet line.

▶ **September 10 — At 1600 EDT, an** experimental, light-sport Quad City Challenger II (N56906) was substantially damaged when it was involved in an accident shortly after takeoff from West Wind Airpark (TN64), Sweetwater, Tennessee. The pilot was fatally injured. The airplane was operated as a Part 91 personal flight.

▶ **According to owner, the pilot** taxied to the end of the runway and began the takeoff roll. As the airplane gained altitude it continued to fly straight and level with no airframe or engine anomalies. About 1/2 mile from the airport, the airplane nosed over and disappeared behind trees.

The airplane crashed in the backyard of a residential property. The wreckage debris path was about 30 ft. long and oriented on a magnetic heading of 180 deg. Ground scars at the accident site and damage to the airplane were consistent with the airplane impacting terrain in a nose-low attitude. A postimpact fire consumed most of the wreckage; all major structural components of the airplane were located within the debris field.

▶ **September 8 — About 1130 CDT, a** Piper PA-28-181 (N4166Z) was heavily damaged when it was involved in an accident near McMinnville, Tennessee. The pilot and two passengers were fatally injured. The airplane was operated as a Part 91 personal flight. The airplane was based at Lebanon Municipal Airport (M54), Lebanon, Tennessee. The pilot flew uneventfully from M54 to Warren County Memorial Airport (RNC), McMinnville, Tennessee. Review of security video at RNC revealed that the airplane landed on Runway 23 about 1123. It then taxied back to the beginning of the runway for takeoff about 1128 and disappeared from camera view during initial climb about 1 min. later. A witness, who was walking in his backyard heard an airplane engine go silent, then heard the sound of an impact about 30 sec. later. During that time, he briefly saw the airplane through trees, but could not determine its attitude. Examination of the accident site by FAA inspectors and a representative from the airframe manufacturer revealed that the airplane came to rest upright in a field about 1,000 ft. northwest of Runway 23. Fuel remained in both wing fuel tanks and the fuel selector was found positioned to the right main fuel tank. Flight control continuity was confirmed from the cockpit to all flight control surfaces and the flaps were retracted. Measurement of the pitch trim jackscrew corresponded to a partial nose-down trim setting.

Accidents in Brief

September 7 — About 1247 CDT, a Beech G35 (N4636D) was substantially damaged when it was involved in an accident near Canyon Lake, Texas. The pilot and one passenger were seriously injured. A second passenger received minor injuries. The airplane was operated as a Part 91 personal flight.The pilot reported to an FAA innspector that while en route to the Canyon Lake Airport (34TS) the engine lost all power a few minutes after he switched the fuel selector to the left main fuel tank. The pilot attempted a forced landing to a clearing but struck trees on the edge of the clearing and the airplane impacted the ground. The airplane incurred substantial damage to its fuselage and both wings.

September 7 — About 0810 CDT, a Piper PA-32R (N3576X) was substantially damaged when it was involved in an accident near Bonham, Texas. The pilot and passenger were not injured. The airplane was operated as a Part 91 personal flight.

According to the pilot, the airplane was on its first flight after maintenance work was completed, which included the replacement of the engine exhaust. Shortly after departure, the pilot noted high TIT and CHT temperatures. The pilot then decided to return to the airport; however, about 2 mi. short of the airport, the engine experienced a total loss of power. During the forced landing the landing gear collapsed in the soft terrain. An initial inspection of the airplane found substantial damage to the right wing, the landing gear had collapsed, and the propeller blades were bent.

September 6 — About 0900 EDT, a Robinson R22 Mariner (N194HC) was involved in an accident at Page Field (FMY), Fort Myers, Florida. The flight instructor and pilot receiving instruction were not injured. The instructional flight was conducted under the provisions of Part 91. Both pilots submitted written statements, and their versions of events were consistent throughout. The preflight and engine-start procedures were completed by the checklist with no anomalies noted. As the engine was accelerated to near its operating rpm, each pilot heard a loud "bang." The student leaned out his door and announced that "the tail was hanging off the back of the aircraft." The engine was stopped, and the event was reported to the helicopter's owner and his mechanic.

September 4 — About 2055 CDT, a Cirrus SR22 (N733CD) was destroyed when it was involved in an accident near Chester, Arkansas. The private pilot and three passengers were killed in the accident. The airplane was operated as a Part 91 personal flight.

According to initial information, the accident pilot called his flight instructor/airplane mechanic at the Muskogee-Davis Regional Airport (MKO), near Muskogee, Oklahoma, on September 4, 2020, about 1900, and advised the mechanic that he intended to fly to North Carolina. Fueling records showed the accident airplane was refueled about 1949, with 36.41 gal. of 100LL aviation gasoline.

According to initial radar data, the airplane departed from MKO about 2027. The airplane flew eastward, had climbed up through 8,500 ft., and the pilot established radio communication with an air traffic controller. The pilot was asked by the controller where the flight was destined and the pilot said it was Pickens County Airport, near Pickens, South Carolina. The airplane was radar-identified, was issued depicted weather, and the controller suggested a 20° right turn for the weather.

The airplane flew about 4 mi. on this heading and then reversed course. The flight was queried on its heading and the pilot replied that they were returning to MKO. The airplane was observed on a northwest heading by the controller who asked the pilot if he still intended to return to MKO, and advised the pilot that the airplane appeared to be on a heading of 340 deg. The pilot replied that the airplane had been caught by the wind and he was correcting its course. However, the airplane turned northeast and began descending. The controller issued the flight a 20 deg. left turn and no response was received in reference to that turn. The controller then advised the flight to turn left heading 270 deg. The pilot acknowledged the 270 deg. heading.

The airplane continued to descend and turn right. The controller then advised that the flight appeared to be losing altitude rapidly and advised the pilot to level the airplane's wings, and fly southbound. The controller subsequently queried the flight multiple times, advised that radar contact was lost, and no response was received. An alert notice was issued, a search conducted, and the wreckage was found in wooded terrain on September 5, 2020.The airplane and engine were recovered and have been retained for further examination.

September 4 — About 1148 PDT, a Beechcraft 35 (N818S) was destroyed when it was involved in an accident near Three Rivers, California. The pilot and the passenger sustained fatal injuries. The airplane was operated as a Part 91 personal flight.

After family members of the pilot became concerned when he did not arrive at his intended destination, the Federal Aviation Administration (FAA) issued an alert notice (ALNOT) for the airplane. The wreckage was discovered in mountainous terrain in Sequoia National Park early morning on September 5, 2020. According to first responders, a postcrash fire ensued following the impact.

Preliminary radar data depicted a primary target consistent with the accident airplane depart Visalia Municipal Airport (VIS), Visalia, California, about 1125 and flew east on a 1200 non-discreet code. The airplane flew toward rising terrain south of Silver City, California, and the last recorded radar target was about 1148.

The pilot was flying in an area of reduced visibility due to smoke from nearby wildfires.

There were no reported witnesses to the accident sequence. **BCA**

Winter Ground Ops

Freezing temps and precip **can have serious consequences**

ALEXEY LESIK/ISTOCK PHOTO

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

Ground operations in the winter create a large number of threats that can cause serious damage to an aircraft. Some of these are adequately addressed in operating manuals and recurrent training, but there are other conditions that aren't covered which can lead to expensive damage.

For example, while the consequences of failing to properly deice an aircraft's lifting surfaces that are contaminated by frozen precipitation are generally well understood, the susceptibility of jet engine components to contamination by ice during ground operations can catch a flight crew by surprise.

Consider the situation in which you are dropping your principal at Colorado's Aspen-Pitkin County/Sardy Field (KASE) for a ski holiday and then you are asked to reposition to Grand Junction Regional Airport (KGJT). If the weather on the approach into Aspen required the use of engine anti-ice, then your engine inlets will be warm during the initial portion of your turnaround on the ramp. And if the weather included frozen precipitation, it is possible for snow to be blown into the engine inlet. Upon contact with the warm engine inlet surfaces that snow will melt and drip down to the bottom of the inlet. Depending on the outside air temperature and length of ramp time, those metal surfaces and the liquid can then freeze. It only takes a small amount of ice at the bottom of the inlet to prevent rotation of the engine fan blades.

Unfortunately, a frozen fan can result in expensive engine damage if a start is attempted. During the start sequence, the N-2 (*i.e.,* "high pressure") shaft is free to turn, but the fan will not. If fuel is then introduced without sufficient airflow, temperatures in the combustion section will quickly soar,

Intake icing occurs when snow or slush enters during low-power engine operations.

impacting the hot section and requiring serious maintenance action. The duration of the over-temp as well as the over-limit temperatures are important to note since those will dictate the post-incident inspections and the maintenance necessary.

As pilots we have been instructed to verify that the engine cowl and inlet are clear of ice and snow, and the fan rotates freely during our walk-arounds. This is not easy on many business jets, particularly in the case of high-mounted engines. Attentively monitoring the engine start process is equally important. "Catching" the lack of fan rotation early in the sequence before introducing fuel and aborting the start before engine temperatures begin to rise will minimize any problems.

Engine Icing During Ground Operations

Additionally, blowing snow, freezing precip or fog, slush, ground contaminants or even airport snow removal operations can cause contamination on many other turbofan engine components. Even after engine start it is possible for snow and slush to accumulate within the intake ducting as well as on the rear surfaces of compressor/fan blades during ground operations when there's moderate to heavy freezing precipitation. That ice may severely affect the aerodynamic performance of the blades and cause compressor stall, engine surging and engine malfunctioning, and reduced thrust. (Reference: EASA Safety Information Notice No: 2008-29 [Issued April 4, 2008] "Ground De-/Anti-Icing of Aeroplanes; Intake/Fan-Blade Icing and Effects of Fluid Residues on Flight Controls")

Intake icing occurs when snow or slush enters during low-power engine operations, such as taxiing after landing or prior to takeoff, and accumulates. Relatively long, curved intake ducts are particularly prone to this phenomenon. It is most likely to occur during heavy snow or rain at temperatures close to 0C before and after engine start. Also, in some cases, accumulation will not take place until after engine start. Then the consequences only become evident when applying power for takeoff.

These accumulations may be unaffected by the use of engine anti-icing, especially when turbofans are operated at or close to ground idle rpm. Intake duct deposits and engine blade deposits may detach and be ingested during the subsequent application of high power settings for takeoff, resulting in adverse effects on engine operation and possible flameout.

According to Andy Mihalchik, technical pilot and program manager at GE Aviation, if flight or maintenance personnel note ice or snow on an engine's spinner with little or a thin layer of ice/snow visible on the fan blades, they should conduct a ground ice shed procedure.

If the preflight inspection reveals ice or snow on the spinner and a heavy accumulation on the fan blades, confer with maintenance techs about the necessity to deice the engine prior to start. Not to be confused with engine anti-icing, engine deicing involves placing engine-specific coverings on the unit and then piping hot air in. If deicing is not an option, put the aircraft in a heated hangar. Spraying aircraft deicing fluid into the engine is *not* approved because it reduces engine efficiency and corrodes the hardware. In addition, deicing fluids can cause contamination of the bleed air system.

Engine anti-ice must be selected ON immediately after both engines are started and must remain on during all ground operations when icing conditions exist or are anticipated. Most manufacturers recommend the use of engine anti-ice during ground operations when the OAT is 10C or less and visible moisture is present. When air is sucked into the engines there is a venturi effect that will decrease temperature. Thus, it is possible to get ice accumulation within the engine's inlet at 10C. Boeing advises pilots not to rely on airframe visual icing cues before activating engine anti-ice. And since engine anti-ice extracts a performance penalty from the engine's thrust, don't forget to apply the necessary corrections stipulated in the aircraft's flight manual to takeoff and climb performance.

Engine anti-ice systems are designed primarily to deter the accumulation of ice on the nacelle intake, leaving the fan blades susceptible to ice accumulation in freezing fog or precipitation when the engine is at or near its ground idle speed. That ice must be removed by engine run-ups prior to takeoff.

ALEXEY LESIK/ISTOCK PHOTO

Ground ice shed procedures usually contain an acceleration of the engine rpm to a minimum thrust setting and then a dwell time at that setting. The acceleration increases centrifugal forces and slightly flexes the fan blades, resulting in mechanical shedding of ice. The dwell time contributes to the thermo-mechanical shedding process involving increased fan airflow temperatures and pressures. Asymmetric fan ice shedding may cause momentary increases in perceived and indicated engine vibration but it should return to normal levels as fan ice departs.

During severe icing conditions; freezing fog, rain or drizzle; or heavy snow, repeating the ice shed procedure at 10-min. intervals may reduce fan ice accumulation. Avoid doing the procedure in areas with loose ice and snow to minimize the FOD potential or in a location where the jet blast could damage other aircraft or nearby structures. Also, don't forget that ice contamination of engine probes can cause erroneous instrument readings.

Carbon Brakes in Slush

Slush on ramps and taxiways can also affect aircraft tires and brake assemblies.

Conditions at Spain's Pamplona Airport (PNA) were "messy" when the Bombardier CRJ-1000 crew arrived for their scheduled flight to Madrid on Feb. 1, 2015. The airport was initially closed for snow removal. But even after it was reopened, the snow continued moderately. When the snowfall finally ceased

Airframe and brake manufacturers have learned that various chemicals used to deice ramps and runways can cause oxidation of those brakes.

temporarily, the flight crew used Type 1 deicing fluid and then slowly taxied the short distance to the runway threshold. There was enough slush present on the runway that snow-clearing vehicles had left tracks, but the pilots were able to see through the build-up of slush.

The subsequent flight to Madrid was uneventful — until touchdown. With wheels on pavement, the aircraft began vibrating so hard, the pilots believed a tire had ruptured. Accordingly, they minimized use of the brakes and reported no problems with directional control during the rest of the landing roll or subsequent taxi. An airport

COOLIMAGESCO/ISTOCK PHOTO

If you are unable to obtain such shelter and winter precipitation is expected overnight, anticipate having a cold-soaked aircraft in the morning as well as contamination on the airframe.

marshaller noticed that the outboard left tire had burst. Once the aircraft was parked, inspection revealed that the right outboard tire had a flat spot and chunks of white ice were stuck to the brake assemblies. The trailing edge of the inboard left flap and flap fairs were damaged, and a gear bay door had broken from its fittings. The airport authority conducted an inspection of the runway and found tire debris and part of the gear door.

FDR data determined that the two outboard tires did not turn. Unlike the CRJ-900s in the Air Nostrum fleet, which are equipped with steel brakes, those on the CRJ-1000 series are carbon. At the post-incident interview, both pilots admitted that they were more concerned about the possibility of ice on the wings and had not conducted the prescribed braking activations during the taxi because the distance was so short.

Furthermore, the pilots were unaware of the porosity of carbon brakes and the implications of this characteristic. Such brakes absorb moisture more readily when cold, which means that the brake units are more susceptible to freezing after taxiing/takeoff/landing with frozen deposits on the surface. When the wheel assemblies are retracted after takeoff and they are exposed to the cold temperatures and reduced air pressure at higher altitudes, the contaminating liquid is spread even farther into the space between the rotors and stators, and can lock the brakes.

The Comisión de Investigación de Accidentes e Incidentes de Aviación Civil determined the primary cause for the incident as follows: "Part of the slush encountered while taxiing and during the subsequent takeoff run is thought to have made its way into the landing gear bays, adhering to the components there. When the gear was retracted, wheels No. 1 and No. 4 [the outboard wheels] were in a lower position and thus more exposed to low temperatures during the flight. As a result, the slush deposited on the gear could have fallen due to gravity to the brake assemblies before freezing in place."

The flight crew operating manual contained a number of precautions for winter operations. When using wet, snow- or slush-covered runways or taxiways, or following overnight parking in known icing conditions, use light braking techniques to warm brakes while taxiing to takeoff and monitor the brake temperature while doing so. Then delay gear retraction following takeoff from slush- or snow-covered runways. And when touching down, carry out a positive landing to ensure initial wheel spin-up and brake-out of frozen brakes. During the landing roll and subsequent taxi, use the brakes to prevent progressive build-up of ice on the wheels and brakes. Following takeoff or landing on wet, snow- or slush-covered runways and taxiways, tires should be inspected for flat spotting prior to the next flight.

Carbon Brake Maintenance

Now that carbon brakes are standard on many types of aircraft, the airframe and brake manufacturers have learned that various chemicals used to deice ramps and runways can cause oxidation of those brakes in addition to corroding electrical connectors and hydraulic system components.

Ever since the 1990s, runway deicing materials containing potassium and sodium have been used as an alternative to those with urea and glycol. It was necessary to find alternatives to those chemicals due to the damage they create in nearby water systems and the toxic threat they pose to aquatic life. Following the introduction of the new runway deicers, aircraft operators began experiencing catalytic oxidation of the carbon-brake heat-sink disks. As a result, the FAA issued Special Airworthiness Information Bulletin NM-08-27 and EASA published Safety Information Notice 2008-19R1 recommending that the main gear wheel removal/installation sections of applicable aircraft maintenance manuals be revised to include inspection of the carbon brake assembly for signs of catalytic oxidation damage whenever a wheel and tire assembly is removed.

Beware of Frozen Liquids


BAONA/ISTOCK PHOTO

If an aircraft is to remain overnight with air temperatures dropping well below freezing, it's important to remove any liquids that could freeze, burst their containers and then, upon thawing, flow into unprotected areas and parts. This especially pertains to the water lines in the lav. If the pipes break, the water will seep into the aircraft's underbelly, and that's a concern.

On May 9, 2007, a Dassault Falcon 20 was descending toward London after a flight from Gander, Canada, when a lateral flight control restriction became apparent. The problem first appeared about 2 hr. into the flight when the pilots noticed a flickering aileron TRIM notice on the PFD. The captain applied corrective trim, but the warning indication reappeared. During descent the flight control problem worsened. While in a left turn, the bank angle continued to increase and when it reached 45 deg., the captain disconnected the autopilot with the intention of flying manually.

However, upon doing so he found that roll control was very stiff when rolling to the right. He used rudder to bring the aircraft to a wings-level attitude. Both pilots then applied full force to both control wheels in an attempt to recover lateral control, but no movement was possible. The captain was only able to make turns through the gentle use of rudder. Accordingly, he restricted the bank angle to a maximum of 10 deg. The pilots notified ATC that they had a jammed flight control and were unable to do turns to the right and were only able to make shallow left turns. Turbulent crosswind conditions were a concern, but due to some apparently extraordinary airmanship, the pilots landed their compromised jet safely at London Stansted Airport (STN) and all seven aircraft occupants exited without injury.

During taxi-out, avoid using reverse thrust on snow- or slush-covered runways, taxiways or ramps unless absolutely necessary since doing so can cause slush, water and runway deicers to become airborne and adhere to wing surfaces.

During the following investigation, a significant volume of water (at least 20 liters) was discovered below the floor panels in the forward fuselage; the water had frozen in flight and caused a restriction to the movement of the aileron trim actuator.

The U.K. AAIB Bulletin 2/2008 said the water in aircraft bilges could have come from a variety of sources: Leaking plumbing, condensation and leaking seals are the most common. It seems likely that the water in the Falcon must have built up in the fuselage over a period of time.

However, Dassault believed a more likely source of the water in question was leakage in the area of the icebox drain over an extended period. The manufacturer had received notification of three previous events similar in nature to that experienced by this Falcon 20 crew. To prevent this problem from recurring, operators were reminded that drains must be checked during daily aircraft inspection, as well as checking both manual and automatic drains.

Ramp and Taxi Precautions

Wintertime aprons and ramps can be slick and the equipment and personnel

Cold Weather Limitations on Systems

If the aircraft has been cold-soaked, then its battery may need to be warmed to a minimum specified temperature prior to start. And if you know the aircraft is going to experience a cold soaking, remove the battery and store it in a warm place.

Frigid flight-deck avionics may require a warm up of up to 30 min. On the ground, the APU will accomplish this task more rapidly than the engines. However, if the APU is inoperative, then the engines will need to be at a mid-range N-2 value in order to provide enough hot air through the bleed-air system. You must ensure that the instruments are operating properly.

In extremely cold temperatures, fuel solubility is reduced and will super-cool any water in the fuel. Your maintenance technician should drain the tank and fuel filter drains frequently. If the drain becomes blocked, it is probably because of ice formation.

When possible, arrange for aircraft to be hangared. If you are unable to obtain such shelter and winter precipitation is expected overnight, anticipate having a cold-soaked aircraft in the morning as well as contamination on the airframe. If you anticipate that aircraft deicing may be required, you should inquire of the FBO on its availability. These issues could impact your next morning's departure.

Engine inlet and exhaust covers and pitot tube covers should be installed on overnight stops to protect against the unwanted accumulation of frozen precipitation. BCA operating thereupon can lack sufficient traction to start, stop or even remain in place when encountering jet blast from surrounding airplanes.

Pilots of parked or holding airplanes might use increased engine thrust to get moving or taxi over surface irregularities like frozen ruts formed by tire tracks. In so doing, excessive engine blast may damage other airplanes, equipment or even harm personnel.

The fact is wet snow cannot be blown off the pavement; rather it will readily compact and bond to the surface when run over by airplane wheels. Consequently, the airport operator needs to implement different clearing or preventive measures for wet snow than those used for dealing with dry snow. Wet snow and temperatures close to freezing can result in slush. Large chunks of ice, from refrozen snow or slush, or deposits from aircraft gear created during landings, can cause severe damage to tires, engines and airframes.

According to FAA Advisory Circular 150/5200-30D, "Airport Field Condition Assessments and Winter Operations Safety," dated March 8, 2017, there are situations where complete removal is difficult or impossible to achieve within a certain timespan. It may require an hour or more for the dry chemical to go into solution and melt the ice.

The obscuration of normally visible surface markings or obliterated signs could make maneuvering on aprons difficult. It also increases the chances of taxiway or runway incursions. And snow piles that aren't located far enough from the taxiway can create additional wingtip hazards.

Accordingly, allowing greater than normal distances between airplanes while taxiing will aid in stopping and turning in slippery conditions. Doing so will also reduce the potential for snow and slush being blown and adhering onto the airplane or engine inlets.

Taxi at a reduced speed since proceeding at excessive speed or with strong crosswinds may cause the airplane to skid. Use smaller nosewheel steering and rudder inputs.

Limit thrust to the minimum required. Use of differential engine thrust assists in maintaining airplane momentum through a turn. When nearing turn completion, placing both engines at idle thrust reduces the potential for nosewheel skidding. Differential braking may be more effective than nosewheel steering on slippery or contaminated surfaces. Nosewheel steering should be exercised in both directions during taxi. This circulates warm hydraulic fluid through the steering cylinders and minimizes the steering lag caused by low temperatures.

During taxi-out, avoid using reverse thrust on snow- or slush-covered runways, taxiways or ramps unless absolutely necessary since doing so can cause slush, water and runway deicers to become airborne and adhere to wing surfaces.

Before brake release, check for stable engine operation. After setting takeoff engine pressure ratio (EPR), or N1, confirm that engine indications are normal, in agreement and in the expected range. Check that other flight deck indications are also normal.

By no means does this article address all of the threats to an aircraft during winter ground operations. Following the recommendations within your aircraft operating manuals is always prudent, but as you can see from these examples, there are a number of threats that have been discovered only through incident reports.

Winter ground conditions create additional workload requiring time and attention to properly identify and manage these threats. So, stay warm and be careful out there. **BCA**

JETLINERIMAGES/ISTOCK PHOTO

Gulfstream G500

A step change **in aircraft design**

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

Gulfstream G500 operators live in a 500+ kt. world where few, if any, competitive aircraft can catch them. They tell *BCA* they only slow down to Mach 0.85 cruise when they need to stretch range to the maximum. And many say their normal cruise speed is Mach 0.90, equivalent to 516 KTAS in ISA conditions above the tropopause, even faster at lower altitudes where it's warmer.

Many of these operators stepped up from the GIV series, aircraft with smaller cabins that are 30 kt. slower, lower flying and considerably more fuel-thirsty. Some changed over from older Dassault Falcons and Bombardier Challenger aircraft, saying they chose the G500 because of its higher cruise speeds and more modern systems.

"We're in Falcon Country," says Ole Christiansen, CEO of Blackbird Air Charter in Billund, Denmark. However, the firm is selling its Falcon 2000S because the operator needs more range and speed. Says Christiansen, "Our owner is a pilot who believes time is of the essence." His first choice was the Bombardier Global 7000 (now Global 7500), but the delivery slot was delayed due to snags in the certification process. Christiansen noted that all new Falcons achieve better fuel efficiency at Mach 0.80 than the G500 does at Mach 0.85.

"We asked Gulfstream to show us the G500's fuel efficiency when slowed to Mach 0.80. Savannah responded that the aircraft couldn't fly efficiently at such a slow speed. At that point, our owner was sold on [the G500]," says Christiansen. He says his firm typically flies the G500 at Mach 0.87 on trips

► ASK FRED

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

GULFSTREAM

Relatively trouble-free entry-into-service since 2018, G500 flies higher, faster, quieter, farther, more fuel efficiently and more comfortably that its predecessor, the G450.

between Denmark and the United Arab Emirates or Africa. Often, the owner pushes up speed to Mach 0.90 if fuel reserves are not a concern.

Stepping up to the G500 was a normal progression in the Gulfstream family for Houston-based Service Corporation International (SCI), says flight department manager Mike Wilson. SCI most recently operated three G450s. Wilson says the new aircraft typically cruises at Mach 0.90, matching the G450's specific range performance at Mach 0.84. He only slows down to Mach 0.85 for the occasional transatlantic mission between South Texas and Europe.

A senior pilot for another Texas firm that operates three G500s for a high-net-worth individual, says he usually flies at Mach 0.90 in the low to mid-thirties, where warmer OATs yield 515 to 523 KTAS cruise speeds. "Our principal formerly owned Falcons," he says. The G500 affords this owner 35- to 40-kt. higher cruise speeds, albeit with higher fuel consumption than the French fuel misers cruising at slower speeds.

"We looked at the Global 5000, but it was too heavy and too fuel-thirsty," says a flight department manager who is based in the Northeast U.S. "We had a Falcon 7X on order, but it was delayed. Then, we became a U.S. launch customer for the Falcon 5X, but that program was canceled. And, deep down, we always knew we wanted a Gulfstream." The firm bought a 2018 G500 that it uses primarily for transcontinental U.S. missions flown at Mach 0.90.

Bob Snyder, who flies for Sedgwick Azure of Memphis, Tennessee, says that his firm, during its new aircraft search, looked at the older G550, Global 6000 and Falcon 7X. "However, our CEO likes the latest technology, especially safety technologies and active side-stick controls." High tech, as well as high cruise speed, sold Sedgwick on the G500, says Snyder. On trips up to 4,500 nm, Snyder pushes up speed to Mach 0.90. He admits he initially slowed down to Mach 0.88 for one trip from Milan to Jacksonville, Florida, because of headwinds. But later, when fuel reserves proved fat, he pushed back up to Mach 0.90.

Who Owns a G500? How Do They Fly?

There now are close to 50 G500s in service. About two-thirds of the fleet is registered in the U.S., with ownership split between corporations and private individuals. Oil and gas exploration firms, Sentry Insurance, Van Tuyl Group and Enterprise Holdings, plus Eli Lilly, Rooney Holdings, Data Management Products and a few commercial finance firms are among the corporate operators. One U.S.-registered aircraft is physically based in Moscow with Avangard Aviation and another N-registered G500 is based at Montreal Pierre E. Trudeau International Airport at Dorval, Quebec, with Nova Steel.

Five G500s are flown by Doha-based Qatar Executive, the Middle East launch customer for the model. The operator has three more G500s slated for delivery, part of a billion-dollar Gulfstream jet order inked in 2019.

Three G500s are based in Russia and single aircraft are based in Austria and Switzerland. A few are carefully cloaked in the Cayman Islands, Malta and Isle of Man registry for very-low-profile private owners.

All but a few survey respondents say their aircraft are outfitted with forward galleys. The three-section cabins typically are configured with a forward,

GULFSTREAM

The G500, the smaller of the GVII siblings, introduces new systems and avionics technologies for future Gulfstreams, such as G700.

Most G500s have forward galleys, plus cabin sections. If buyers opt for the aft galley, they should be aware of an aft shift in the center of gravity that may require ballast in the nose.

four-chair section; a four-seat conference grouping, either flanked by two facing chairs or a credenza in mid-cabin; and an aft private stateroom with a divan on one side and one or two chairs on the other side. Aircraft with aft galleys tend to be tail heavy. Some even require ballast in the nose to keep the aircraft in the allowable CG range when ferrying with crew only and light fuel loads.

As expected, corporate fleet operators fly two to three times as many annual hours as small flight departments supporting individuals or family businesses. Yearly utilization ranged from 250 to 700 hr. among respondents to this survey prior to this year's downturn due to COVID-19. Operators tell BCA that aircraft utilization has declined by as much as 75%. Average flight time is just 2 hr.

"We normally fly 600 to 700 hr. I doubt we'll fly more than 250 hr. this year," says Sedgwick's Snyder. The fleet has accumulated more than 12,500 hr. of total flight time, but the average annual utilization now is only 187 hr. per aircraft, according to Gulfstream Aerospace.

Most respondents say they would be comfortable flying the aircraft 5,000 nm to 5,200 nm. The longest missions have spanned 10.0 to 10.5 hr. That's sufficient to fly from London to Los Angeles, Beijing or Tokyo, from New York to Bueno Aires, Cairo or Lagos, or from Moscow to Dallas, Seattle or New York.

Some cap max range at 4,400 nm to 4,500 nm, but that's because they're pushing up cruise speed to Mach 0.88 to 0.90. That's London to Seattle, Tokyo to Los Angeles, or Dallas to Paris at nine-tenths the speed of sound.

Those numbers, though, are predicated on keeping aircraft empty weight in check. Gulfstream says a *BCA*-equipped G500 weighs in at 46,850 lb. Most respondents told us their aircraft tip the scales at 47,000 lb. to 47,400 lb.

Anticipating that customers would load up their aircraft with hefty options, Gulfstream bumped up maximum ramp and takeoff weights by 2,750 lb. during late-stage development. The weight increases assure that even very-well-equipped airplanes still can carry 10 to 11 passengers with full fuel.

What Operators Praise, What They Pan

Exceptional performance tops the five favorite features list for most respondents. The G500 has the sportiest thrust-to-weight ratio of any aircraft in its class, enabling it climb through FL 370 in 15 min. and level-off at FL 430.

It also cruises efficiently at 488 to 500 KTAS. Operators ballpark fuel consumption at 3,000 lb. to 3,200 lb. for the first hour and 2,500 lb./hr. for subsequent hours. Scott Farrar at Eli Lilly says his two G500s burn 30% less fuel than the GIV-series aircraft they replaced.

Cabin comfort, quiet and high pressurization rank high with operators. "It's a big jump up from the GIV," says Farrar. The cabin cross-section is a squared oval, rather than circular shape of first-generation Gulfstream jets. It's 7 in. wider and 2 in. higher than the GIV. The 10.69-psi pressurization system provides a cabin altitude about 2,500 ft. lower than the GIV at the same cruise altitude. At FL 510, the aircraft's maximum certified altitude, G500 cabin altitude is 4,850 ft. Lower cabin altitude results in reduced

Typical floor plan features a four-chair club section up front, four-seat conference grouping in mid-cabin and aft-cabin staterooms, usually closed off by a bulkhead and door (not shown). Symmetry flight deck, powered by Honeywell Epic, features ten touchscreen controls and standard HUD with EVS. The G500 introduces active sidesticks to business aviation.

GULFSTREAM (3)

air-travel fatigue for passengers. "It's a night and day difference for passengers," says Farrar.

Cabin window size is another popular feature. The wide oval windows are adapted from the G650, so they're 16% larger in area than on legacy Gulfstream models.

Gulfstream's Symmetry flight deck, powered by Honeywell Primus Epic, received plaudits because of systems integration and shortened checklists. Christiansen, for instance, says his crews can go from dark cockpit to taxi in 7 to 10 min. *BCA* Contributor James Albright, who flies a G500 based in the Northeast U.S., says checklists are easy, the touchscreen controls are intuitive and they provide multiple ways of entering data.

Some pilots said they experienced a steep learning curve in making the transition between early Gulfstream cockpits and the radically changed Symmetry flight deck. The G500 has 10 touchscreen controls, including three on the overhead panel, that control and display avionics and systems functions with left/right, up/down swiping motions, plus press and release positive-action soft buttons. The touchscreen feel is far different than that of consumer electronic devices because Gulfstream engineers wanted to make sure they weren't prone to inadvertent actuation. It takes practice to adjust one's touch, hold and release technique to make the system work as intended, they say.

Overall, Symmetry, the sidestick controls and the digital flight control system received high marks. "The fly-by-wire flight controls are amazing," says Hangar One's Joe Statt, who flies a G500 based at Scottsdale, Arizona. "It's fun to fly, a pilot's airplane. It's also super-efficient for its size and speed." He says he flew the aircraft from Wilmington, Delaware, to Kona, Hawaii, in 9.5 hr. and had plenty of fuel to spare.

"I appreciate the increased room on the flight deck because of the sidesticks," says Hector Moctezuma, who flies for Franklin Mountain Assets. "We also like the aesthetics, the ramp presence. It looks like a baby G650."

The G500 has had a relatively trouble-free entry-into-service period, operators say. But it has had its share of early teething pains with serial number units. Ice shedding from the fan spinners of the Pratt & Whitney Canada PW814GA engines, for example, has both alarmed some passengers and caused minor damage to the engine inlet fan ducts. Early aircraft lacked a takeoff and landing (TOLD) V speed and distance calculation function. A few operators report BIT check failures of the BAe active sidesticks that can ground the aircraft.

A few early serial number operators have experienced multiple AOG squawks, usually related to the same components. Many of these problems

The aft stateroom typically has a sofa sleeper that converts into double bed. Most layouts feature a hard bulkhead that provides privacy, but not in this aircraft.

GULFSTREAM

GULFSTREAM

All G500s have forward and aft lavatories with a high-capacity vacuum waste system.

appear to be related to operating system software. The G500 is the most sophisticated, integrated business aircraft yet built by the firm.

Gulfstream also was caught up in the FAA's considerably tougher certification gauntlet that was put into place in the wake of the Boeing 737 MAX accident inquiries. It took several months, for instance, to earn approval for using Type IV deicing fluid, including adding a requirement to operate the wing anti-ice system for at least 4 min., but no longer than 20 min., before takeoff.

As Albright notes at his Code 7700 website, many of the shortcomings were corrected with the mid-2020 Block 1 improvement package, including ASC 022, which includes a heavier, redesigned fan spinner to shed ice more efficiently, plus a new N1 shaft front bearing. In addition, there's revised FADEC software, ASC 901, that updates the Symmetry software package; ASC 01A, which adds TOLD computations; and ASC 025, which updates the fuel quantity management system. Block 1 essentially contains all the improvements wrapped into the G600 entry-into-service hardware and software package.

Other areas needing improvement are not addressed by the Block 1 package. Among these are an automatic acoustical curtain stow feature that slams open the door when flaps are selected to 10 deg. or greater on approach, thereby disturbing passengers. Next, the preselect refuel quantity shuts off prematurely during refilling, unless the APU or external power is powering the IRSes. It's also difficult to build a VFR approach into the FMS to a runway not served by an instrument approach. The flight guidance system and autothrottle have no coupled one-engine-inoperative go-around capability. The autobrake system is very smooth and powerful, but it lacks a brake-to-vacate at a specified taxiway intersection function.

A few early serial number airplanes had interior completion quality control issues and minor exterior paint peeling.

G500 autothrottle operation is somewhat of an art form because of the initial engagement criteria on takeoff roll, says Albright. The engines often spool up at different rates and there may be an rpm split when both throttles are pushed up to the same angle. To engage, the throttles have to be advanced to at least 19 deg. and the split in engine rpm may not exceed 10%. For instance, if the left engine tach reads 45%, the right engine tach must be within 4.5% (10% of the split) of the left.

Yet, a large majority of operators praised Gulfstream for its customer support and AOG response. SCI's Wilson said he was stuck in Grand Junction, Colorado, with an AOG problem. Gulfstream dispatched its Field and Airborne Support Team (FAST) from Long Beach, California, and had Wilson's aircraft in airworthy condition in several hours. Christiansen and Snyder were just as enthusiastic about support from the Savannah, Georgia, manufacturer, listing it among their five favorite features. Albright says his aircraft was AOG with a throttle quadrant snag. Gulfstream had a replacement part delivered to his hangar in less than 24 hr. Farrar said Eli Lilly has experienced next-day parts deliveries as well.

Some operators, though, say that Gulfstream's product support specialists are hard to reach. They say Dassault now provides better customer support for its Falcon Jets.

FlightSafety International, the sole provider of initial and recurrent training for the G500 and G600, received positive mention. Some early class students said that its instructors struggled to answer complex questions about the aircraft. Others acknowledged that everybody experienced a sharp-edged learning experience in the early weeks of the program.

On Balance

Operators say they're confident that Gulfstream will continue to make improvements to the aircraft to increase operating flexibility and utility. As Albright notes, minimum OAT for engine start has been decreased from -20C to -40C; restrictions for using autothrottle for takeoff have been relaxed; the aft lav baggage door now may remain open up to 45,000 ft., a 5,000-ft. increase; some checklists have been even more streamlined; weather radar and brake temp checks are no longer required; and some non-essential advisory CAS messages have been eliminated.

Gulfstream officials fully appreciate that the G500 represents more than just a new model. It's a step change in aircraft design that's the basis for the new G700 flagship and other unannounced models in the pipeline. Thus, they're committed to ironing out the G500's wrinkles. And it appears they're succeeding.

"We're diehard Gulfstream fans," says Albright, whose firm flew the GIV and G450 prior to acquiring its G500. "We couldn't be happier," says Farrar. "We love this aircraft," says Christiansen. With comments such as these, the G500 is off to a strong start. BCA

Flying Petri Dish

Aircraft can **accelerate the spread of disease**

ANDRESR/ISTOCK PHOTO

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

As pilots, we regard aircraft as technological marvels, but infectious disease specialists and epidemiologists have quite a different view. To them the growing mobility of people via air transport has amplified the potential for rapid dissemination of disease. For confirmation we need only look at the current COVID-19 pandemic to understand the potential magnitude.

What is the actual risk of getting sick when traveling by air? Joseph Allen, an assistant professor at Harvard's School of Public Health, notes many factors including time in terminals, hotels and security queues; changing time zones; and lack of sleep negatively impact a body's immune system. Was your seat's previous occupant a disease carrier?

And being seated at the very front of an aircraft does not shield crews from exposure. Consider what lurks within the oxygen mask or the composition and handling of what's on the food tray.

The fact is aircraft cabins and cockpits are prime environments for disease. The four routes for the spread of microorganisms on an aircraft are contact, airborne, common vehicle and vector-borne.

Contact transmission involves direct body-to-body contact, or indirect in which a person comes into contact with a contaminated particle. As we have learned from COVID, diseases can be transmitted when an infected person sneezes, coughs or talks, propelling droplets that can remain suspended in the air for sufficient time periods and travel distances to infect others nearby.

Airborne transmission happens by aerosolization of an infectious agent from large droplets that have evaporated into smaller droplets (less than 5 microns) and disperse widely. Depending on environmental conditions, aerosolized droplets can remain suspected in the air for indefinite time periods.

According to Drs. Alexandra Mangili of the Division of Geographic Medicine and Infectious Diseases at Tufts Medical Center and Mark A. Gendreau of the Lahey Hospital and Medical Center, large droplet and airborne mechanisms probably represent the greatest risk for passengers within the aircraft cabin because of the high density and close proximity of those travelers. Documented cases of airborne infectious transmission aboard a commercial airliner include tuberculosis, severe acute respiratory syndrome (SARS), influenza and measles.

There are other methods that can make ourselves and our passengers sick. "Common vehicle transmission" is typically caused by microorganisms that are spread by food and water. Examples include salmonellosis and staphylococcus. Vector-borne transmission results from the spread of disease by insects and vermin. The most common example that is documented is malaria.

Resources Available to Aircraft Managers

A number of documents specifically for the air transport industry addressing the prevention of disease transmission include "Preventing Spread of Disease on Commercial Aircraft: Guidance for Cabin Crew" by the U.S. Centers for Disease Control and Prevention (**bit.ly/CDC_GuidanceCabinCrew**) and "Transmission of Communicable Diseases on Aircraft" by the World Health Organization. BCA

Cabin Air Transmission

The aircraft cabin is an enclosed environment that exposes passengers to hypobaric hypoxia, dry humidity and each other. The outside air passed through bleed valves into the aircraft's ventilation system is sterile at cruising altitudes. Typical systems flow air into the cabin through the overhead, whereupon it circulates across the cabin and then exits near the cabin floor. Little front-to-back airflow occurs, which limits the spread of airborne particles throughout the space.

Business aviation crews and passengers tend to spend a lot of time on airliners. Consequently, it's worth knowing that many of those aircraft recirculate 50% of the air delivered to the cabin for improved control of cabin circulation, humidity and fuel efficiency. This recirculated air usually passes through high-efficiency particulate air (HEPA) filters before delivery into the cabin. Normal airline cabin air-exchange rates vary from 15 to 20 changes per hour, compared with 12 changes per hour for a typical office building. Properly maintained HEPA filters remove dust, vapors, bacteria, fungi and viral particles.

Because the aircraft cabin is enclosed and flights can be hours long, there is the risk of a contagion among passengers. And while the risk is much greater for those sitting near a passenger with an illness, diseases spread through airborne routes can infect those sitting rows away.

Airborne transmission involves droplets exhaled by an infected person that are dispersed through the cabin and inhaled by others nearby. The dispersion depends in part upon the airflow as well as the force of the exhalation, with a coughing passenger spreading the infected droplets farther than when simply breathing or talking.

The swine flu epidemic in 2009 caused concern due to transmission among air travelers through direct contact, indirect contact, droplets and/or airborne routes. Epidemiologists determined that transmissions spread

EXTREME-PHOTOGRAPHER/ISTOCK PHOTO

to passengers rows away from the infected person, thus indicating the potential for airborne spread.

SARS may seem like a distant memory, but it actually was our first experience this century with a coronavirus that was widely spread by air travelers. Post-incident evaluation of 40 flights carrying SARS-infected passengers has led epidemiologists to believe that the disease was spread by airborne small droplets. A "superspreading event" occurred on March 15, 2003, aboard a 3-hr. flight from Hong Kong to Beijing with 120 passengers aboard. The evidence shows that 37 of those people showed symptoms of SARS after the flight. Laboratories were able to confirm SARS coronavirus infection in 16 passengers, while two were probables and four were reported to have the syndrome but could not be interviewed. Epidemiologists believe that more than 300 people were subsequently infected by these passengers.

Jitendra K. Gupta, Ph.D. of Purdue University's School of Mechanical Engineering, Chao-Hsin Lin, Ph.D. of the Environmental Control Systems Division of Boeing Commercial Airplanes and Qingyan Chen of Tianjin University's School of Environmental Science and Engineering conducted a study on the risk of airborne infectious disease transmission in aircraft cabins. They evaluated a condition in which a passenger infected with the flu is sitting in the center of a twin-aisle, fully occupied airliner for 4 hr. Employing computational fluid dynamics, they computed the effects of small versus large droplets being trapped by masks of varying weave thickness, whether the infected person was gently coughing or sneezing, the inhalation differences among passengers, their proximity to the infected passenger, and the airflow differences within the cabin.

And their findings? Passengers seated near the infected person inhaled high doses of the influenza infectants. The airflow then caused droplets to move rearward and toward the window. Thus, the dose inhaled by passengers sitting at the window seat behind the sick passenger was high.

Simply breathing the ejected droplets doesn't ensure that a passenger will become sick. The infection probability is proportional to the amount of

About Shared O_2 Masks

Pilot oxygen masks should be kept clean to reduce the danger of infection and to prolong their lives. Various mild cleaners and antiseptics that are free of petroleum products can be used.

Whether in an actual aircraft or a simulator, the standard practice in this industry is for the sharing of oxygen masks. With that in mind, is the so-called "swabbing" of the mask sufficient? Public health specialists are concerned that gaps in the process could expose pilots to an increased risk for contracting transmissible disease. The inherent inability of the oxygen mask to be properly disassembled and cleaned between users raises the risk of exposure. After all, other pilots could harbor a virus or life-threatening bacterial infection without exhibiting symptoms. And some pathogens can live for weeks on the hard surfaces within the mask during the disease's incubation period and be unknowingly transferred to the next user.

An educational letter from the Air Line Pilots Association informs its members that the inside of the mask supply hose is an oxygen-rich, dark, moist environment that is conducive to significant bacteria growth. Inspections of those hoses have found a loose powder coating on the inside that can be forced into the lungs. Moreover, the supply hoses are never cleaned once installed on an aircraft and that is an unsanitary lapse.

Dr. Nancy Burton, leader of the Industrial Hygiene Team Hazard Evaluations and Technical Assistance Branch of the National Institute for Occupational Safety and Health, points out that all other respiratory devices with multiple users must follow a six-step disassembly and disinfection process after each time they are used. The respirators must be disassembled and immersed in a disinfectant solution in order to reach all crevices.

"The ideal solution would be to redesign the oxygen masks to have removable microphones that can be cleaned separately, and then the oxygen masks can be cleaned in the same manner as respirators," she notes. "In the interim, they should be thoroughly washed with soap and water and then wiped down with a disinfectant recommended by the manufacturer before donning." Currently, aviation oxygen masks cannot be disassembled, which leaves our industry in an exposed condition.

In order to reduce the spread of viral and bacterial agents in the workplace, the importance of hand washing, staying home when ill and covering one's nose and mouth during sneezing/coughing needs to be stressed in pilot training programs. While ideal, out in the real world there are complicating factors. It is entirely possible for a pilot to report for duty feeling well and not begin to show adverse symptoms until well into the flight. And, of course, there are economic considerations as well. A pilot who doesn't report for a flight might suffer a decreased paycheck and thus has economic incentive to report for duty even when sick.

A supply of individually wrapped alcohol wipes is often kept in cockpits for flight crews to wipe the inside of masks for sanitary purposes. But don't be lulled into thinking this is sufficient. In order to effectively kill infectants it is necessary to immerse the mask in a wet solution for an adequate time period. But the microphone where respiratory fluids accumulate and the inside of the oxygen supply hose are completely inaccessible to the disinfectant. Moreover, wipes are less effective against certain types of bacteria and there is concern that they could merely spread pathogens to a wider area when being used.

Further details on this issue can be obtained from "Air Line Pilots Association White Paper: Oxygen Mask Use in Aviation" (**bit.ly/Alpha_AviationOxygenMaskUse**). **BCA**

IZUSEK/ISTOCK PHOTO

Being seated at the very front of an aircraft does not shield crews from exposure — consider what lurks within the oxygen mask.

influenza inhaled, and also depends on the strength of one's immune system.

They also determined that N-95 respirator masks can provide a protection factor of 10. In other words, wearing such a mask would protect a passenger by reducing the amount of inhaled virus particles to one-tenth of that without a mask. If the infected passenger is also wearing a mask, the amount would be even lower.

Surface Contamination

Dangerous bacteria can survive for days on surfaces, particularly porous material such as armrests and seat-back pockets, along with tray tables, window shades and metal lavatory buttons. Kiril Vaglenov, a graduate student in Auburn University's Department of Biological Sciences, helped lead researchers in a two-year study funded through the FAA's Airliner Cabin Environmental Research Center to determine how long E. coli O157:H7 and methicillin-resistant staphylococcus aureus, or MRSA, would survive on commonly touched cabin surfaces. They even used simulated sweat and saliva since body fluids would affect the survivability and transmission (because of the pH) of a pathogen.

"Our data show that both of these bacteria can survive for days on these surfaces," said Vaglenov. MRSA survived the longest — 168 hr. — on material from the seat-back pocket, while E. coli lived for 96 hr. on the armrest material.

"The point of this study is not to be alarmist, but to point out to the airlines the importance of providing a sanitary environment for travelers," said professor Jim Barbaree, director of the study and Vaglenov's mentor. "We want to work with them to minimize the risks to human health."

Consumption Considerations

Food or water-borne sicknesses manifested during flight can disable a person to the extent where a medical divert might be warranted. If this happens to a flight crewmember to the point of incapacitation, then the flight's safety is compromised, or worse.

Dr. David G. Newman of the Australian Transport Safety Bureau (ATSB) conducted a study to investigate the prevalence, type, nature and significance of inflight medical conditions and incapacitation of civilian pilots Down Under.

Newman's project reviewed the ATSB databases comprising 8,302 accidents, 95 serious incidents and 151,941 incidents. A "serious incident" is one in which an accident nearly occurred. There were 98 occurrences in which the pilot of an aircraft was incapacitated for medical or physiological reasons.

The study determined that a majority (21%) of inflight medical and incapacitation events were due to acute gastrointestinal illness, and usually food poisoning. This confirmed the findings of other international reports and pilot surveys that gastrointestinal illness is the most-common cause of pilot inflight incapacitation. According to Dr. Robin Wilkening of the Johns Hopkins School of Public Health, pilot surveys indicate acute gastroenteritis accounts for approximately 60% of incapacitation or impairment cases. And a review of the UK Civil Aviation Authority's Mandatory Occurrence Report (MOR) database from 1990 to 1999 for all public transport operations found there were 127 incapacitation events, of which 68 (53%) were gastrointestinal.

These are significant findings for many reasons. Appropriate education programs and preventive strategies can help to reduce the risk of an acute gastrointestinal event. It is important that crew meals are prepared to the highest possible hygiene standards, and that paired pilots receive different meals. However, the risk is not limited to in-flight catering. As Newman points out, in many of the events studied, it was what the pilots ate and drank during layovers or in the preflight period that might have been responsible for the later illness.

Food- or water-borne infections can also occur to passengers, of course. Salmonella has been the most-reported food-borne incident on commercial airliners. A total of 15 incidents between 1947 and 1999 infected 4,000 passengers and resulted in seven deaths. During that time period there were also eight food-poisoning outbreaks caused by staphylococcus. One of the largest cases infected 57% of the passengers who were served a ham omelet on an international flight in 1975.

Cholera from a cold appetizer infected 47 people on a flight from London to Sydney via Singapore in 1972, killing one passenger. During a cholera epidemic in Latin America in 1992, 75 passengers were infected on a flight from Buenos Aires to Los Angeles via Lima. Ten passengers required hospitalization and one died.

Improvements in food handling and inspection and greater use of prepackaged frozen meals in recent years have likely contributed to minimizing the frequency and severity of food- and water-borne outbreaks.

Bad Bugs

Diseases spread by insects are common causes of sickness and death throughout the world. Insects such as mosquitoes can carry deadly diseases including malaria, dengue fever and yellow fever. Mosquitoes imported on aircraft have transmitted malaria to insect populations adjacent to airports. A total of 87 cases of "airport malaria" have been reported, 75 of which happened in Europe. Flies and cockroaches present the greatest hazard because of their feeding habits and the sites that they visit. Insects can hide in the most inaccessible places onboard aircraft and may transfer organisms from their legs and bodies to food and equipment as they move around.

Under the Chicago Convention, which governs international civil aviation, a country could impose a "disinsection"

Reducing Your Own Risk

On a private or business aircraft you have direct control over who will ride onboard, allowing you to screen passengers for illness. So, out of consideration for your own safety, along with that of fellow crewmembers and other company employees who could become infected, passengers with illness should remain on the ground.

On the other hand, if you are a fractional pilot who travels frequently on airliners, your exposure to the spectrum of communicable diseases carried by the general public is substantial.

Joseph Allen, an assistant professor at Harvard's School of Public Health, reiterates evidence-based recommendations that have been scientifically determined to reduce the risk of disease transmission. The air transport industry can reduce the risk of airborne transmission by a factor of 10 if everyone wears a mask that would prevent an infected person from disseminating droplets onto others.

Another effective method of preventing infection is the practice of good personal hygiene. Carry a hand sanitizer and wipe down your seating area. Washing hands will considerably reduce the risk of contamination from hand to face, foodstuffs and other surfaces. The use of appropriate biocide wipes/gels as an alternate method for hand hygiene helps in reducing possible cross-contamination.

Turn on the cabin airflow valve to the highest rate possible and face it directly down. Higher ventilation rates help to decrease the amount of airborne virus. Directing the airflow downward will hasten the movement of infected particles away from your face and toward the floor where it will return to the air system.

Limit your interaction with other passengers because you have no idea if they are infected, especially as we are learning that a relative percentage of persons currently have COVID-19 but are asymptomatic. BCA

BARANOZDEMIR/ISTOCK PHOTO

PHOTOS: EXTREME-PHOTOGRAPHER/ISTOCK PHOTO

The four routes for the spread of microorganisms on an aircraft are contact, airborne, common vehicle and vector-borne.

requirement, which is the use of insecticide for insect and disease control, should it perceive a threat to its public health, agriculture or environment. In order to minimize the risk of importing disease-carrying rodents or insects or pests that might cause crop damage, some countries require cabin disinfection of inbound commercial aircraft in accordance with World Health Organization International Health Regulations. (The U.S. Department of Transportation's "Aircraft Disinsection Requirements" page at **bit.ly/USDOT_AircraftDisinsection** contains a list of the countries.) Operators should ensure that they have adequate pest control measures in place to comply with a country's entry requirements.

Disinfection is frequently done by spraying the cabin with an aerosol before opening the cabin doors at the destination or by applying a residual solution to the aircraft interior that lasts for several months. It is recommended that aircraft traveling from countries with malaria and other vector-borne diseases utilize disinsecting measures. Some countries mandate them. Public health agencies and mosquito abatement districts surrounding international airports now have to be concerned about sampling for these exotic diseases and applying vector control to manage their outbreak.

Summary

The best prevention for the spread of illness is postponement of travel in any public transport by anyone with a contagious disease until the danger has passed.

Mangili and Gendreau said in their March 2005 article in the Lancet scientific journal ("Transmission of Infectious Diseases During Commercial Air Travel"), "SARS exemplifies the ever-present threat of new infectious diseases and the real potential for rapid spread made possible by the volume and speed of air travel. The distribution pattern of SARS transmission aboard the flight emphasizes the need to study airborne transmission patterns aboard commercial aircraft."

The world's economy was sent into a downward spiral in just a month by the outbreak of COVID-19. Nations and states, each acting out of self-interest, instituted various measures, often without coordinating with neighboring entities.

We need to make our businesses and our economy more resilient to these unexpected and deadly threats. COVID-19 will certainly not be the last pandemic the world will face. A harsh lesson from it is that the containment of this disease extracted a tremendous toll by causing mass unemployment and business bankruptcies.

The "new normal" needs to provide layers of protection against biohazards so that the spread of communicable diseases can be managed at low infection levels.

Fortunately, there are emerging technologies that offer effective means to kill pathogens in aircraft. Bio-tech companies are utilizing UV rays and ion-producing machines that are compatible with aircraft materials. Not only do these devices kill COVID-19, they also are effective against a wide range of bacteria and other viruses. In the short term, they offer an effective tool to confront COVID-19. In the long term, these devices could protect us against the next nasty flu.

Responsible businesses will recognize their obligation to provide the best possible protections for their employees and customers against these hidden dangers. We don't want another near-collapse of the national and world economies. It is in all of our best interests to do our part. **BCA**

Aireon in Service

The space-based system is **revolutionizing air traffic management** globally

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

Innovation is often cited as native to the American character. The ability to recognize an opportunity and exploit it with a unique idea has been the cornerstone of American progress for more than two centuries and remains the driving impulse behind today's tech revolution.

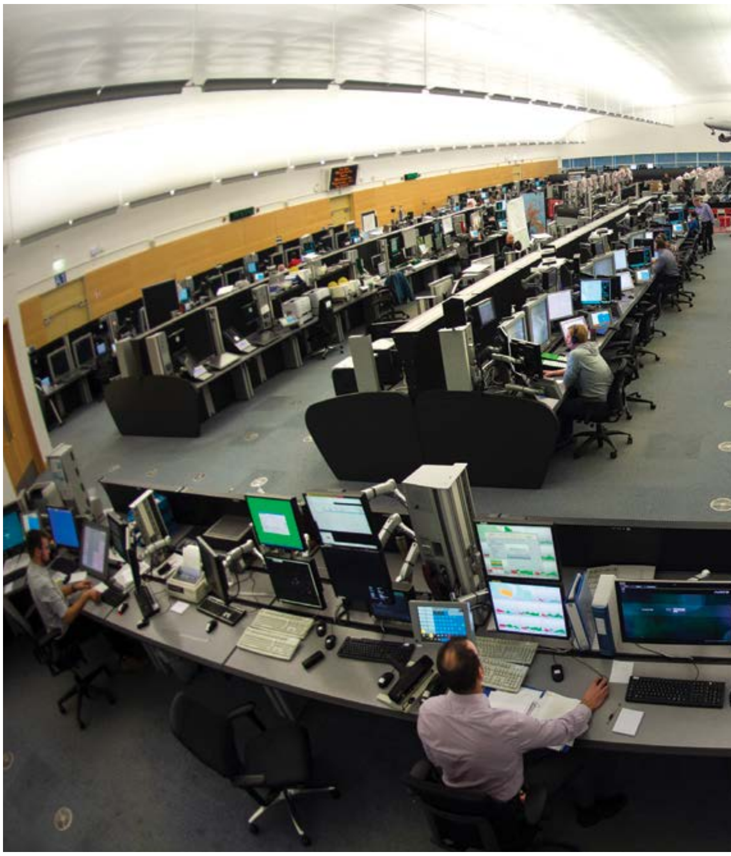
In 2006, the principals behind the Iridium satellite telephone enterprise came up with an innovative idea: Lease excess capacity on its planned second-generation communication satellites to host the payloads of others looking for a global perspective from space. Among the entities they probed were various U.S. government agencies including the FAA, where they learned of an interest in hosting an air traffic control payload aboard orbiting satellites and that Automatic Dependent Surveillance-Broadcast (ADS-B) had become the paradigm for ATC on the ground.

Further, mandates existed around the world to equip aircraft with ADS-B avionics, and new aircraft were rolling off production lines with the avionics already installed and certified for use. There was also a need to provide ATC in remote regions where ground infrastructure like radar or even ADS-B ground stations were nonexistent. It was a "light-bulb moment" for Iridium: With 66 satellites in low Earth orbits (LEO) of 484 sm (780 km) altitude, it could provide global coverage. Not only that, but the satellites were designed to interlink — that is, they could pass signals among them without having to relay to the ground, obviating the need for ground stations. This made them useful over remote territory or oceans, facilitating true global coverage.

Discussions commenced with the FAA, Nav Canada, NATS in the U.K., and other air navigation service providers (ANSPs). Then in 2012, Iridium and Nav Canada formed Aireon LLC, with the latter contributing $150 million for a 51% ownership. The new entity proceeded to raise $202 million more in equity by signing additional partners the Irish Aviation Authority (IAA) for a 6% ownership, Italy's ENAV (12.5%) and Denmark's Naviair (6%). (Additionally, in 2018, Aireon signed a $200 million credit facility with Deutsche Bank.) Aireon moved forward, using the additional capitalization to build the ADS-B components for Iridium Next satellites, which the satcom company was scheduled to begin launching in late 2015.

Global Coverage — Even in Antarctica

Altogether, it took eight launches over two years to put up 66 satellites plus six spares (with nine more stored on the ground), replacing the original Iridium constellation launched in the 1990s. Primary launch vehicle was the Space X Falcon 9, while the first two launches were aboard Russia's Kosmostras Dnepr rockets. The satellites were distributed 12 each among six orbital planes, traveling at 16,777 mph (27,000 kph). Because satellite coverage overlaps, there are no voids, and ADS-B reception is now available anywhere in the world, even in Antarctica. Receivers aboard the satellites listen on the 1090 MHz ADS-B frequency, meaning any aircraft outfitted with ADS-B avionics can access them. L3Harris Technologies oversees Aireon's ground-based facilities, controlling them from its center in Herndon, Virginia. Meanwhile, Iridium is responsible for controlling the satellites out of its center 13 mi. away in Leesburg.

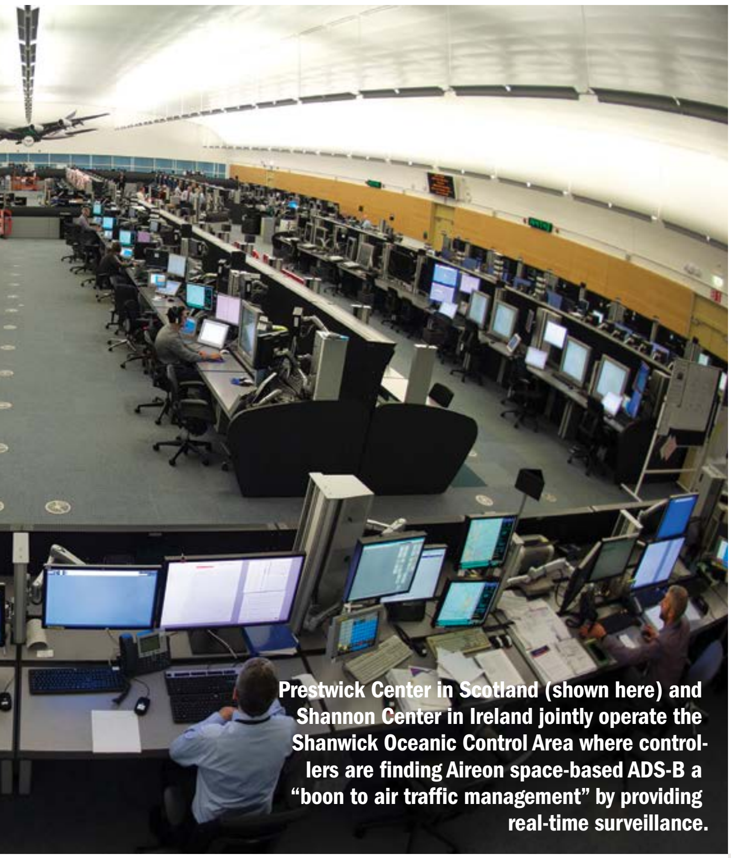


AIREON

Following the final launch in January 2019, Iridium began certification of the satellite constellation after which Aireon and its customers commenced a testing phase of the ADS-B function. (Just as a footnote, think of the magnitude of this endeavor: Sixty-six satellites had to be successfully lofted into their designated orbits and positioned at the proper distance from one another, then turned on and interlinked with each other and the ground, and, finally, the ADS-B payloads all had to awaken and begin accepting aircraft positions. Despite the challenges, it all went flawlessly.)

"All that was completed in March 2019 when we went active," Aireon CEO Don Thoma told *BCA*. "That was the global rollout."

As of today, 18 ANSPs including Eurocontrol have signed onto Aireon or are in the evaluation process. (At this writing, it was 16 plus two in the process of joining. See "Aireon Customers" sidebar for a full list.) Many represent multiple countries, and when looked at that way, there are 38 beneficiaries of the space-based system. With the exception of Eurocontrol, which is using Aireon satellite-based ADS-B as a data source for air traffic flow management, all of the ANSP customers are using the service for ATC surveillance.


Prestwick Center in Scotland (shown here) and Shannon Center in Ireland jointly operate the Shanwick Oceanic Control Area where controllers are finding Aireon space-based ADS-B a "boon to air traffic management" by providing real-time surveillance.

"With the contracts we have signed and are in the process of implementing," Thoma said, "we were on schedule to be profitable this year — that is, prior to the COVID-19 pandemic. So we are drawing down the Deutsche Bank credit to keep operating. No users have pulled out, which shows the uniqueness of this capability and that it has a place in the ATC infrastructure in any financial environment. We pulled together many ANSPs around the world to deploy the capability and share how they can use it to everybody's benefit. It has been a collaboration."

Aireon is a new model for the ANSPs, Thoma maintains, "in that, instead of operating their own systems, they are buying into the space-based service. Because it is a safety-oriented function, we had to implement secure data circuits in the ANSPs. Actually, this is a fairly simple process, as it fits into their systems easily." In fact, it is a simple rack of equipment that plugs into the ANSP's system, followed by certification testing.

"Of course, it has to have a high fidelity of operation," Thoma continued. "Every time we implement a service with a customer, we go through a service-acceptance test, a revaluation of the service to ensure it performs to defined levels of service metrics. We monitor it from our control/data center in Ashburn, Virginia, plus an operations center at L3Harris in Herndon and a second one at our headquarters at Tysons Corner (Virginia). We provide transparency to the operation of our system. If there is an issue, we can respond very quickly and report it immediately to our customers. We also operate some equipment — the payloads on all the Iridium satellites — out of the Iridium ops center in Leesburg."

The FAA is an Aireon customer, too, currently running an operational trial in Caribbean airspace. "We worked with the FAA under an MOA for many years, starting in 2011 [the genesis of the project]," Thoma said, "sharing with the FAA our plan and they with us their experience with ADS-B, and over time, that relationship evolved as we finalized our designs and conducted critical reviews, and the FAA was with us all the way through that process. They also volunteered their aircraft for testing our system over the Atlantic and in some terrestrial airspace."

As part of its relationship with the FAA, Aireon was granted contractual authorization from the agency to purchase Miami Oceanic Airspace to support operational use of ADS-B beginning in August this year. Meanwhile, upgrades are in progress to ATOP (Advanced Technologies and Oceanic Procedures) for deployment into the oceanic regions of the U.S.

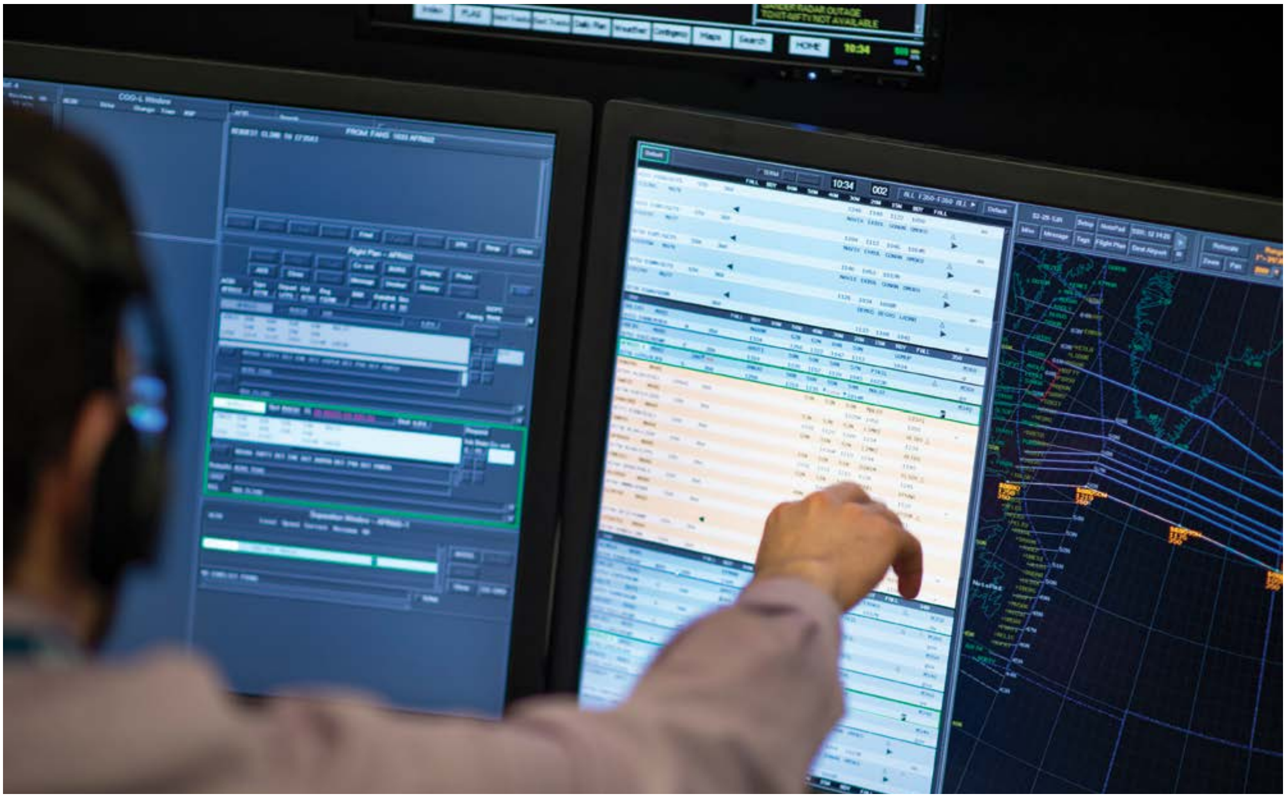
How Effective Is It?

Aireon had only a year of "normalcy" to prove itself as a useful adjunct to air traffic management — that is, from its activation in March 2019 to the global lockdown in March 2020 in response to the COVID-19 pandemic and the consequent precipitous worldwide decline in air travel. During that relatively brief introduction, what did the aviation community learn about the effectiveness of the space-based ADS-B program?

"When traffic is booming," Thoma said, "Aireon provides efficiencies, and even in a downturn, it provides more alternatives. It can supplement ground-based systems or even replace them, so that in a downturn, ANSPs can discontinue using expensive radar in lieu of using space-based surveillance. Secondly, in this kind of environment [the pandemic], where there are lockdowns, some countries found that they could not get out to maintain their ground-based equipment but could use

Avionics Necessary for Satellite-Based ADS-B

"If you meet the ADS-B mandate standards, our receivers can pick up the signals," Don Thoma, CEO at Aireon, promised. "It is evolutionary and backward-compatible to the original ADS-B spec. So, it can be used for oceanic operations. We cover 100% of the globe with substantial redundancy. Seventy to 80% of the time you will be in three-satellite coverage, and at the most, you might have six, and the least would be small areas around the equator where there would be only one. BCA



Shanwick Oceanic remains a procedural control unit, but space-based ADS-B allows controllers to "see" the airspace, thus facilitating reduced separation and accommodating more traffic.

the space-based service to continue operating in their airspace until they could get into the field to attend their facilities there."

Any discussion about the value of satellite-based ADS-B always arrives at "efficiencies," or how surveillance from 500 sm in space — an authentic "big picture" but in real time — can free operators from the limitations of procedural airspace control. "This means getting the desired flight level, flying at optimal speeds and having better access to the optimal track [of an Organized Track System]," Thoma explained. In a year in which there was substantial growth over the North Atlantic, one British Airways Boeing 787 made a transit in 3 hr. thanks to more efficient routing.

COVID-19 Impact on North Atlantic Ops

"In a normal year, which is to say, prior to March of this year," Doug Dillon, Gander Center's general manager, told *BCA*, "we were processing 550,000 North Atlantic crossings. The Organized Track System typically accommodates 50% of the oceanic traffic, and the other 50% is random route flights. Right now [early fall 2020], we are down 70%; typically this time of year we'd be working 1,600 to 1,700 flights a day; now it's 400 to 500." **BCA**

Then there is the safety issue — again enhanced by the perspective of the view from space, where ANSPs can see traffic coming before it enters their airspace, and automated features call operators' and controllers' attention to possible conflicts. "There's a metric that the ANSPs in the North Atlantic apply to altitude busts, or large height deviations (LHDs) of 300 ft. or more," Thoma said, "which are a persistent problem. Here, with Aireon, we see the value of the difference between real-time reporting of satellite-based ADS-B and the 10-min. reporting of ADS-C [Automatic Dependent Surveillance-Contract, the system recently mandated in North Atlantic airspace for procedural conformity].

"If Aireon 'sees' an LHD," he continued, "it automatically sends a message to the pilot to check altitude. In other words, it sends an alert directly to the pilot — the alert no longer goes through the relevant supervisor's desk and a subsequent radio call. This vastly reduces the time from the altitude bust to a correction. Now, for the first time, the Oceanic Control Centers [OCCs] can meet their target levels of safety."

Out Over the North Atlantic

To get the perspective of that space-based view of oceanic airspace — a logical application for ADS-B because of the absence of radar surveillance — we talked with Doug Dillon, general manager of the Gander Area Control Center (ACC) operated by Nav Canada. "We had invested in ground-based ADS-B and were looking at opportunities for extending coverage in oceanic airspace to utilize surveillance to reduce separation as far east as we could," he began.

At the time, separation in the North Atlantic was 10 min. in trail, a significant distance of up to 80 or 90 nm, depending on the longitude. "A radar cost $8 million to install," Dillon said, "while a ground-based ADS-B station cost $800,000, so we went with the latter and began installing [ground stations] along the Canadian coast and in Southern Greenland. This gave us the ability so see aircraft farther into oceanic airspace. Then in 2012, our CEO pitched the idea of space-based ADS-B with global coverage and what that could mean to our customers. So, we partnered with Aireon, a huge collaboration of systems, procedures, safety management and other benefits."

If an air traffic management system could add more beneficial flight profiles earlier and faster, more efficient and safer operations would be possible because controllers would have "extrapolated targets" to work with. "Under procedural ops," Dillon explained, "we had to apply longer separations because we couldn't actually see aircraft" — in other words, "extrapolate" where they were.

One of the biggest areas of improvement with space-based ADS-B is "the safety aspect of being able to see targets going from end to end between North America and Europe," Dillon said. "This would give us a significant improvement to our target level of safety. The other impact is service to the customer in terms of efficiencies: more efficient profiles, lowered separation allowing more aircraft to operate in a given area at a time."

Normally, 85% of aircraft were getting their requested routings, flight levels and speeds (in the non-surveilled scenario), "but we weren't meeting all three criteria — the routing is the easier one; the harder one in the non-surveilled environment would be the flight level. When we looked at space-based ADS-B, we went from a 10- to a 5-min. longitudinal separation, equating from 40 to 80 nm down to 14 to 17. Due to the reduction in separation standards, it increased a significant capacity to put aircraft at their most-optimal profiles. So, those were our two biggest gains: a safety bump and a significant increase in efficiencies."

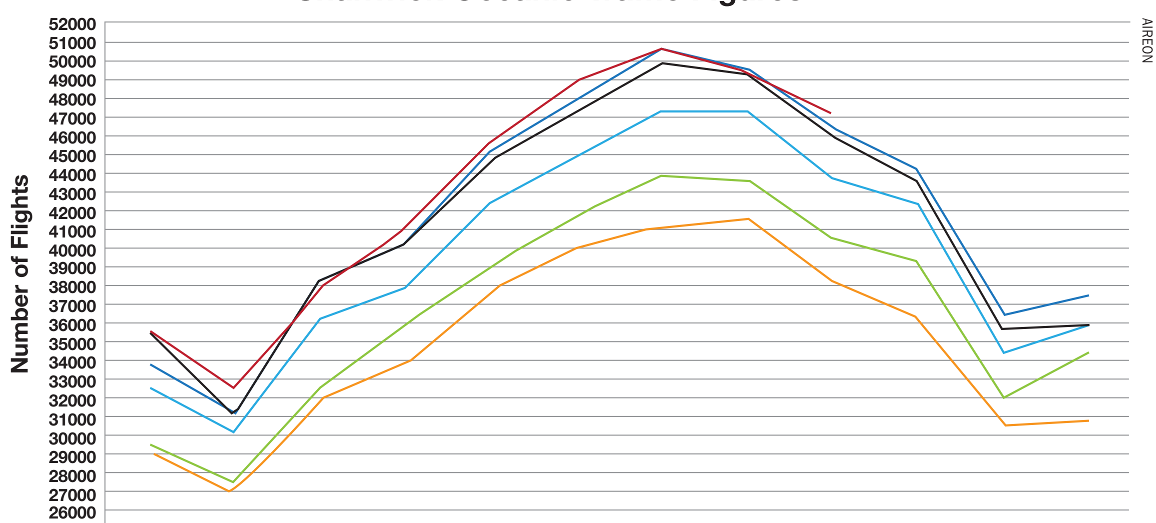
Beginning in 2015, the transition to space-based ADS-B was "a significant collaborative event" between Nav Canada and Britain's NATS, as between them, the two ANSPs control about 85% of North Atlantic traffic. "So we knew that for a successful implementation," Dillon continued, "it required us to be on the same page, a common technology platform, so controllers could be able to adequately position aircraft at the handoff points. We would have to incorporate the new separation standards as well as the collaboration tool built into the system for safety assurances." The earlier controller system was called GAATS; when NATS joined the Nav Canada platform, new technology requirements were developed to launch GAATS+. All testing was collaborative, with procedures aligned under the International Civil Aviation Organization (ICAO) and the North Atlantic Systems Planning Group (NATSPG) regulatory umbrella. Altogether, the effort consumed three years of development and testing — and lots of transatlantic meetings.

Game Changer

"The first ADS-B launch went up in January 2017," Dillon said. "As the satellites were becoming operational, we would receive data on them, and it was impressive the coverage we could get with one satellite — two-thirds of the oceanic airspace! We could see coverage from just one satellite and see twice what was originally predicted. It took a year to get the others in place, and we went live in our domestic [Canadian] airspace first on March 19, 2018, and on the 21st in our oceanic operations.

"As we went through the testing phase," Dillon continued, "it was apparent how robust the system was. When we started with space-based over the ocean, we were getting metrics for the customer where we now had real-time surveillance of every

Shanwick Oceanic Traffic Figures

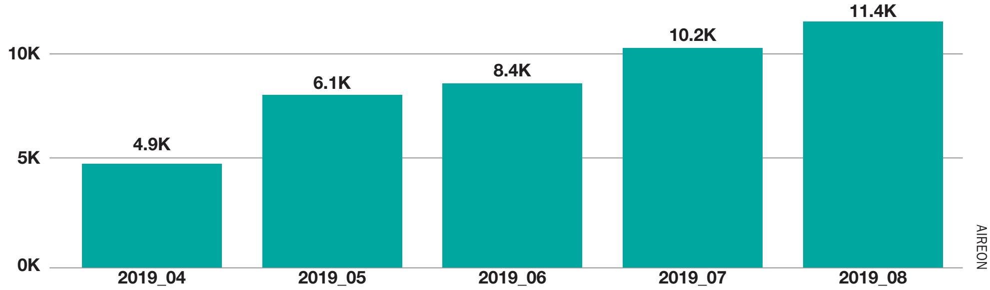


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	29094	26427	31698	33823	37636	40236	41126	41693	35188	36365	30708	30915
2015	29436	25493	32633	35923	39023	41825	43930	43630	40439	39333	31999	34468
2016	32548	30202	34216	37896	42451	44517	47372	47319	43728	42386	34467	35928
2017	35497	31194	34366	40332	44652	47471	49910	49261	46045	43614	35591	35992
2018	33752	31390	34265	40448	45161	47976	50657	49571	46400	44097	36477	37500
2019	33757	32445	37663	45018	45700	48911	50673	49420	47249			

equipped aircraft in the entire North Atlantic between Nav Canada and NATS. It is second to none in terms of our goals. Unfortunately, the pandemic has slowed us down in terms of gaining our full benefits, but nevertheless, it still provides significant safety benefits and reduction of separation. It has been a game-changer for oceanic airspace and is proving to be a solid system."

And the safety payoff includes flight profiles that might be out of conformance in terms of lateral and vertical deviations with their operators' clearances. "Our system knows the trajectory of every aircraft and its profile," Dillon claimed, "and if the target deviates from that profile, it will immediately alert the controller that the aircraft is deviating in either the horizontal or vertical plane." The ANSPs are also implementing a "deviation tool" that gives the controller the ability to protect aircraft in the case of weather deviations, based on the deviating pilot's request. "In the procedural world, when pilots needed to deviate around buildups, often an ATC clearance would not be available," Dillon said, "and the pilots would take contingency procedures for the deviation with the knowledge of traffic passed to them. With surveillance and the reduction of separation standards, we can now provide deviation clearances while having a system monitoring the aircraft's profile."

Thanks to these tools, gross navigation errors (GNEs) have almost become "a thing of the past" because oceanic controllers receive early warnings of deviations. "We can message to the avionics automatically so that, prior to entering oceanic airspace, the system can probe the avionics to ensure the recorded profile matches the profile protected by the ATC system," Dillon said. This is in lieu of the old read-back by the crew and the possibility that the course might be entered incorrectly. Now, if there is an incorrect coordinate, the system can determine it and alert the pilot. (This is an ADS-C function that is also being implemented for space-based ADS-B.)



"No Assigned Speed" trial commenced on April 15 and during the 169 elapsed days to Sept. 30, 52,309 flights have been cleared to "Resume Normal Speed" for a cumulative total of 2,684,188 minutes, with an average duration per cleared flight of c. 51 minutes. An average of 310 flights per day are being instructed to "Resume Normal Speed", representing 38% of all eastbound flights. Peak day (Aug. 21) 483 flights (c. 57%) of all eastbound flights. Lowest day (July 29) 62 flights (c. 12%) of all eastbound flights.

A Controller's Perspective

At NATS' Prestwick Center, development head Jim Nelmes recognized the long-running partnership with Nav Canada to devise a strategy for joint ways of managing the two ANSPs' mutual oceanic airspace with more consistency.

"We'd agreed with them that this was something we wanted to develop, and we already had their software, so we were using the same systems as Gander," he told *BCA*. Given the mutual use of the software, it was then an easy step to integrate the Aireon data into the NATS system.

In the busy months before the pandemic, ops performance manager Jacob Young said, "We were receiving 130 million ADS-B reports into Shanwick, the busiest oceanic control center in the world." (The Irish Aviation Authority's Shannon Center and Prestwick Center jointly control the Shanwick Oceanic Control Area.)

Rob Mitchell has been an oceanic operational controller at Prestwick for 14 years, enough time to live through the transition from "old school" procedural control to today's Automatic Dependent Surveillance and Controller-Pilot Data Link Communication (CPDLC) systems. The former tells controllers where aircraft are — or confirms where they're supposed to be — while the latter facilitates textual communication in lieu of scratchy, interference-prone high frequency (HF) radio. Together, these technologies transform oceanic air traffic management from a level of assumption to one of knowledge.

"We were operating in an old-school environment in many ways," Mitchell began, "a hands-off approach to control using procedural operations. It's not quite real ATC, which for most controllers is a desire to actually run a radar sector. The GAATS system didn't change on the opening day [of space-based ADS-B surveillance] — we still had our map displays, paper strips, and so forth — but the reality of the [existing] situation was guesswork on where we thought the aircraft were. And all of a sudden, we were not procedural airspace controllers anymore — now we could match the situation to where the aircraft actually were. A powerful moment! We now had that capability on our own sectors — doing things we could only imagine." In other words, oceanic controllers could "see" the aircraft they were vested with controlling — and for which they were ensuring safety. Powerful, indeed.

In the past, controllers played catch-up, responding to messages from their aircraft or neighboring sectors. "But now we are getting the ability of seeing the aircraft before they enter our sectors," Mitchell continued. "We have a service volume area that not only encompasses our airspace but 200 nm all around it, another safety feature allowing us to perform conformance checks on known aircraft plus those on the way in."

How Secure Is Satellite-Based ADS-B?

"ADS-B has built into it a figure of merit that tells you the performance of the GPS information imbedded in the ADS-B message," Aireon CEO Don Thoma told BCA. "If there was interference, it would flag that aircraft so that controllers would see that its avionics were miss-performing, and they could adjust separation."

In addition to that, there is the case of multiplicity of satellites. "If an aircraft is being spoofed," Thoma explained, "we can tell if it is not in the place where it says it is — a triangulation process." **BCA**

Not only that, but Shanwick can see domestic traffic in U.K. and Spanish airspace that abuts its sector. "There are a lot of aircraft transiting through there but not entering oceanic airspace," Mitchell said. "We can see them, too, and in the event that any of them get too close to our airspace or enter it, we would get an alert."

Another place where non-oceanic traffic could be seen with Aireon ADS-B was the area adjacent to the southeastern corner of the Shanwick OCA. Young explained: "Another benefit we have now is the ability of non-data-link aircraft [i.e., those not equipped with the now-mandated CPDLC avionics] to traverse the southeast corner of our airspace from Ireland to the Canaries, and had we not implemented the system, they would have flown around that airspace, and now they can fly through the airspace, plus we have added VHF comm on two specific routes that run along our boundary with Brest. This provides reduced separation with an option to enter our airspace. That corner is particularly busy on a daily basis."

Now, because Shanwick controllers can see aircraft 200 nm before they enter their system, they have a valuable assist for their decision making. "With time restrictions, there are concerns," Mitchell said, "and previously, we had to call the appropriate control system and get a radar check on when an aircraft would meet our boundary — now we can see it, and we have tools to make decisions on how to handle it."

More Real-Time Info

There are two functional controllers in an oceanic control center: the planning controller responsible for clearing aircraft from domestic to oceanic airspace and the en route controller or oceanic controller having responsibility for where aircraft actually are in the relevant airspace.

"We are still a procedural control unit," Mitchell pointed out, "but by planning aircraft into oceanic airspace safely, we can control more aircraft. What ADS-B has allowed us to do is to have more up-to-date information on what is going on — a contingency, a deviation, level busts, an aircraft routing to an incorrect position, and so forth. Very much in the past we were playing catch up in terms of what aircraft were doing, and now we can see them leaving oceanic to domestic airspace.

"We can act on incorrect flight levels — sometimes innocent and sometimes a precursor to what might happen. A lower flight level might indicate the aircraft is having a problem and we can move other aircraft out of the way. Often when an issue develops, there isn't time for the aircraft to call in, as the crew is handling a problem — remember the mantra, 'aviate, navigate, communicate, in that order.' Now we get a notification immediately if there is a change in height. Now we can be a lot more proactive."

In their training and annual recertification, controllers are taught "what an aircraft is supposed to do," Mitchell said, "but we don't always know when and how that were to happen. With ADS-B, I can see now how they are doing what they are supposed to do — a reassurance. I now have the knowledge of what the crews are up against and how they are handling it and I can be sympathetic to the users."

While North Atlantic airspace is still procedural, controllers can now see it, thanks to space-based ADS-B. "There are clear benefits from the surveillance environment," Mitchell claimed. "We can now react to things we could not see before — a huge safety benefit. And because of it, we can now reduce

SAR Tool

Yet another benefit harvested from Aireon satellite-based ADS-B is data enabling the tracking of equipped aircraft for search-and-rescue purposes. This has led to a spinoff joint venture, Aireon Aircraft Location and Emergency Response Tracking (ALERT), with the Irish Aviation Authority (IAA), itself one of the founding partners of Aireon.

ALERT, which went live in July 2019 and is claimed to operate as a public service, provides Air Navigation Service Providers (ANSPs), airlines and other commercial operators, aviation regulators, and search-and-rescue services with the last known position of any ADS-B-equipped aircraft anywhere in the world since Aireon offers global ADS-B coverage. The service is managed by IAA out of its North Atlantic Communications Centre at Ballygirreen, County Clare, Ireland.

ALERT users need not be Aireon or IAA customers; however, they must register with the service so that they can access the Centre to report an emergency and activate the process of obtaining the last-known position of an aircraft. The service then responds with a map depicting the last 15 min. of the distressed aircraft's flight with one plot per minute and a 4-D report including altitude, latitude, longitude and time data.Aireon and IAA do not charge for the service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Aireon ALERT plot depicting last five minutes of Cessna Centurion's descent into ocean in the Bahamas in 2019.

Among cases where ALERT has been used, one involved a missing Cessna Centurion in the Bahamas in December 2019. An SAR team activated the service and Aireon data showed the last-known ADS-B position to be 2 nm from where the team's helicopter was conducting a grid search. The helicopter was redirected to the last ADS-B ping location and found the pilot treading water in the ocean after the aircraft had sunk.

As of this fall, ALERT had registered 394 users: 308 organizations from 119 countries of which 145 were airlines, 108 were ANSPs, 67 were regulators, 57 were SAR groups, and 17 were unclassified. BCA

Aireon Milestones

In only its first year of service (March 2019 to March 2020), Aireon ADS-B has chalked up these service milestones:

- Average update rate to controller (*i.e.,* latency): approximately 2 sec.
- Aircraft using Aireon for tracking and GADSS (Global Aeronautical Distress & Safety System): >8,000.
- Times Aireon data used for accident investigations: 40.
- Number of satellites overlapping most of the globe at once, allowing independent validation: three.

In addition, these key statistics were racked up for North Atlantic operations during the same period:

- Separation achieved in the NAT as a result of satellite-based ADS-B surveillance: 14/15 nm.
- Reduction in large-height deviations (LHDs): approximately 30%.
- Reduction in time spent at uncleared level: 94% (from 48 to 3 min. average).
- Previously undetected safety events: 62.

the separation standards. And again, because of the benefits of having ADS-B in our airspace, we have managed to keep the same amount of controllers and still increase capacity in the sectors. We have been able to absorb the rise in traffic with these tools."

Another windfall from space-based ADS-B involves service benefits. "We can absorb the increase in traffic with lower separation standards," Mitchell said. "We have the tools that can do a sweep and look ahead to, for example, allow a requested change in flight level. And the system can check to ensure a planned level change has actually happened. We can give you more if you ask for it. Predominantly, the comm is by CPDLC, but we are still using HF. Also, satcom is being used more — it is always a backup to CPDLC and HF."

But, according to Young, the biggest service delivery benefit with oceanic ADS-B passed on to customers is separation reduction from 40 to 14 nm, packing more aircraft into the same volume of airspace. "Last year, we handled 508,000 flights in our airspace," he said. "The way we look at our performance is how often an aircraft gets a request satisfied. Prior to Aireon, we were getting 62%, but after ADS-B was introduced, we got a 10% improvement in the first year, and what that improvement meant was that 8,000 fewer flights had an ATC-enforced level change, and 7,000 fewer aircraft were given an entry point change. The second number is crucial because what it means is that we were able to halve the number of flights receiving entry point changes, reducing the number of miles added onto those flights previously."

A Different Use of ADS-B

At Eurocontrol in Brussels —the only Aireon customer not using the ADS-B service for surveillance — Christos Rekkas, head of surveillance and code, described Aireon as "a useful tool for many applications but especially for flow management." To fully understand this, consider that the intergovernmental agency coordinates air traffic management among 41 Western European member states and two associates in North Africa and the Middle East. Flow control is its raison d'etre and air transportation at modern levels simply could not function across the Continent without it. (See "Eurocontrol and Business Aviation, Parts 1 and 2," *BCA,* October 2019, and November 2019.)

Eurocontrol began harvesting Aireon's ADS-B data in February of this year. The applications include:

- Flow management.
- Crisis management.
- Contingency management, *e.g.,* in case other data sources are temporarily unavailable.
- Safety assessments.
- Environmental monitoring.
- Performance monitoring of all sorts.
- Airport-related applications.
- Research and development.

"We get the data from the space-based system and are using it as an additional input to our applications," Rekkas said. For Air Traffic Flow Management (ATFM), Eurocontrol will use ADS-B data for flight trajectory prediction in order to better estimate when aircraft will arrive in its airspace; software is currently being integrated into the Eurocontrol Network Manager and will be fully operational in early 2021. "Space-based ADS-B will provide us with information we did not previously have from outside the European network that can improve the quality of our trajectory predictions," he said. "With the space-based ADS-B service, we now have traffic data up to 6 hr. out from European airspace borders in support of our flow-management systems. This is extremely important."

The data can be used in other ways, too. "For example," Rekkas continued, "we get it for environmental monitoring to see how the aircraft are flying close to the airports for more efficient routing. And we can use it for safety monitoring. We use it for crisis cases such as the current COVID pandemic in order to monitor the traffic evolution and patterns in specific parts of the airspace like the Middle East. We are also using it as input for seeing how systems are performing — a quality monitoring tool, if you will. Every application has a different way of using the data."

The data is delivered by Aireon in two ways. The first is live-streamed every minute for the agreed area. "This is suitable for ATFM," Rekkas said. The second option is historical information from an Aireon database that arrives at a higher data rate (on the order of seconds), and supports a variety of other applications.

Does Eurocontrol share the Aireon data with its member states? "We cannot provide the space-based ADS-B data itself to the Eurocontrol member states," Rekkas said. "But we can provide the processed information — the output of the applications using the data. But in practice, all our applications aim at performance benefits to the member states and other stakeholders."

The key benefit is improved predictability. "We know better when the trajectories will appear in European airspace. The current level of traffic predictability at the boundary of European airspace is estimated to be significantly less than in the core area." This is because the peripheral ANSPs did not have sufficiently accurate information outside their borders for the incoming traffic, so were relying on predictions based on flight plans, which are not as accurate as the surveillance information.

Reduced predictability results in sector capacities having to be set at conservative levels with capacity buffers in order to avoid over-delivery of traffic. This, in turn, results in underutilization and reduced capacity and efficiency. "Now they will know exactly when the aircraft will arrive, and this will improve predictability. We would consequently like to unlock the capacity buffers, and we expect that the Aireon data will

AIREON

Miami Center is currently conducting operational trials in Caribbean and Atlantic oceanic airspace with Aireon satellite-based ADS-B.

allow us to do this. In summary, we try to push the periphery to align with the core area with respect to predictability levels."

Satellite-Based ADS-B's Future

So, what other tasks will space-based ADS-B be put to? "We just completed a release . . . for a capability to see aircraft on the surface — that is, in the airport environment," Aireon CEO Thoma told *BCA*. "A major benefit of a satellite-based system is that everything is software-defined, meaning we can upgrade the software in the satellites. Thus, we have an ability to enhance the system."

The next standard for ADS-B (DO260C) will include weather information coming off the aircraft. "One [software] change can go across the whole constellation," Thoma noted. "We have been investing heavily in how to make the data available to additional applications, not just ATC surveillance — a capability in a cloud-based environment to host the data and provide tools for use in other applications. Flight Aware is already providing a service to airlines using our data. For Airbus and Passur, which have customers in the airport environment, we can provide a tool-set they can use to support those customers."

Gander Center's Dillon looks out 10 years when "adding the fourth dimension of time gives the users predictability for profiles allowing efficient use of departure and arrival times as well as more control over contingency fuel, as less can be carried. In other words, you can better cope with a predictable profile rather than having to plan for worst-case scenarios."

Prestwick Center's Young believes the ability afforded by ADS-B to satisfy service requests will allow future developments like reducing the number of OTS tracks and eventually get to eliminate the track structure altogether. "The difference in performance of aircraft on random routes and on the tracks is getting closer and closer," he observed, "and the likelihood of getting the route you want in the random area is increasing due to ADS-B." As a result, the benefits of the OTS are decreasing "because you can get what you want more often in the random area."

Will space-based ADS-B replace ground-based ADS-B? "There are still areas where you need ADS-B on the ground," Thoma said, such as "highly congested areas needing redundancy and clarity with multiple forms of surveillance including radar. On the positive side, we were quite surprised with the amount of coverage we could get from space — the payloads are very high performance. The system allows multiple coverage — at least three satellites can see the aircraft over 80% of the Earth, so at least 80% of aircraft can be seen by three satellites."

However, since one satellite can see the whole U.S., it can pick up all the equipped aircraft, and that's a lot of signals. So, in congested areas like New York, Chicago, Atlanta or Los Angeles, it becomes challenging to deliver the information on the targets to the degree necessary for separation. "In that case, it becomes a situational-awareness tool," Thoma suggested. And conventional surveillance radar will continue to be used in busy terminal areas to sort out the traffic. (See "Whither Analog Navaids?" *BCA,* October 2020.)

"But you can also see everything, including general aviation aircraft with bottom-mounted antennas, and you can see that their performance is not as good, so it gives you a tool to measure avionics performance on board the aircraft. That information is reported to our customers by aircraft ID and tail number. Aviation is built on multiple layers of redundancy, and this is one more layer of surveillance."

Will Aireon's space-based ADS-B replace ADS-C in oceanic airspace? "Both have their merits," Dillon at Gander maintained. "ADS-B allows for full-time monitoring, but ADS-C provides a frontal view of what the aircraft is going to do, a projection of where it's going to be. So both have their place.

"Aireon is stable and reliable," he concluded, "systems are behaving, acceptance has transitioned well, and it's hard to give the full benefits now because it's only been operational for a year and we have the COVID-19 pandemic that has reduced traffic." **BCA**

Aireon Customers

Since officially launching its satellite-borne ADS-B program in 2015, Aireon LLC, has signed 16 customers — 15 Air Navigation Service Providers (ANSPs) plus Eurocontrol; as of press time, two more ANSPs were in the process of being integrated into the service and will probably be announced as this is published. All of the ANSPs are or will be using Aireon ADS-B for surveillance; Eurocontrol is harvesting data from the service for use in air traffic flow management.

Aireon is a partnership of the Iridium satellite telephone company, Nav Canada, the U.K.'s NATS, Italy's ENAV, the Irish Aviation Authority and Naviair of Denmark. The satellite-based ADS-B service became active in March 2019.

The customers identified by Aireon are:

- Nav Canada.
- NATS (U.K. National Air Traffic Services).
- IAA (Irish Aviation Authority).
- Naviair (Denmark).
- ENAV (Italy).
- DC-ANSP (Curacao).
- ATNS (Air Traffic and Navigation Services South Africa).
- CAAS (Civil Aviation Authority Singapore).
- SCAA (Seychelles Civil Aviation Authority).
- ISAVIA (Icelandic Civil Aviation Administration).
- ASECNA (Agency for Aerial Navigation Safety in Africa and Madagascar).
- PNGASL (Papua New Guinea Air Services Ltd.).
- AAI (Airports Authority of India).
- COCESNA (Corporacion Centroamericana de Servicios de Navegacion Aerea of Central America).
- FAA.
- Eurocontrol (European Organisation for the Safety of Air Navigation).

Fred George
Senior Editor
fred.george@informa.com

Gulfstream G450

Third-generation GIV — **good value in large cabin**

THE GULFSTREAM G450, BUILT FROM 2003 TO 2017, IS THE LAST of the legacy Gulfstream jets with roots to Grumman's original Gulfstream I turboprop. Savannah built more than 360 units during its 14-year production run before replacing it with the far more capable GVII-G500.

Typically priced at $7 million to $8 million on the resale market, the G450 is one of the least expensive, large-cabin aircraft capable of flying eight passengers over 4,200 nm at Mach 0.80 and landing with 200-nm NBAA IFR reserves. It has nearly 200-nm more range than the first- or second-generation GIV or GIV-SP aircraft due to subtle drag reduction modifications and upgraded RR Tay Mk 611-8C turbofans. The G450 also has a larger capacity APU with revised intake and exhaust ducting that greatly reduces external noise.

The G450 retains the basic GIV airframe, but it incorporates the GV's automated electrical and pressurization systems, plus it has a relocated cabin door, GV's higher aileron servo boost and automatic anti-ice control systems, among other changes. The entire nose of the G550 (aka GV-SP) was grafted onto the airplane, thus air crews enjoy a much needed 12-in. stretch to the cockpit.

Its PlaneView flight deck, also adapted from the G550, features four large LCD displays, along with standard HUD with EVS. Numerous optional Aircraft Service Change (ASC) bulletins give G450's PlaneView many capabilities that are standard in G500's Symmetry system. Synthetic vision PFDs (ASC 037B), CPDLC/FANS1/A (ASC 071), Honeywell Runway Awareness and Advisory System (ASC 040A), and TCAS 7.1 (ASC 077) are among the features. ADS-B OUT requires the ASC 912B, or later, Plane–View operating system software, plus WAAS GPS (ASC 059D) and Mode S ES transponder (ASC 079B) upgrades. Operators strongly recommend G450 buyers check aircraft for the latest ASC 912C PlaneView operating system upgrade.

The airframe, systems and engines are rock-solid reliable, but cabin management system components are showing their ages, especially the half dozen, or so, encoding and decoding interface boxes that link various components to the digital backbone. Some operators are swapping out the original CMS for the higher tech and more robust Collins Venue CMS. And they're upgrading to GoGo Biz Avance L5 air-to-ground internet systems, capable of 200 to 250 kb connectivity speeds. In addition to text messaging, passengers can use portable phones for WiFi calling when in line of sight range of GoGo's ground stations. Budget $200,000 for the upgrade.

The main cabin typically is divided into three sections. There is a four-seat club section up front, a four-seat conference section with a credenza or two facing chairs in the center and an aft semi- or fully private stateroom with a divan and/or other furniture. Forward and aft vacuum lavatories are standard.

The G450 is more enjoyable to fly than previous GIV models because the ailerons have higher power boost. PlaneView provides unsurpassed situational awareness. The automated systems reduce pilot workload and graphic systems synoptic keep the crew in the loop.

Gulfstream's product support is one of operators' favorite features. Basic maintenance intervals are 12-months or 500 hr., whichever comes first. The carbon/carbon wheel brake heat packs last 2,000 landings or more. TBO for the Tay 611-8c is 12,000 hr., but most aircraft will time out at 120 months, requiring a $1 million overhaul for each engine. Pay-per-hour Rolls-Royce Corporate Care, though, averages $400 per engine. FMS CDUs, emergency batteries, the engine fire detection control box, the horizontal stab actuation motor and APU starter pose occasional problems for operators.

GULFSTREAM

In daily operations, crews say they ballpark fuel flow at 3,000 lb./hr. on average. First hour fuel burn is 3,200 lb., decreasing 100 lb./hr. for the next four hours. The aircraft can comfortably fly 9.5 hr. and land with NBAA reserves. Normal cruise speed is Mach 0.80 for shorter missions, but the longest, 4,350-nm missions are flown at 0.77, depending upon aircraft weight. Gulfstream's advertised 43,200 lb. BOW is realistic for the average equipped aircraft. Push up speed to 0.85M and range decreases to 3,300 nm.

The G450's main competitors are Bombardier Global 5000 and Dassault Falcon 900EX, respectively having ten-inch and five-inch wider cross sections. Global 5000 essentially has the same cabin length as G450, but Falcon 900EX has a 3.8-ft. shorter cabin, thus three seating areas are more cramped. Having leading edge slats, both large-cabin competitors have better runway performance than the "hard wing" G450.

The Global 5000 can fly eight passengers 5,500 nm while cruising at Mach 0.82. But, being a larger and heavier aircraft, it's also considerably thirstier. In contrast, the lighter weight Falcon 900LX can fly eight passengers 4,500+ nm and it gets better fuel mileage, but it also cruises at Mach 0.75 to 0.78 on the longest missions. Now that G500 deliveries are in full swing, there's downward pressure of G450 resale prices.

The COVID-19 crisis has further depressed the market. Thus, if you're interested in stepping up to a long-range, large-cabin Gulfstream, G450 could be quite a bargain in late 2020. **BCA**

ADVERTISERS' INDEX

On Duty

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

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

▶ **The Air Charter Association (ACA),** London, named **Glenn Hogben** joint chair. He will share the role with **Julie Black,** the existing deputy chair. Each will have specific roles and responsibilities. Hogben joined ACA in 2008. He has more than 17 years of experience in aircraft charter, leasing and management.

▶ **Airshare,** Lenexa, Kansas, promoted **Alex Franz** to chief operating officer and Ben Petersen has been named director of operations. Franz joined Airshare in 2003, most recently serving as vice president of flight operations. Petersen, who joined the company in 2007, was the chief pilot.

▶ **Bombardier Aviation,** Montreal, Canada, named **Marc Beaudette** general manager of the company's facility in Fort Lauderdale, Florida. Beaudette was head of the Bombardier Tucson Service Center. **Michel Menard** has joined Bombardier as general manager of the Tucson center. Menard previously served as vice president and general manager of StandardAero and Dassault Aircraft Services.

▶ **Connecticut Aeronautical Historical Association - New England Air Museum,** announced that **Robert (Bob) Stangarone** has been named chairman of the board and president of the effective immediately. Stangarone succeeds Scott Ashton, who has served in the role for the past 12 years. Ashton will remain on the board as past president for a one-year term. Stangarone has held senior management positions with United Technologies' Pratt & Whitney and Sikorsky units, Rolls-Royce, Litton, Fairchild Dornier, Cessna Aircraft and Embraer.

▶ **National Aeronautic Association,** Washington. D.C., announced that **David Franson,** president of the Wichita Aero Club, has been named a recipient of the 2020 Wesley L. McDonald Distinguished Statesman and Stateswoman of Aviation Award. Also named were **Brig. Gen. John Allen**, most recently of JetBlue; **Capt. Julie Clark,** aerobatic airshow pilot and one of the first female pilots to be hired by a major U.S. airline; **Einar Enevoldson,** pilot and explorer of the stratosphere in a glider using high altitude waves; **Col. Kathryn Hughes,** a medical doctor who has made advancements in aviation and aerospace medicine; and **Michael Quiello,** a military aviator, airline captain, industry executive and leader of a nonprofit.

▶ **Jetcraft,** Raleigh, North Carolina, announced that **Fabrice Roger and Massimo Burotti** have joined the company as sales directors for Europe. Roger joined Jetcraft in 2013 and will relocate from Miami to Nice, France. Burotti comes to Jetcraft from Bombardier as sales director for Italy, Switzerland, Austria, Germany and Hungary. He will be based at the company's London headquarters.

▶ **JSSI Parts & Leasing,** Chicago, Illinois, named **Ben Hockenberg** president and J**im Sellers** chief commercial officer. Hockenberg previously served in investment banking, private equity and credit investing at Deutsche Bank, The Pritzker Organization, Venor Capital and Greenbriar Asset Management. Sellers co-founded JSSI Parts & Leasing and previously served at Prime Air, Chase Aerospace and the AAR Corp.

▶ **Meridian,** Teterboro, New Jersey, announced that **Kelly Forester Pappas** has joined the board of directors. Pappas is the granddaughter of Meridian founder John Kenneth Forester and daughter of the current CEO, Ken Forester. Pappas opened Meridian's regional office in Santa Rosa, California, and remains with the company.

▶ **King Aerospace,** Dallas, Texas, announced that **Boyd Hunsaker** has joined the company as director of sales. Most recently, Hunsaker served as director of sales and marketing for ST Aerospace San Antonio, AERIA Luxury Interiors, a unit of Singapore Technologies Engineering.

▶ **Wheels Up,** New York, New York, named **Lt. Gen. Thomas Bergeson** COO replacing Jason Horowitz, who has been named chief business officer. Bergeson most recently served in the U.S. Air Force as deputy commander of U.S. Central Command. Horowitz joined Wheels Up as general counsel in 2013 and was named COO in 2017. **BCA**

AVIATION WEEK

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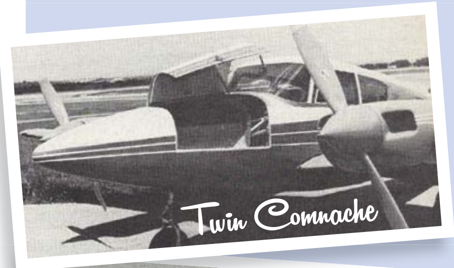
November 1970 News

FAA's **monstrous goof** in the matter of the Washington TCA confirms the **confidence-shattering premise** that, all its expertise, experience, facilities and consultants . . .

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

. . . notwithstanding, the agency is very capable of making monumental conceptual errors in air traffic control. . . . The fateful blunder proved to be that the demands made by the TCA exceeded the performance of the airplanes that were supposed to carry them out.



The conversion by San Antonio's Miller Aviation, adds vim and vigor, and puts Piper alumnus in performance class with Beech Baron. The expanded nose adds 11 cu. ft. of baggage or avionics space (130 lb. total) capacity and decreases drag.

Oddest-looking plane at the 1970 Farnborough show was this BN-2A Islander Mk III from Britten-Norman. They created a larger, 17-passenger transport by adding a tail-mounted third Lycoming O-540.

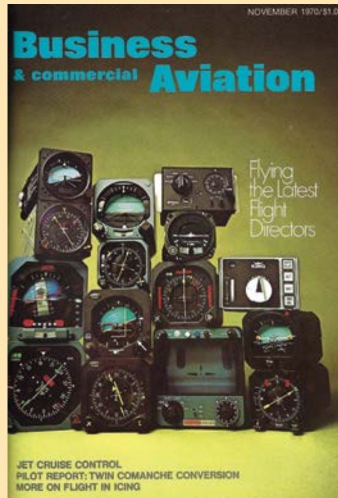
Cessna's Citation fanjet has entered FAA certification flight testing after completion of all developmental trails, which resulted in significant performance improvements, according to the company.

New landing gears are features of two models in Cessna's 1971 lineup, the 150 and the Skyhawk/172. The Cardinal/177 (bottom) gets its new look from the landing light in its nose.

John L. Baker is the new "Mr. General Aviation" at the FAA; Gates and Northrop call off Learjet purchase talks after nine months of intensive negotiations, physical and financial inspections, and rumor generation.

Reno pylong race winner is Clay Lacy, Van Nuys, California, whose P-51 finished first in the Sept. 20 race, but had been disqualified for cutting a pylon. The committee later reversed the decision. **BCA**

THE ARCHIVE



The profusion of current flight control instruments on our cover sorts out this way, reading from Left to right and top to bottom: first column — Mitchell FD-283 attitude director indicator and pictorial nav indicator, Bendix Navigation & Controls FGS-70 ADI (Bullseye) and PNI; second column — Collins ADI and PN-101 PNI, Sperry Stars ADI and PNI; third column – Brittain B-7 autopilot and turn coordinator, King K-550 PNI, Kaiser FP-50 cathode ray flight path indicator; fourth column – King H-14 autopilot, Bendix Avionics FCS-810 ADI and PNI.

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