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PILOT REPORT

Gulfstream G600

A worthy successor to the G550

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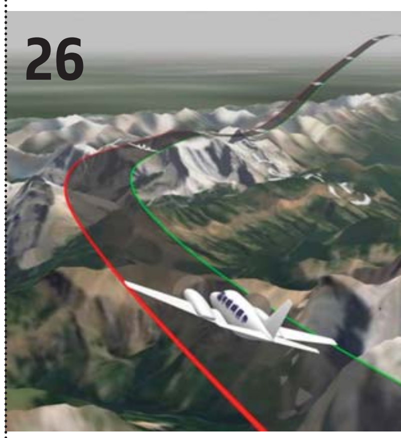

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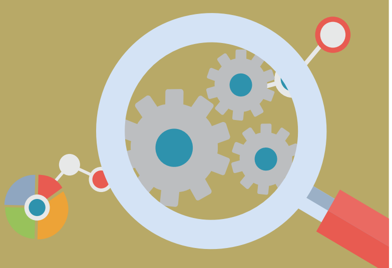

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Rationalizing Reno

Lessons drawn from the **Golden Age**

THE SEPT. 30 – OCT. 13 ISSUE OF OUR SIBLING *AVIATION WEEK &* *Space Technology* re-published a story from 90 years earlier titled "Simulated Landings, Takeoffs in Fog Made by Lieut. Doolittle" and detailing the first "blind flight," which occurred on Sept. 24, 1929, at Long Island's Mitchel Field.

The account interested me on several levels: The feat changed aviation forever; it happened in my hometown; and the story made the pilot's name part of the headline, assuming readers would recognize it. They did.

Not because James Doolittle was a seasoned test pilot, or he earned the first doctorate of aeronautics from the Massachusetts Institute of Technology, or his Distinguished Flying Cross award at age 25. No, they knew Doolittle's name because he flew fast.

Seven years earlier, he'd flown a de Havilland DH-4 from Jacksonville, Florida, to San Diego in 21 hr. and 19 min., becoming the first person to cross the U.S. in less than a day. And in 1925, Dr. Doolittle won the Schneider Cup, clocking his Curtiss R3C seaplane at 232 mph. Oh, and he'd also completed the first outside loop.

So, by 1929 his flying exploits were already legendary and continued steadily with him winning the first Bendix Trophy in 1931, setting a 296-mph record in the following year's Shell Speed Dash, and then taking the Thompson Trophy in the notorious Gee Bee racer.

Back in aviation's Golden Age, the purpose of air racing was not simply to collect trophies and headlines, but to help advance the science of aeronautics and propulsion, which it did. But does it still? I recently went to Reno, Nevada, to find out.

The National Championship Air Races, long sponsored by Stihl, the chainsaw and power tool maker, have been taking place annually at Reno/Stead Airport for 56 years. They have become an aviation staple and a check-off item on most aviators' bucket lists. Long overdue, this was my first visit, along with my eldest, a former HH-65 aviator, and the gathering was immediately impressive. The hangars and ramps were teeming with airplanes of every stripe, from sleek L-39s and full-throated Texans to a PT-6-powered Wilga and a six-pack of Thunderbird F-16s.

The races themselves are divided into classes — Unlimited, Jet, Sport, T6, Formula 1 and Biplane — with a STOL contest for the tundra-tire set. The nuances of race strategy, timing and moves can be difficult for a novice to discern, but we had a knowing insider to guide us. Well known as an aviation attorney and author of our Point of Law column, Kent Jackson doubles as owner and pilot of "Once More," a highly modified (as are they all) Cassutt racer in which he competes. His aircraft then undergoing even more mod work, Kent's Reno role this year was as an alternate Formula pilot.

Briefed quickly, we moved to the grandstands and watched the proceedings. The Unlimiteds — World War II fighters exclusively, their Merlin and Wasp Major engines modified to nearly double their original output — were impressive, as notable as the T6s were noisy. The Jets, Czech L-39s mostly, made a quick show of it, while the Sports featured the Airs brothers, Lanc and Glas. The midget-sized Formulas were almost all Cassutts, which is to say they emerged from garages decades earlier, and were painstakingly constructed from plans, not kits. For some reason, we missed the bipes and heavy winds grounded the STOL birds during our visit.

The speeds were impressive — "Dreadnaught," a Sea Fury, hit 420 mph around the pylons; "Just Lucky," an L-29, checked out at 510 mph; and several O-200-powered Formulas easily topped 200 mph, which this former Cessna 150 owner found

KEVIN ECCLES

astonishing. But what really got my attention was the flying. All the heats were close to the ground; the knife-edge turns delivered heavy Gs; and in the early circuits at least, some of the racers were startlingly close to one another with nearly overlapping wings. Keep in mind, most of the pilots — many of them airliner or business jet drivers — do this kind of flying but once a year.

So, in my view the real contribution of racing today is not eking more power from 80-year-old radials, but rather producing pilots who really master flying. Observed Kent, "Racing makes for better pilots. For me, 51 weeks out of the year, 'CFR' means 'Code of Federal Regulations.' At Reno, it means 'Crash, Fire, Rescue.' Racing pilots truly prepare for mayday events because they happen."

At a time when planemakers are adding technology to compensate for piloting inadequacy, Reno's racers serve as refreshing reminders of what flying can be still. Dr. Doolittle would surely agree. **BCA**

A Change in the Lineup

I've been meaning to drop a line since my August copy of *BCA* arrived with a by-line other than Richard N. Aarons atop the **"Cause & Circumstance"** feature. My understanding is that my old colleague had expressed a desire to "step away from the computer . . ." or at least not be tied to it every month. If that's the case, good for him. After 50-some years as a key cog, airplane and avionics evaluator, *Handbook* numbers-cruncher, Publisher persuader, regular target of the executive editor's deadline wrath and sometimes EIC, there is no question Mr. Aarons deserves a break.

It also got me pondering about how many pilots his safety articles have helped to stay out of the trees, granite cumulus and NTSB accident reports. While there is no way to accurately calculate a precise number, my guess would be tens of thousands, and multiple generations over the years. Pilots who read and assimilated his *C&C* reports every month could not help but become smarter and safer. For Mr. Aarons, it wasn't just a job, it was a mission he took seriously. Congratulations on all that good and valuable work.

Dave Collogan
Former BCA "Washington" columnist
Silver Spring, Maryland

Author's response: Absolutely great to hear from you. Thank you for the very kind words. I especially appreciate your thoughts that the *C&C* lessons might have done some good — I hope so.

Yes, it is time I step back a bit, if not only to allow folks with a fresh point of view to contribute, but also to allow my tired eyes to move back from the screen. Ross Detweiler will write some, and some folks from International Society of Air Safety Investigators (tin kickers) have volunteered to write for the column. I have reserved the right to step in from time-to-time to contribute when my interest is really piqued.

We are deep into the transition from cockpits staffed by aviators to cockpits staffed by system managers. Unfortunately, that has led to a transition period when it is sometime questionable as to who's flying the airplane. Sometimes the right seat is occupied by an old, experienced aviator, but often it's occupied by a young pilot just out of the regionals who is great at pushing buttons, but terrible at actually flying an airplane without "the magic."

On Our Toes

Nice **"Point of Law"** in the September issue. A follow-on article discussing potential liability to the fulltime employer of a pilot who does occasional contract work on the side would be informative. This *BCA* reader has a personal and professional interest in the topic. Your "Point of Law" articles keep readers like me on our toes and anxious for the next edition of the magazine.

Marty Rollinger
Director of Flight Operations
LECO
South Bend, Indiana

Thanks for the Service

I loved **"Seat Surrender" (Viewpoint, October 2019)** and just wanted to reach out and say thank you for your service to the Safety Committee and to express my appreciation for bringing to light the great work that NBAA committees do for our industry and the association.

It isn't often that committee members get the recognition they so deserve doing thankless work and spending a great deal of personal and professional time improving our industry.

Jad Donaldson
Director of Aviation
Harley-Davidson Motor Co.
Milwaukee, Wisconsin

Comments Regarding Eurocontrol and Business Aviation, Part I, October, BCA

An excellent article. Well researched, presented, written and highly informative.

Diane Hughes
Via email

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

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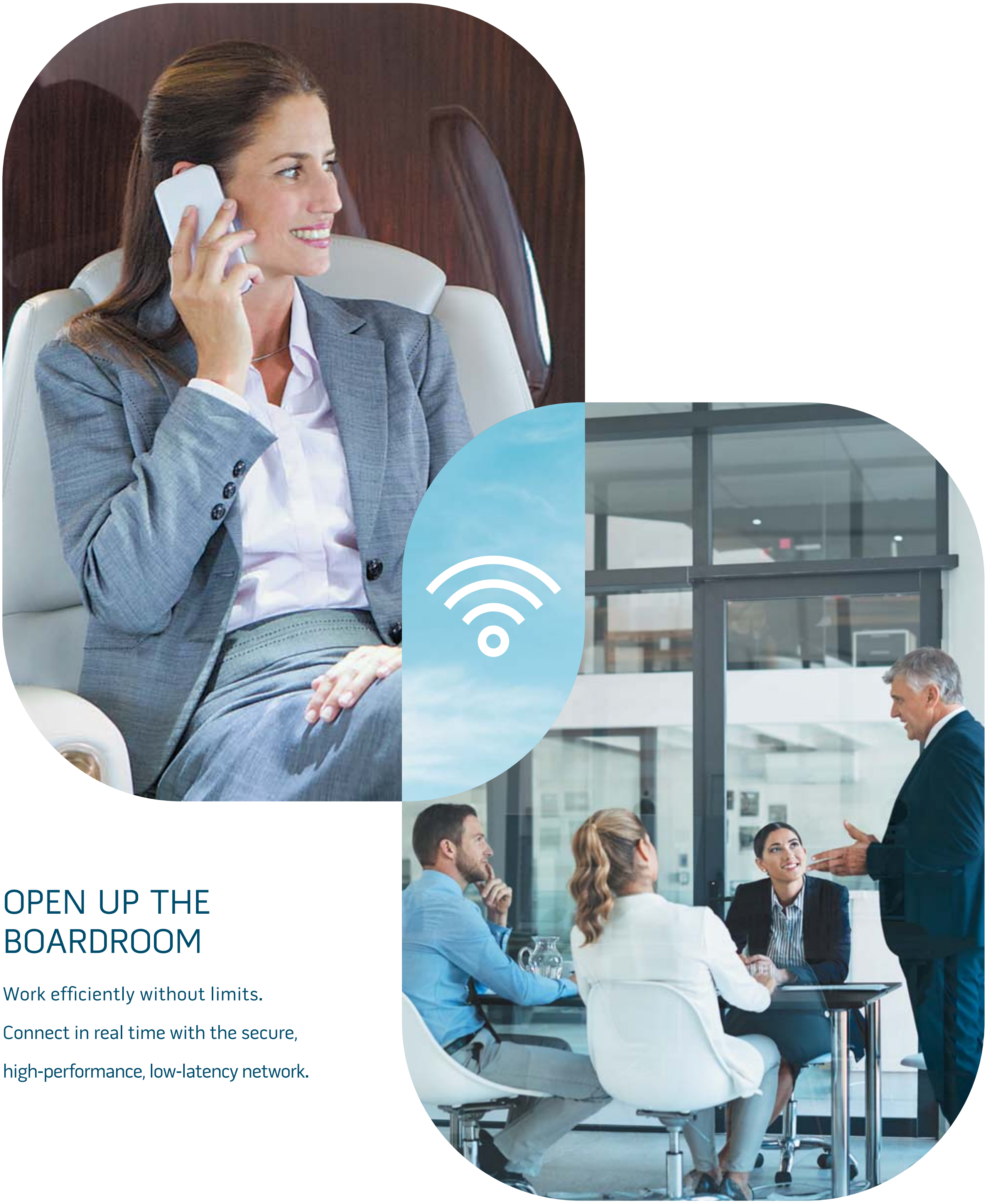

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SYBERJET AIRCRAFT FLEW ITS UPGRADED SJ30i jet for the time on Oct. 9 out of San Antonio International Airport (KSAT). The twinjet features an all-new cockpit based around the Honeywell Epic 2.0 avionics suite, new ergonomic enhancements, and electronic standby attitude/heading display, among other changes. The flight marked the start of an n 18-month certification test program which is to result in an amended type certificate and initiation of deliveries. The aircraft was piloted by Mark Elwess, chief engineering test pilot and Robert Moehle, senior flight test engineer. The SJ30i retains the performance characteristics of the SJ30-2 but the enhanced flight deck is fitted with four 12-in. liquid crystal displays, including synthetic vision, moving map display, electronics charts/maps, TCAS II, TAWS Level A, synoptic displays, dual FMS with dual WAAS GPS/LPV, single inertial nav system, onboard weather radar, full EICAS, electronic checklists, DME, ADS-B Out, and 0.3 nm RNP, as well as support for FANS-1A, ADS-B In, emergency descent mode, and RVSM operations. Options include CPDLC, XM weather, flight data recorder, cockpit voice recorder, dual charts/maps, HF radio, SATCOM, enhanced vision systems, second MFD, and the flexibility for other customer requests. Mark Fairchild, vice president of Customer Experience said, the SJ30i "remains the fastest and longest-range jet in its class" but now has digital cockpit as well as "the lowest cabin altitude of any business jet flying today."

GULFSTREAM IS REDUCING JOBS AS IT "JUDICIOUSLY" realigns its business. At this stage, according to a spokeswoman, it's too early to specify how many workers will be impacted, but the jobs are primarily indirect or support staff, rather than manufacturing personnel and all Gulfstream sites will be affected. Meanwhile, the company continues to hire in certain areas, as evidenced by recent service center openings in Appleton, Wisconsin, and Savannah, Georgia, and in the coming months in Palm Beach, Florida, and Van Nuys, California. In the past 10 years, Gulfstream has doubled its workforce worldwide. It employs nearly 18,000 globally, including about 11,000 at its headquarters campus in Savannah. The company delivered 65 large- and midsize-cabin business jets, during the first half of the year, up from 52 for the same time a year ago. And gross orders for its division, which includes Jet Aviation, for the totaled $5.33 billion, up from $3.74 billion for the previous year. At the end of the second quarter, its backlog totaled $12.15 billion.

ITALIAN PLANEMAKER TECNAM RECENTLY delivered the first pair of its new nine-passenger P2012 Travellers to launch customer Cape Air. The regional carrier, which is based in Hyannis, Massachusetts, has expressed interest in putting up to 100 of the high wing piston twins into service. The regional has ordered an initial 20 Travellers to be delivered over two years, and CEO and founder Dan Wolf says he then wants to accelerate deliveries to replace the rest of Cape Air's 85-aircraft Cessna 402C fleet within 5-6 years. The carrier began working with Tecnam on design of the P2012 in 2011. The aircraft made its first flight in July 2016, received European Aviation Safety Agency certification last December 2018 and FAA approval this past August.

Jet-A and Avgas Per Gallon Fuel Prices

October 2019

Jet-A			
Region	*High*	*Low*	*Average*
Eastern	$8.85	$4.48	$6.26
New England	$7.85	$3.90	$5.21
Great Lakes	$8.22	$3.41	$5.55
Central	$7.61	$3.37	$4.94
Southern	$8.31	$4.35	$6.05
Southwest	$6.90	$3.36	$5.32
NW Mountain	$7.99	$3.45	$5.35
Western Pacific	$8.83	$4.00	$6.11
Nationwide	**$8.07**	**$3.79**	**$5.60**

Avgas			
Region	*High*	*Low*	*Average*
Eastern	$8.71	$4.48	$6.55
New England	$7.45	$5.05	$5.94
Great Lakes	$8.59	$4.79	$6.10
Central	$7.59	$4.51	$5.46
Southern	$9.24	$4.30	$6.27
Southwest	$7.19	$4.12	$5.74
NW Mountain	$8.45	$4.74	$5.88
Western Pacific	$8.52	$5.10	$6.46
Nationwide	**$8.22**	**$4.64**	**$6.05**

The tables above show results of a fuel price survey of U.S. fuel suppliers performed in October 2019. This survey was conducted by Aviation Research Group/U.S. and reflects prices reported from over 200 FBOs located within the 48 contiguous United States. Prices are full retail and include all taxes and fees.

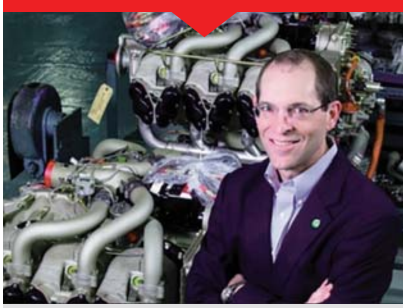
For additional information, contact Aviation Research/U.S. Inc. at (513) 852-5110 or on the Internet at www.aviationresearch.com

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

Macquarie Acquires Fanborough Airport

In a surprise development, the Macquarie Infrastructure and Real Assets has acquired Farnborough Airport from a consortium of private investors, which includes TAG Aviation. The deal was announced Sept. 30. TAG has owned the business aviation hub outside London since 2007 and invested heavily in upgrading its terminals, hangars and infrastructure since then. The airport handles some 30,000 aircraft movements annually and also hosts the biennial Farnborough International Airshow.

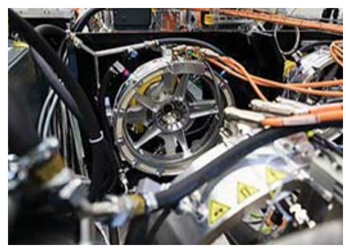
Continental's Ross Retires



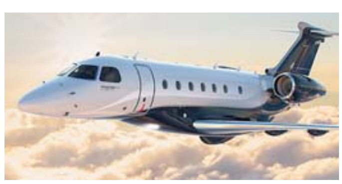
Rhett Ross, CEO and president of Continental Aerospace Technologies, the Mobile, Alabama-based aircraft engine maker, plans to retire and become an entrepreneur. During his 12-year tenure, Ross led the company through a recession, the sale to China's AVIC International Holdings and the acquisition of five business to add technology and product lines. He also recently championed the construction of a $75 million manufacturing facility in Mobile.

NOT MANY COMMERCIAL HELICOPTERS reach 1,000 deliveries, yet Leonardo's AW139 has achieved this feat in just 15 years. The success of the Italian medium twin transformed company revenues and paved the way for a family of derived products, including the AW169 and AW189. The 1,000th machine, a public service mission version for Italy's Guardia di Finanza (Financial Police) was handed over during a ceremony at the company's facility in Verigiate, near Milan on Sept. 20. The AW139 was born as the AB139, one a trio of products developed by the-then Bell-Agusta Aerospace Company, along with the BA609, now the AW609 commercial tiltrotor and the AB412+ an enhanced version of Bell's Model 412 utility helicopter. Bell later exited the arrangement. Powered by two Pratt & Whitney Canada PT6 engines and featuring a Honeywell Epic Primus avionics suite, the AW139 went on to dominate the medium-twin rotorcraft market ever since, outselling much of the competition. And its outlook continues to look positive; Leonardo currently has a backlog of around 140 aircraft, at least two years of production under current build rates.

ROLLS-ROYCE HAS ACQUIRED THE ELECTRIC AIRCRAFT PROPULSION ACTIVITIES OF SIEMENS. The British engine maker says the buy will further its aircraft electrification strategy. With 180 employees in Germany and Hungary, eAircraft, the former Siemens unit, is developing a range of electric motors, including working with Rolls on the 2-megawatt hybrid-electric propulsion system for Airbus' E-Fan X regional aircraft demonstrator. That aircraft is planned to fly in 2021. Siemens also worked with Airbus to develop a torque-optimized motor, the SP200D, for the CityAirbus electric vertical-takeoff-and-landing (eVTOL) demonstrator. With a record-breaking torque density of 30 Nm/kg (10 ft.-lb./lb.), eight of these 100-kW motors powered the ducted-rotor CityAirbus on its first flight in May. And eAircraft is now certifying the SP70D motor, which powers Bye Aerospace's eFlyer two-seat trainer, and plans to certify the SP260D, three of which will power Israeli startup Eviation's nine-passenger Alice electric regional aircraft. The Alice is scheduled to fly this year and the eFlyer is planned for certification in 2020. In addition, Rolls is developing a hybrid electric system for vertical flight based on its M250 helicopter turboshaft engine, paving the way for flight tests in 2021.



TEXTRON AVIATION AND BOMBARDIER are celebrating entry-into-service of two new business jets, while Embraer is cheering Praetor approval. Cessna's super midsize Citation Longitude was delivered to an unnamed customer after earning FAA certification on Sept. 21. (See related story on page 48) Bombardier's new long-range Global 6500 entered service following Transport Canada approval on Sept. 24. Bombardier is leasing back the aircraft from the customer for demonstration use. And Embraer has received FAA and European Aviation Safety Agency (EASA) approval of its new Praetor 500 midsize business jet, following approval by Brazil's regulatory agency in August.



TEXTRON AVIATION HAS DELIVERED its 500th Cessna Grand Caravan EX utility turboprop to South Aero, a family-owned company based in Albuquerque, New Mexico. The operator purchased its first Grand Caravan in 2007 and now operates five in conducting its charter and freight services.

WHEELS UP, THE MEMBERSHIP-BASED CHARTER PROVIDER, is acquiring Avianis Systems, a private aviation technology company, in an asset deal. According to Wheels Up founder **Kenny Dichter, the purchase will enable his company to accelerate development of a broad-based market for charter customers and suppliers.** "We want to be the Uber, the Airbnb, the HotelTonight, the Open Table of the private aviation space," he said. Daniel Tharp, Avianis founder and managing director Avianis, said he "quickly recognized" that combining

teams and assets would accelerate development of its web-based aviation management system used by the aircraft owners, operators, management companies, charter brokers and flight departments. The combination, he said, will bring value and opportunity to an industry "ripe for positive disruption." "Charter Marketplace" is to connect a supply of safety-vetted and verified aircraft with customers while helping operators digitize and streamline their services. According to Dichter, it's to offer post-booking automation, calculate real-time pricing, feasibility and availability and access additional flight demand. The plan is to digitize and organize business aircraft operators to create "more ease of use" and more innovative services. As a result, Wheels Up members are to have a significantly larger choice of private aircraft and aircraft types with competitive real-time pricing, and the ability to book through a dedicated app. In addition, the company recently purchased Travel Management Co., which operates a fleet of light jets. In August, it completed a $128 million round of funding that values the company at $1.1 billion.

A GLOBAL 7500 RECENTLY FLEW NONSTOP from Sydney, Australia to Detroit, Michigan, a distance of 8,225 nm, which Bombardier touts as the longest city-pair in business aviation in history flown by a purpose-built aircraft. According to the manufacturer, the Oct. 6 benefitted only modestly from tailwinds averaging approximately 20 knots. Previously the aircraft's non-stop record was a 7,990 nm trip between Singapore and Tucson, Arizona.

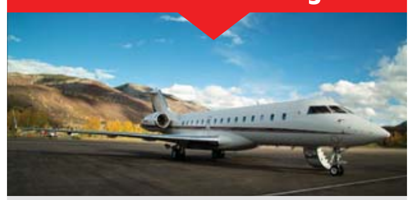
ACCORDING TO AN ACCOUNTING RELEASED IN OCTOBER, there were 1,214 accidents involving general aviation aircraft during 2016 and of those 195 resulted in fatalities. Even though the number of accidents increased by 41 over the previous year's tally, fatal mishaps declined by 26. Meanwhile, flight hours increased roughly 2% to 24.6 million. The figures were compiled by the Aircraft Owners and Pilots Association's Air Safety Institute (ASI) and released in the latter's annual Joseph T. Nall Report. According to ASI Executive Director Richard McSpadden, the reduction in general aviation fatal accidents – preliminary figures for 2017 suggest the decline is continuing – appeared to support the effectiveness of numerous industry initiatives to reduce those mishaps. The Nall Report analyzes data from the most recent year for which probable causes have been determined for at least 80% of accidents. It covers airplanes with maximum gross takeoff weights of 12,500 lb. or less and helicopters of all sizes, thus encompassing nearly all general aviation flight activity. Pilot-related accident causes of non-commercial fixed wing aircraft remained significant factor, accounting 775 accidents, and of the 1,036 accidents involving fixed-wing non-commercial aircraft, 185 (17.9%) were mechanical in nature. Notably, **weather related accidents—a topic of major emphasis in the industry's safety awareness campaign – fell from 39 total in 2015 to 23, a 10-year low,** and from 30 fatal crashes to 12. As usual, most were attributable to VFR flight into instrument conditions. Non-commercial helicopters experienced 79 mishaps, a 10-year low, but 14 of those were fatal, an increase over 2015. Meanwhile, there were 35 commercial helicopter accidents, of which three were fatal. In addition, there were 64 total commercial fixed-wing general aviation accidents, 19 of them fatal; and ag aircraft suffered 40 mishaps, 13 involved fatalities.

SGS Acquires Stake in ARGUS

ARGUS®

SGS has acquired a majority stake in ARGUS International, a specialized aviation information and services provider. With headquarters in Geneva, Switzerland, SGS says the purchase should strengthen its existing aviation auditing and consulting services and increase market penetration.

NetJets Gets 100th Challenger



NetJets recently took delivery of its 100th Challenger – a super-midsize 350 – raising the fractional operator's Bombardier fleet to 80 Challenger 350s and 20 Challenger 650s. "We're very proud of our long-standing relationship with NetJets," said David Coleal, Bombardier Aviation president, adding that the century figure "shows how sought-after this aircraft is and why it's simply the best business jet in its class."

Stillwater FBO Expands

IStillwater Flight Center, an FBO at Stillwater Regional Airport in Oklahoma, has expanded. The move follows the loss of most of its space to accommodate commercial air service, which began at the airport three years ago. The expanded FBO space in the main terminal includes a briefing room, pilots' lounge and sleeping area.

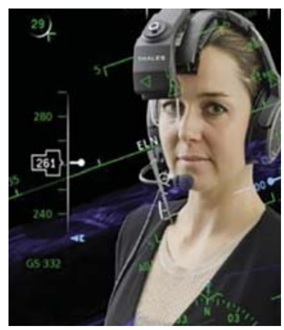
Red Aircraft Introduces RED A03 Engine

Red Aircraft, a German provider of aviation services, plans to introduce a new high-performance engine to the U.S. agricultural sector. The company's Red A03 engine offers operators lower operating costs and a lower ecological footprint compared to turbine or radial engines, the company said.

▶ **THE FAA SAID THE LAST TWO** of 155 planned airports now receive and display aircraft targets by automatic dependent surveillance-broadcast (ADS-B), completing its final implementation goal for the program. Akron-Canton Airport and Mansfield Lahm Regional Airport, both in Ohio, became operational for ADS-B in September. Aircraft flying in most controlled airspace will be required to transmit their GPS-derived position and other information by ADS-B by January. "This brings the operational rollout of ADS-B baseline services to a successful conclusion, on schedule and within budget, well in advance of Jan. 1, 2020, the date by which aircraft flying in certain, controlled airspace must be equipped with the technology," the FAA said Oct. 7. Controllers now track aircraft by ADS-B at airports, terminal radar approach control facilities responsible for aircraft approaching and departing airports and air route traffic control centers responsible for high-altitude, en route airspace.

▶ **JET AVIATION HAS ANNOUNCED** the opening of its new 40,000-sq.-ft. hangar and renovated fixed base operation in Teterboro, New Jersey. The new hanger is built to meet growing demand for long-range business jets and will accommodate most large aircraft, it said. The construction is part of the company's efforts to expand and improve its global FBO network of 35 locations.

▶ **THALES AND STANDARDAERO HAVE SIGNED** a long-term partnership agreement to certify and distribute Thales' TopMax wearable head-up display (HUD) for business aviation aircraft. The system comprises a full-color monocle display and head tracking system, mounted within a headband, that can be worn over either eye. It displays flight symbology and features as options a synthetic vision system, enhanced flight vision system and one that overlays SVS and EFVS imagery. It weighs 1.1 lb. It presents competition for the Elbit Systems SkyLens, a wraparound visor that also displays flight symbology and EFVS/SVS imagery. The wearable HUD provides operational credits as an EFVS and supports reduced takeoff and landing minima, manual eyes-out Category II landings, and lower-visibility Instrument Landing System approaches.



▶ **THE ROLLS-ROYCE RR300,** the engine powering the Robinson R66 helicopter, has accumulated 1 million hours in service. Frank Robinson announced the simultaneous launch of his company's first turbine-powered model and of engine, a compact derivative of the M250, that would make it possible in 2007. The helicopter was certified and began service three years later. Since that time, the R66 fleet has grown to nearly 1,000 helicopters units. Kurt Robinson, president of the company his father founded, said of the million-hour mark, "We believe this milestone is a testament to the R66's outstanding performance and confirms its place as a leader in the helicopter industry." The RR300 is manufactured in Indianapolis, Indiana, and the manufacturer reports having invested nearly $1 billion in Research and Development in the U.S. since 2013.

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INTERVIEW BY **WILLIAM GARVEY**

David Horton
President and Managing Partner
Schweizer RSG
Fort Worth, Texas

A native of Dimmitt, a Texas farm town between Lubbock and Amarillo, Horton gravitated to aviation early on since his father owned an aerial spraying operation there. He recalls the arrival of a Grumman AgCat, and was instantly captivated by the rugged, radial-powered biplane and equally rugged types who flew it. His career path clear, he earned an A&P on his 18th birthday and worked his way through Texas Tech as a ramp agent with Southwest Airlines. There followed a steady succession of aviation executive positions, primarily in the rotary-wing world first with Bell and Heli-Dyne and in 2008 installation by Sikorsky as president and general manager of Schweizer Aircraft in Elmira, New York. By then a private airplane pilot with a glider rating — he learned in a Schweizer 2-33 — when off duty he occasionally flew towplanes for the Harris Hill soaring club. Leaving Schweizer prior to its closure in 2010, he took the top executive slot at Uniflight and then a vice presidency at Safran Helicopter Engines until he began working on the Schweizer acquisition from Lockheed Martin in 2017. His private goal? Earning a rotary-wing rating.

Questions for David Horton

1 **Your group acquired rights to the former Schweizer Aircraft helicopter line in January 2018. What's the current status?**

Horton: We have a production certificate for articles, or parts. And we hope to earn a full aircraft production certificate in early 2020. To accomplish that, we're currently assembling four aircraft — two S300Cs and two S300CBi's — in our hangar at Meacham Field and FAA inspectors are carefully assessing each phase. Once satisfied, they give the go-ahead to proceed with the next phase. They're offering helpful comments and just want to be sure we've got the right plans and processes. If things go as well as we hope, we should be able to deliver 12 to 14 aircraft next year.

2 **What are your market projections?**

Horton: We estimate there may be as many as 1,700 Models 300s still operating and they've not had factory support in almost a decade, so we're addressing that first. At the moment, we're got firm orders for 27 aircraft — 26 of them for CBi trainers — and commitments for another 36, split evenly between utility operations and training. Estimated base prices for the 300C and 300CBi are $450,000 and about $410,000, respectively. We think the market can support 50 to 75 aircraft per year. We've got the resources now and will probably add another 15 to 20 employees as production ramps up and we begin overhaul and repair services.

3 **That include China?**

Horton: No. That could become one of the largest markets in the world and AVIC approached us to build our helicopters under license there for distribution in China and other places that accept aircraft with CAAC certification. How many aircraft are we talking about? Heck, it could be 100 or 10,000 — we really don't know. In my opinion, they could produce maybe 1,500 over five years. We'll see.

4 **What about the 333?**

Horton: We want to put that back into production, including some needed upgrades. We think it's got legs. It's robust, has an impeccable safety record and should go out the door at $1.1 million or $1.2 million VFR, so it will be a player in the marketplace. We just need a launch customer, and we're working on some proposals to get one. The aircraft is the basis for the MQ-8B Fire Scout drone and we're an approved vendor for Northop Grumman and have completed some engineering contracts for them. Going forward, we hope to provide some manufacturing work as well.

5 **Considering your long interest and Schweizer's history, any chance you'll be building AgCats as well?**

Horton: No, no, no. Personally, I'd love to see that. But we'll let Air Tractor and Thrush dominate that market. We're going to focus and work hard to be the best at what we do, which is building and supporting our helicopters. Besides, there's danger in trying to do too much outside of our core business. **BCA**

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


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Ending NOTAM Nonsense

When will international aviation **elevate these critical notices** to the digital age?

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

Normally overcast on a Bay Area summer night, the weather was unusually clear at San Francisco International Airport (KSFO) on July 7, 2017, when Air Canada Flight 759, an Airbus A320 inbound from Toronto and on a visual approach to Runway 28R, was cleared to land. It was 23:46 local time.

Waiting for takeoff on Taxiway C, parallel to Runway 28R and nearly 500 ft. to the north, were two United Airlines Boeing 787s, a Philippine Airlines Airbus A340 and a United Boeing 737. Runway 28L had been closed earlier in the evening for maintenance and was unlighted except for a flashing "X" at its threshold. The combined passenger and crew load of the five airplanes exceeded 1,000 people.

Confusing Runway 28R for the closed 28L and thinking Taxiway C was the active, the Airbus crew lined up on it for approach and landing. As the descending aircraft came within a half mile of the end of Taxiway C, the apprehensive Philippine crew turned on their A340's landing lights and the captain of the lead United 787 radioed the tower, "Where is this guy going? He's on the taxiway."

Still descending, the A320 overflew those first two airliners, clearing the A340's vertical tail by just 14 ft. and coming within 81 ft. of the ground before the crew, realizing their error, advanced the aircraft's thrust levers, just as the sole controller in the SFO tower ordered the flight to abort the landing and go around. In the seconds it took for the A320's turbofans to spool up, the aircraft continued to descend to an altitude of 59 ft.

It is generally assumed that, had not fate, bright landing lights and an alarmed pilot's radio transmission intervened, the SFO incident could have resulted in one of the worst aviation accidents in history. The ensuing NTSB investigation determined that the probable cause of the incident was the Air Canada crew's mistaking Taxiway C for the active runway, as they had missed the Notice to Airmen (NOTAM) on the Runway 28L closure, a fact buried in their briefing package of dozens of NOTAMs. Contributing factors included the crew not backing up the visual approach with the ILS for Runway 28R, which had not been tuned as part of their pre-landing preparations. In addition, there was the matter of crew fatigue since the captain of the late-night transcontinental flight had had no significant rest for the previous 19 hr., nor the first officer for a dozen hours (legal under Canadian rules at the time but not under FARs; the Transport Canada duty time regs were subsequently tightened).

"Although the Notice to Airmen about the Runway 28L closure appeared in the flight release and the aircraft communication addressing and reporting system message that were provided to the flight crew," NTSB Finding Number Nine of the subsequent investigation stated, "the presentation of the information did not effectively convey the importance of the runway closure information and promote flight crew review and retention."

The NOTAM finding is emblematic of the increasing shortcomings of the system, developed in the 1930s and changed very little in most parts of the world since then, to convey critical information to pilots. In addition to

AD DOWARD/ISTOCK

archaic formatting issues, complicating interpretation and consuming time to translate, read and absorb, the system is overwhelmed with a proliferation of NOTAMs, which have increased from 500,000 in 2007 to 2 million and counting this year, worldwide.

Buried in the 'Stuff'

The latter was addressed by NTSB Chairman Robert Sumwalt in an interview with BCA concerning the Air Canada 759 incident at SFO.

"We did find that Air Canada's ineffective NOTAM presentation was a contributing factor in that near-accident," he said. "The crew missed the NOTAM that the runway was closed. Today, they are reading [their briefing packages] on iPads, and the SFO runway closure was on page 8 of 27 iPad pages, and of the 27 pages, 10 of them were NOTAMs. And we all know that these were 10 pages of 'stuff' written in a computer-like code where the user has to decipher abbreviations, convert times to be useful to the given flight, and everything you need to know is buried down in there. In the Air Canada incident, there was something that was critical for them to know about — and it was buried down in the 'stuff.'"

Concern among NTSB members about the limitations and propensity for misuse of the outdated NOTAM system has been so rife over recent decades and the SFO debacle so significant that, for the first time in its history, the Safety Board conducted a full-up accident-level investigation of an incident. "If that had been an accident," one member pronounced, "it would have been worse than Tenerife," the 1977 runway collision of two Boeing 747s in the Canary Islands that killed 583 people.

"We acknowledge that NOTAM modernization has to happen, a better way to present the material, and that the current system is archaic — 'just a bunch of garbage,' as I was quoted in the media," Sumwalt, a former airline captain, continued. "I believe that having timely information is critical to safety of flight. But when it is buried down in a lot of code — stuff — and people can't find the important items, the critical information essentially becomes useless — which is why I said 'garbage.' I do want to emphasize that the idea of NOTAMs is not garbage, but it is the amount of material that is irrelevant that obscures safety of flight."

The inadequacy of the worldwide NOTAM establishment can best be

About Europe's NOTAMs

Eduard "Eddie" Porosnicu, a senior aeronautical information management expert at Eurocontrol, is that organization's lead researcher on NOTAM renovation. Here's a Q&A *BCA* conducted with him on the digital NOTAM project his organization is prosecuting for the European Aviation Safety Agency's Single European Sky-ATM Research (SESAR) ATC modernization program.

BCA: What is the state of NOTAM modernization and why, six years after we talked about this for our 2013 article, are flight crews still having to look through dozens of paper notices as part of their preflight?

Porosnicu: A radical improvement in the pilot preflight information bulletins (PIBs) requires a radical change in the NOTAM concept. The research done within the SESAR "Digitally Enhanced Briefing" (ePIB) project has confirmed that we can significantly improve preflight briefing, on condition that the NOTAM information was provided according to a digital data model. A prerequisite is that all other aeronautical data, such as airport layouts, airspace structure, procedures, etc., is also available according to the same digital aeronautical data model.

Unfortunately, progress toward digital NOTAMs was slower than expected. In the U.S., the FAA has already deployed a digital NOTAM production system at more than 350 airports (see https://notams.aim.faa.gov/#news). However, the FAA digital NOTAM data does not seem to be used yet on a large scale for improving the preflight information bulletins. A reason could be that the potential developers of applications and the potential users are waiting for a critical mass of Digital NOTAMs to exist. Other regions of the world need to provide Digital NOTAMs before users are willing to make the investment that would allow benefiting from the FAA Digital NOTAMs. In Europe, Digital NOTAM capabilities will be provided by the new European AIS Database (EAD) system, which is planned for the coming years.

The main difficulty, in my opinion, is that we are in a vicious circle: Data providers hesitate to make the investment because there is no immediate use, and data users wait for sufficient digital data to be available in order to start their developments and begin using it.

BCA: Is your research at Eurocontrol being done on behalf of EASA and ICAO?

Porosnicu: At the global level, ICAO is now making the necessary steps to break the vicious circle that I mentioned. Since November 2018, ICAO Annex 15 has introduced recommendations for states to provide digital data sets, which will progressively replace the paper Aeronautical Information Publications (AIPs). Digital NOTAM is mentioned in the Annex 15 recommendations. The ICAO Information Management Panel (IMP) has a dedicated working group for aeronautical information, which has the task to develop a new NOTAM system concept, based on digital data services.

BCA: Is there coordination with the U.S. FAA?

Porosnicu: Yes, the Digital NOTAM specification is developed in close cooperation with the FAA and other international partners. (See **https://ext.eurocontrol.int/aixm_confluence/display/DNOTAM/overview**)

BCA: When we visited Eurocontrol this year, you showed some examples of a digital NOTAM format. Is this a prototype for what could be a universal format?

Porosnicu: Yes, the objective is to develop a specification that is applicable globally. The U.S. FAA Digital NOTAM system applies the same concept format, based on the Aeronautical Information Exchange Model (AIXM).

BCA: Pilots want a NOTAM system that can operate through a search engine with filtering so they can retrieve only those NOTAMs that are specific to their operations. When will this be available?

Porosnicu: In Europe, this is expected to come with the enhanced EAD project, which is, for the moment, in the planning phase. In the U.S., based on the existing FAA Digital NOTAMs, such applications could probably be made available already, at least for the airports covered by the FAA Digital NOTAM system. **BCA**

appreciated when one considers that the information delivery system was conceived nearly a century ago and based on telegraphy, which was the fastest method for conveying textual information at the time. This determined the "archaic" format of capitalization, code and abbreviations, the last two to reduce the cost of telegraphing the messages, which at the time was expensive. Some of this technology dates from 1909 ("Q-codes" for categorization) and 1924 (the ITA-2 International Telegraph Alphabet character set). Plain text has had to wait for digitization and the internet — and most of the aviation world is still waiting.

In addition to the awkward and hard-to-read formatting is the ever-increasing number of NOTAMs, bloating briefing packages with up to 100 pages of them, depending on the length of the trip and whether it's domestic or international (the average is 50). This is what confronted the crew of Air Canada 759, and every professional flight crew understands the problem.

As Mark Zee, founder of the Ops Group flight information service, wrote in an article critical of the current NOTAM system posted on the Medium website and also carried in the Ops Group weekly briefing in July, "Your job, as a pilot at briefing time, is to find the one NOTAM that will end your career or endanger the aircraft, in a package the same size as a short novel. Buried deep in Birds of Bangkok, War and Peace by Greece and Turkey, Unlighted Tiny Obstacles, goat grazing times, grass cutting timetables — is a runway closed, a diversion airport unavailable, a decision height changed. And you'll miss it."

In an interview with *BCA,* Zee summarized the NOTAM problem, breaking it down into constituent parts:

▶ The huge number of NOTAMs in the briefing package, "making it way too difficult to find the critical element that could lead to disaster."

▶ The telegraphic format issue, specifically, "everything is printed in caps and hard to read."

▶ "Coding and abbreviations, and most pilots don't know them all. You can take any message and make it unclear with those two things, caps and coding."

▶ Lots of rubbish: grass cutting, birds, fireworks, foxes on the airport — all useless information to the pilot. There are a lot of animals in the NOTAMs and nothing you can do about it in your airplane."

▶ The count, 2 million total this year worldwide. "It shouldn't matter to the pilot how many there are worldwide, but each airport contributes to that number, so no matter where you fly, there will be more of them. We are drowning in the data and missing the message."

The Legal Argument

The data proliferation issue that is overwhelming flight crews was addressed by the NTSB in its Air Canada 759 findings: "Concerns about legal liability rather than operational necessity drive the current system to list every possible Notice to Airmen (NOTAM) that could, even under the most unlikely circumstance, affect a flight. The current system prioritizes protecting the regulatory authorities and airports. It lays an impossibly heavy burden on individual pilots, crews and dispatchers to sort through literally dozens of irrelevant items to find the critical or merely important ones. When one is invariably missed, and a violation or incident occurs, the pilot is blamed for not finding the needle in the haystack!"

So, what is the most efficient and effective way to communicate critical information? "Why not start with the idea that the pilot has to have the critical information for a safe flight to an airport?" asked Zee. However, the current system "is inherently flawed from the 1930s and [so] you have to start from scratch." The objective, he maintains, is to communicate clearly to pilots what is happening on the intended route of flight, at the destination airport and the alternate.

If all this seems familiar, it is. In fact, *BCA* focused at length on the same subject and its flaws in "NOTAMs in Transition," which we published in our January 2013 issue (page 24). In it we described the same NOTAM shortcomings and the need for a transition to a digitized system with information presented in plain text and accessible via search engines equipped with filtering so users could bring up only the most critical information for a given flight. The consensus of the sources we interviewed back then in government and air traffic management was that NOTAM modernization was just around the corner. Six years later, while some progress has been made by the FAA with a beta version of a digitized system (more on that later), most of the world is still reading NOTAMs written in code and flight crews are snowed in avalanches of them. And occasionally they can miss a critical one about a runway closure.

NBAA and NOTAM Modernization

The National Business Aviation Association has been part of an industry taskforce to provide input to the FAA on NOTAM reform and other information management issues.

According to Heidi Williams, director, AT Services and Infrastructure at NBAA, "Industry came together in early 2017 and formed the Aeronautical Information Services (AIS) Reform Coalition composed of airlines, general aviation, NBAA, AOPA, IATA, and others." The coalition then met with Teri Bristol, COO of the FAA Air Traffic Organization, "and talked to her about what we saw as challenges, NOTAMs being a big part of that."

This included not only the volumes of NOTAMs flooding the system but lack of digitization, change from domestic to ICAO format, inconsistencies in aeronautical data, and a common point of interface at FAA, since these issues have characteristically been handled by a multitude of divisions with little coordination. "This is a big challenge when you're trying to work the issues," Williams said. "[Bristol] understood and embraced the challenge and had her team do an assessment of the challenges we laid out. She appointed Abigail Smith as her liaison with industry to work the challenges." Williams is the industry lead for the coalition.

"Abby has wrangled all the FAA, and we are making excellent progress," Williams told BCA. "The lack of digitization is a key focus – this will entail going from [the present NOTAM format and distribution system] to the FNS, or Future NOTAM System." Transition to the FNS and an ICAO format was predicted for "later this year."

The coming months will see the introduction of an ICAO flight plan, as well. "This will allow greater global harmonization of data sharing and will allow us to get to a digital format to reduce the volume and have the ability to filter and parse NOTAMs and aeronautical data," Williams claimed. "We are excited that this has Teri's attention and FAA executive level support to get us there." BCA

So Why?

Why does a system critical to high-density jet travel yet rooted in the teletype age continue to be employed? The answer is a combination of bureaucratic machinations and an entrenched status quo, combined with the difficulty of achieving technological compatibility and gaining international agreement.

Listen to Saulo Da Silva, chief, global interoperable systems, at the International Civil Aviation Organization (ICAO) in Montreal: "Aviation is a safety-oriented business by default, so you can't necessarily change something overnight. We're aware of the need for a NOTAM evolution. As of today, in and of itself, the NOTAM does not provide a safety risk. What we have is a need for the evolution of the NOTAM system to improve the efficiency of exchange of critical information . . . that affects the operation of an aircraft. This task not only impacts safety but the efficiency of flight operations. Because this evolution needs time and a discussion between many stakeholders, ICAO has convened an Information Management Panel [IMP], drawing on about 25 members from among our 193 signatory states and seven international organizations, covering all seven ICAO regions, including a team of advisors, to evolve the NOTAM system into a web-based information service."

That effort has been under way for five years, and counting.

What appears to be slowing implementation of an international NOTAM solution is the goal of making digitized notices part of an overall electronic information management system. Accordingly, NOTAMs must become part of universal System Wide Information Management (SWIM) and nothing meaningful is going to be achieved until that occurs.

"So the NOTAM service would be a SWIM service," Da Silva confirmed. "But it has taken a lot of time because it is not simply [an effort] to convert from a system developed in the 1930s to the present level of technology."

According to Da Silva, among the concerns that must be addressed are information confidentially, integrity and availability. "When you transition to a modern IT basis, that is, plan to use the internet structure as its foundation, you have to understand that there are security parameters that must be considered so the information can't be tampered with. So, we need a system that is robust enough to prevent hacking. There is no silver bullet that will solve this; it takes a lot of work and discussion."

And Alexander Pufahl, ICAO technical officer, notes that SWIM is intended to be the management platform for all information related to civil aviation including NOTAMs. "However they will look in the future, NOTAMs will be distributed as an information service over SWIM, an IP-based, ground-to-ground and ground-to-air network," he explained. "Today we still have the Aeronautical Fixed Telecommunications Network [AFTN], over which, for more than half a century, NOTAMs have been distributed. So, this will be replaced with an IP-based network."

Currently, NOTAMs, flight plans and other documents are distributed as messages over the AFTN. It is envisaged in ICAO document 9854, the global air traffic management operational concept, that "in the future" they will be disseminated over an IP-based SWIM infrastructure in digital format. The working group is assessing a host of concerns, including information security and need-to-know versus nice-to-know value, in making recommendations. So, from the global information management perspective, NOTAMs are "one small aspect" of the information that will be distributed by SWIM. "And," he said, "that explains part of the delay."

The integrity of the information on the SWIM network has to be guaranteed, which also contributes to the delay. "We are not only changing the NOTAM format but have to guarantee, among other aspects, the integrity of the information," Pufahl said. "Whatever system is used to exchange information currently being processed via NOTAM, it has to be robust enough so we will not be trapped in the future with something worse like a denial-of-service attack or another type of cyberattack that may corrupt the information. SWIM is not an isolated project; we have other projects to guarantee the cybersafety and resilience of the system. It has to be a trusted network as part of a global trust framework."

Target Date

So, when will a new system be in place? "The most important thing is to establish NOTAMs as an information service," Pufahl said. "And our goal is to do this before 2030." He says implementation will be up to the individual states but the system will be interoperable and "technologically agnostic."

"I know there are problems with the current NOTAM paradigm," he continued. "I'm a pilot, too, and we all feel the pain." And have waited long years for an anesthetic.

Eduard "Eddie" Porosnicu, senior aeronautical information management expert at Eurocontrol, offered his perspective on the current NOTAM conundrum during a *BCA* visit to Eurocontrol's Brussels headquarters in June. NOTAMs "are still dominated by paper," he observed. "It may be a PDF document, but it's still a very long one, usually printed out and very difficult to read."

As an example, he cited a flight from Paris to Singapore whose attendant NOTAM list totaled 80 pages. And this — called a "narrow route bulletin" — was for a swath 40 nm left and right of course and 25 nm around the planned airports. "We want to change this to a map and a list of events termed a Digitally Enhanced Briefing or Enhanced Preflight Information Bulletin (ePIB),"

REGION	2000	2006	2007	2008	2009	2010	2011	2012	2013
Europe (L+E+B)	117,560	200,384	232,105	255,959	284,972	305,851	298,312	286,987	298,367
Pacific (A+N+Y)	16,919	27,642	31,462	38,897	39,405	42,058	45,462	41,129	42,310
Asia (R+V+W+Z)	30,452	47,624	51,104	56,565	64,937	69,344	70,530	73,274	81,974
Russia + Central Asia (U)	3,817	10,220	10,675	11,838	11,949	15,534	22,109	28,054	28,429
Africa (D+F+G+H)	12,242	17,981	19,949	21,868	21,905	23,290	22,668	26,087	25,702
Mid Asia (O)	5,571	12,998	12,973	13,353	14,376	13,800	14,598	13,140	13,404
North America (C+K+P)	78,897	120,441	135,587	221,497	255,040	306,744	338,131	360,358	445,075
South + Central America (M+S+T)	25,614	41,518	44,003	45,226	45,940	47,862	52,416	50,872	57,244
TOTAL	**291,072**	**478,808**	**537,858**	**665,203**	**738,524**	**824,483**	**864,226**	**879,901**	**992,505**

Attention: International NOTAM only!
MIL and National Series not included.

he said. This would include a list of relevant NOTAMs for the airport, in which items can be clicked on, and the location subsequently seen on the map. Digital NOTAMs would also be written in normal text, rather than all upper-case letters and in code as in the traditional model. “Pilots have recommended that the list be prioritized by the pilot,” Porosnicu said, “with the most important items at the top.”

Sounds good, so far, but then this: “The prerequisite for all of this is the digital aeronautical data set,” he continued, “and we are progressing slowly.” Oh.

“The U.S. already has the data set and digital NOTAMs for more than 300 airports as a SWIM service, but most pilots are not qualified to use it, and a developer will have to provide a device that connects to the service and translates the data,” Porosnicu explained. “In Europe, we have the baseline data but not the digital NOTAMs. Estonia has a project to have digital NOTAMs for airspace restrictions this year.” In Europe, Eurocontrol provides the European AIS Database (EAD); planned is an upgrade that will include digital NOTAMs and graphical preflight information bulletins.

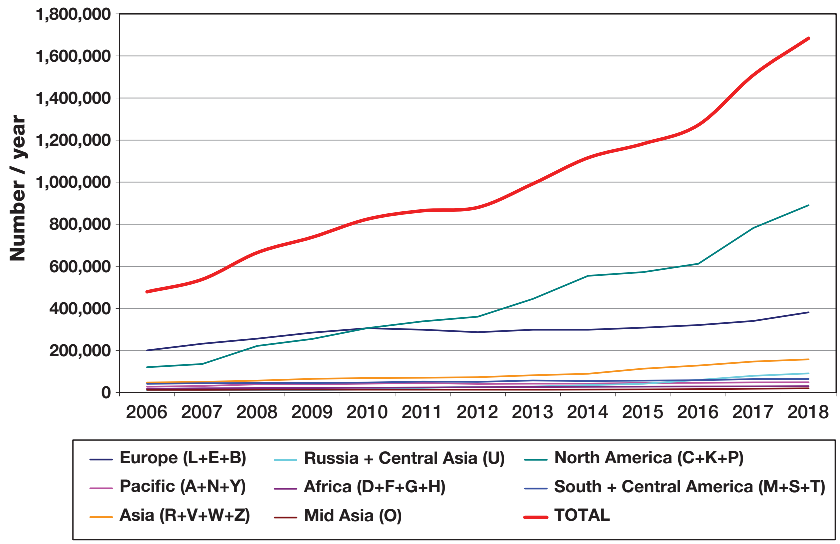
The forgoing aside, since anyone can find almost anything on line with Google, a search engine in wide use for 20 years, why is it taking so long to build a comparable system for NOTAM retrieval? “It is not rocket science,” Porosnicu maintained, “but it is truly complicated because of the global dependencies and the huge legacy embedded in the current NOTAM system. In many places around the world, the current NOTAM system employs very modern IT systems. Complex algorithms and data input interfaces ensure that the NOTAM messages follow the ICAO standards. NOTAM elements such as geographical coordinates, frequencies, etc., are automatically extracted from quality-assured data sources, the same that are used to create the AIP and the aeronautical charts.

“Ironically,” he continued, “the output of these very modern IT systems remains a text message with telegram-style aspects such as full upper case, abbreviations, contractions and codes, which make it very difficult to read and use . . .because that is the global standard! The standard needs to change in order to make progress. The good news is that ICAO is finally getting there with the IMP working group. If there is progress on a new ICAO NOTAM concept, we can expect that around 2025 many pilots around the world will see a radical improvement in the preflight information bulletins brought by digital NOTAM.”

At 700 Independence Avenue

Meanwhile, as noted and largely undercover , the FAA has been engaged in its own NOTAM modernization program in response to the 2012 FAA Reauthorization Act and the Pilot’s Bill of Rights. “We are working to modernize the system,” Abigail Smith, director, air

(International) NOTAM Trends



Source: Eurocontrol via Frequentis

Below: EAD NOTAM statistics per region. The table is courtesy of the Eurocontrol AIS Database (EAD) Services.

2014	2015	2016	2017	2018	Increase 2000 - 2018
298,876	308,226	320,976	340,514	381,270	324%
42,200	45,367	46,297	48,323	48,717	288%
89,133	113,364	128,595	147,062	157,723	518%
35,397	41,587	60,282	79,563	90,995	2384%
26,612	29,342	29,913	29,107	30,293	247%
14,008	15,520	15,392	18,077	20,074	360%
554,668	572,196	611,984	782,702	890,566	1129%
54,976	56,896	58,378	64,089	64,578	252%
1,115,870	**1,182,498**	**1,271,817**	**1,509,437**	**1,684,216**	**579%**

Source: Eurocontrol

traffic organization's technical training at FAA headquarters, explained. "Work spooled up in 2012 after the reauthorization, and I became the executive champion in March 2019 for this and it has gained more energy in the reauthorization of 2018."

The result is NOTAM Search, a fully digitized NOTAM retrieval system offering plain-text messaging and filtered searching and sorting.

"Go to the FAA web page," Smith instructed, "log on, and you have the choice of reviewing NOTAMs in plain language or the old format. Additionally, you can search on key words like 'airport,' 'chart,' 'communications,' 'GPS,' 'international,' 'air traffic,' 'military,' 'navaid,' 'obstruction,' 'route,' 'procedures,' 'security' and 'services.' You can sort by location number, class, UTC and condition. If you are flying, you can state a route, it will save it, and it will filter appropriate NOTAMs to you as you ask it."

And all of this is available right now and has been since January 2013, a fact unknown to many. Perhaps more pilots will become aware when the old Pilot Web service is shuttered on Jan. 24, 2020, and users will be referred to NOTAM Search. "The word hasn't gotten out," Smith admitted. "Turning off Pilot Web will be an improvement."

Yet to be done for NOTAM Search will be loading Geographic Information System software (GIS) — the data that supports graphics — into the system for airport information. "There are many providers of aviation graphics," Smith said, "and some are innovative in terms of display, so we want to get the data set right so pilots can get the information in the most valuable way for them. This is ongoing. We add airports to NOTAM Search every week — new ones come on — in partnership with other government agencies to get that data in a more rapid manner."

Of the 300 most NOTAM-producing airports in the country, 289 of them are originating digital NOTAMS — i.e., they have the data sets — and the FAA is working to get the rest of them. Another product of the FAA modernization project is NOTAM Manager, an app for generating NOTAMs. "We are getting the word out that [airports] can generate NOTAMS using NOTAM Manager," Smith said. "They have control of their own data."

The FAA claims that since NOTAM Search went on line, it has identified 400 NOTAMs in its portfolio that had become stagnant. Half of those were canceled, and the agency claims it is in the process of clearing out the other half. It is also conducting outreach to airport managements to purge their stale NOTAMs from the system, as well, since the FAA cannot cancel NOTAMs issued by outside agencies. Furthermore, it is considering "rearranging" Flight Information Regions to reduce the overall number of NOTAMs in the system. Both of these moves could go a long way toward reducing the proliferation of NOTAMs swamping flight crews in their preflight preparation.

One of the next steps in the development of NOTAM Search will be to make the system archival, too. Then, in June 2020, all other feeds will be

Team Effort

For Mark Zee, founder of the Ops Group flight information service, it's time for the NOTAM user community to take matters into its own hands. "For 55 years we've been asking, 'Why doesn't somebody fix this?'" he asked.

Now, after a call to action in an article he posted on the Medium website, readers and Ops Group members are crowdsourcing solutions to fix the NOTAM deficiencies. Within a month of the article's appearance, some 200 people, predominantly airline and business aviation pilots and flight dispatchers, formed the "NOTAM Team" to take responsibility from the users' perspective in fixing the system. "We've started with Slack, a collaboration software app, that allows us to come together and work," Zee explained.

"The key to why this is different and will work is that it is not the normal way we've tried to solve it for 55 years," Zee continued. "Now we are harnessing that energy to solve it by virtue of the fact that we are not part of a subcommittee — no rules to follow, just crowd-sourcing."

The idea behind the NOTAM Team is to help the aviation authorities in solving the problem, Zee insists. "We are not trying to circumvent the authorities. But does it have to go through them? And the answer is, I don't know. It may be the solution doesn't require five years of committees and approval processes, if it's good enough."

The group has set a lifespan for itself of nine months.

According to Zee, "We are starting to figure it out. We are asking, what is the way in which to solve it; who's involved; what expertise outside of aviation can we enlist, like designers, info-graphics people, those from other industries who have solved similar problems — for example, the nuclear industry? The answer may not come from aviation but outside. NOTAMs are not an aviation problem, they're an information problem. We are broadening the diversity of the team. Send me an email if you want to participate, or read the article on Medium [**www.medium.com**] or Ops Group."

But the question follows: Where to take the ideas? Presenting them to the regulatory establishment — ICAO, FAA, *et al.* — runs the risk they will be sucked into the black hole of bureaucracy and disappear for years, possibly never to reemerge.

Zee admits that, at this early stage of the project, he has no idea what direction the endeavor will take or how to implement the recommendations that result. But he notes, "What we're seeing is a move away from a single government source to independent private-sector flight planning and support services, for example, Jeppesen, with charts and flight planning, and all the other players in the flight planning and trip support business." And that segment of the industry may be accepting of new ideas for presenting and organizing NOTAMs in such a way that the important messages and information aren't buried. In the meantime, as Zee pointed out, "This is pilots solving problems." **BCA** turned off so NOTAM Manager will be the only way to file and NOTAM Search the only way to retrieve NOTAMs, consolidating all NOTAMs into "a single authoritative source." In late 2020 or early 2021, the FAA will switch to ICAO standards in terms of how it groups NOTAMs. "We likely will establish between 15 and 20 categories to make it easier for pilots to group and sort NOTAMs," a spokesman told *BCA*. Categories will include airport surfaces, navaids, obstructions, etc.

Problem Solved?

So, how well does NOTAM Search work, and does it solve the endemic problems of the traditional system? We queried one business pilot who has used the site and he said it was "definitely easier" to harvest NOTAMs than with the paper system but wondered if it would reduce the overall number of notices confronting crews. On the other hand, he maintained, "it certainly helps, as you are able to order them in a 'list' format by subject matter and also apply a filter and sort functions. But it is still up to the crew to go through them and decide on importance. There is no AI [artificial intelligence] function to sort based on impact to operations."

Once a user is accustomed to it, he said, NOTAM Search is "pretty robust in its graphical and text presentation. The map is very useful for seeing airspace restrictions." In conclusion, though, he said "the bigger issue is the 'language' of NOTAMs. It takes 2 in. of single-spaced type to relay a very simple item. . . . The language needs to be changed from 'legalese" to plain English."

Another business aviation pilot was skeptical that NOTAM Search really solves the bigger problems of the NOTAM system, such as the lack of ranking and proliferation. "The order doesn't make any sense and nothing stands out," he emailed to *BCA*. He cited a runway closure at JFK International Airport announced for a date in summer 2019 "and while there are hints that Runway 13L/31R will be closed . . . it doesn't appear explicit until the last page, [with] some 80 or so NOTAMs ahead of it. The only thing they [the FAA] have done is to put a color-coded symbol on the online app. I think the crux of the problem is that the guys who cut the grass and repair the signs get equal billing. They shouldn't be in the NOTAMs at all."

In that pilot's opinion, the FAA hasn't "gotten anywhere close to fixing anything." For his flight planning, he prefers to use commercially available apps like ForeFlight and NOTAM Decoder, the latter of which arranges NOTAMs for a given airport according to their criticality and codes them red, amber, blue, etc.

Pointing out that NOTAM Search works solely in the U.S. — only one of ICAO's 193 signatories — Ops Group's Zee insists that "the problem is not solved. It's a glimmer of hope, a step in the right direction, but not the solution. The question is what the briefing package looks like, and that's 100 pages of NOTAMs for an international flight. The FAA system has done a better job of standardizing what NOTAMs say and look like, but it doesn't solve the larger problem, which is that pilots are not getting the information they need for their flights, and they are missing important things. If you're flying from New York to Buenos Aires, you're going to be transiting across multiple countries and so you're going to get multiple sets of information. NOTAM Search doesn't change the story from an international standpoint. It is part of what the solution might look like."

The NTSB has urged the FAA for two decades to rectify the NOTAM issue. It could be that the Air Canada incident at SFO will serve to break the bureaucratic logjam. The near disaster spurred the Safety Board to speak loudly to the public on the matter, as underscored by Chairman Sumwalt's pronouncements here and in the Board's SFO incident findings. It is generally accepted that the FAA (ICAO, too) contributed to the NOTAM problem by years of its inaction. The fact that within the FAA bureaucracy a minimum of five offices have had responsibility for NOTAMs may explain, to some extent, why this has been so. Evidence that the agency means to change its ways is the fact that it recently assigned Smith, a senior agency executive and former air traffic controller, to coordinate the NOTAM modernization initiative.

When the Pilots' Bill of Rights was accepted by the FAA as part of the 2012 reauthorization, the agency was given one year to fix the NOTAM system. Yet now, seven years later, all the industry has is a beta-level website and a lot of good intentions. As things stand, the agency is prohibited from violating any operator on a NOTAM issue until it gets the system fixed. Nevertheless, even though in its present state it does not solve the NOTAM proliferation problem, NOTAM Search could serve as a foundation for a useful IT-based system. But both users and industry observers believe it needs to go much further. **BCA**

Canada Takes Action

Nav Canada has announced that as of Oct. 10 it will transition to an ICAO format and a new website for distributing NOTAMs. The air navigation service provider said one key difference is that notices will be geographically referenced instead of based on NOTAM File identifiers for airports, flight information regions (FIR) and nationwide notices.

Pilots and operators will be able to search for NOTAMs by entering an airport identifier, navaid, FIR or geographic coordinates, with a desired radius around points of interest as an option. They will also be able to enter a flight route and receive all NOTAMs that geographically intersect it, Nav Canada said.

In addition to the new format, notices obtained from the Nav Canada Aviation Weather Web Site will be available using a NOTAM retrieval tool on its Collaborative Flight Planning Services (CFPS) website. Pilots were able to use the CFPS site to access notices beginning in mid-September.

"The adoption of the ICAO NOTAM format — already used by most countries — will ensure compliance with international standards and will eliminate the need for pilots who fly international routes to be familiar with more than one NOTAM format," Nav Canada said. "It will also pave the way for more advanced filtering functionality, reducing NOTAM clutter by helping pilots access just the NOTAMs pertinent to their flight." — *Bill Carey*

Richard N. Aarons
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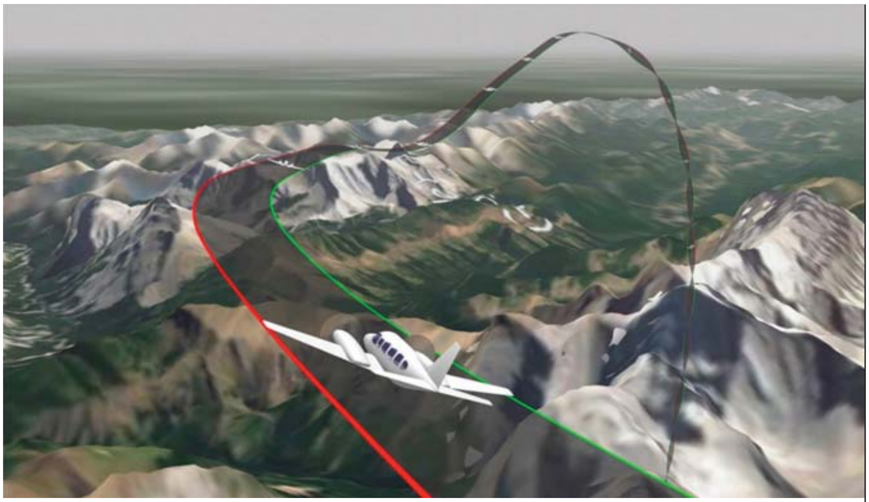
A Fatal Unmasking

Oxygen is as **critical as fuel**

TRANSPORT SAFETY BOARD



Final flight path of the aircraft leading up to the loss of control and spin entry (looking toward the southeast).

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

An Aries Aviation International Piper PA-31 Navajo (registration C-FNC) crashed near the summit of Canada's Mount Rae at 1336 MDT on Aug. 1, 2018. A brief explosion and fire followed ground impact, leaving both occupants — the pilot and survey technician — dead. They had just completed 2 hr. of survey work near Penticton, British Columbia, and were proceeding on an IFR flight plan from Penticton Airport (CYYF) to Calgary/Springbank Airport (CYBW), Alberta.

The flight was cruising at 15,000 ft. MSL and was approximately 40 nm southwest of CYBW when ATC began sequencing the aircraft for arrival into Calgary airspace and requested that the pilot slow the Navajo to 150 kt. and descend to 13,000 ft. About 90 sec. later, the aircraft departed controlled flight from 13,500 ft., and crashed.

Eleven witnesses saw the crash and notified authorities. Additionally, the Canadian Mission Control Center received a 406 MHz emergency locator transmitter signal from the aircraft and notified the Joint Rescue Coordination Center. Search and rescue arrived on site approximately 1 hr. after the accident.

The fire extinguished shortly after the crash. First responders noticed superficial burn damage and soot around the engines, nacelles and inboard wing sections. The accident was not survivable because of the impact forces.

The investigation of this accident was conducted by Canada's Transport Safety Board (TSB). Investigators said they were greatly assisted by the fact that the aircraft was equipped with an engine monitoring system and an Appaero cockpit video/voice recorder. Thus, the TSB team could gain a rare insight into the loss of a Part 23 (light) aircraft. This investigation certainly backs up the U.S. NTSB's recommendations that all Part 23 charter and air taxi aircraft be equipped with data recorders and that their operators use data collected to develop Safety Management Systems (SMS) for their respective operations.

The Investigation

Weather at the time of the accident was generated by a weak low-pressure system over the southern border between Britiah Columbia and Alberta, centered west of Red Deer. An upper trough oriented north-to-south over the central portion of Alberta was moving eastward at 15 kt. The graphical area forecast for the area near the accident site called for a few clouds based at 12,000 ft. up to 14,000 ft. Isolated thunderstorms were forecast for the area northwest of CYBW after 1400. The freezing level was forecast to be at approximately 12,500 ft.

Observed weather at the location and time of the accident was consistent with the forecast. A broken layer of cumulus clouds based at 13,000 ft. was prevalent, with no significant wind or turbulence. A few hours after the accident, there were thunderstorms near CYBW.

The captain held an ATP and had accumulated 4,400 hr., some 2,800 of which were in type. He had flown 41 hr. in the previous seven days and 135 hr. in the previous 90 days. He had been on duty for 5.6 hr. prior to the flight, preceded by 14 hr. of rest.

The pilot had begun flying in 1999. After obtaining a commercial pilot license in 2002, he flew for a variety of flight schools and air-taxi operators. In 2007, he started training for his multiengine instrument rating, which he obtained in 2009. At the time of the accident, his license and instrument rating were valid and current in accordance with the Canadian Aviation Regulations (CARs).

In 2012, the pilot was hired by Aries Aviation, and, in 2015, he obtained his ATP. Survey flying at Aries Aviation is done primarily in visual conditions (VMC), and instrument flying is limited to training or transiting to and from the work area. The pilot's flight time in instrument conditions (IMC) could not be determined from the information collected during the investigation.

The aircraft had been manufactured in 1981 and had accumulated about 7,277 hr. on its airframe. It was powered by two Lycoming TIO-540-A2C piston engines turning Hartzell HC-E3YR-2ATF propellers. Maintenance had been accomplished according to regulations and was up to date. The aircraft was equipped with a BLR Aerospace LLC vortex generator kit that had been installed in accordance with an STC. The kit consisted of 86 vortex generators of different sizes installed on the wings and on the vertical stabilizer, as well as four strakes (two on each nacelle). The STC also provided for an increase in gross takeoff weight from 6,500 lb. to 6,840 lb. Additionally, the markings on the airspeed indicator were changed to reflect the change in performance for the aircraft.

When the aircraft departed Penticton, it weighed approximately 6,885 lb. (45 lb. over the gross takeoff weight) and was within the forward and aft limits of the center of gravity envelope. When the aircraft departed controlled flight, it weighed approximately 6,000 lb., and its weight and center of gravity were within the prescribed limits.

Performance charts from the airplane flight manual (AFM) indicate that the Navajo's single-engine service ceiling at the time of the accident was 16,500 ft. At 13,500 ft., the single-engine climb rate (V_{YSE}) at 97 KIAS was 350 fpm.

Approximately 95% of the wreckage was recovered from the accident site and shipped to the TSB regional office in Edmonton. The flight control system was examined, and no pre-impact anomalies were noted. The landing gear had been in the retracted position, and the flaps were in the up position.

The aircraft fuel system was examined to the degree possible. The left and right fuel-tank selectors were found in the INBOARD positions. The right nacelle-tank fuel cap was tested for water leaks; none were observed. The inboard fuel-tank caps were also tested for water leaks, and it was noted that some water (about 2.5 mL per hour) was seeping by the O-ring gaskets that were cracked and aged.

TSB personnel, along with a Lycoming representative, examined the right engine. None of the components from the recovered fuel, air or ignition systems indicated any faults that would have prevented the engine from developing rated power. (The right engine was the center of interest because of the engine performance monitoring that we'll discuss a little later.)

Nothing of note was found in the postmortem examination of the pilot, nor was there anything in his medical history that would indicate a predisposition to sudden incapacitation.

Although not required to be equipped with a traditional flight data recorder (FDR) or a cockpit voice recorder (CVR), the Navajo was fitted with an Appaero Systems Vision 1000 and a J.P. Instruments Engine Data Monitor 790 that provided significant information about the flight path and engine performance.

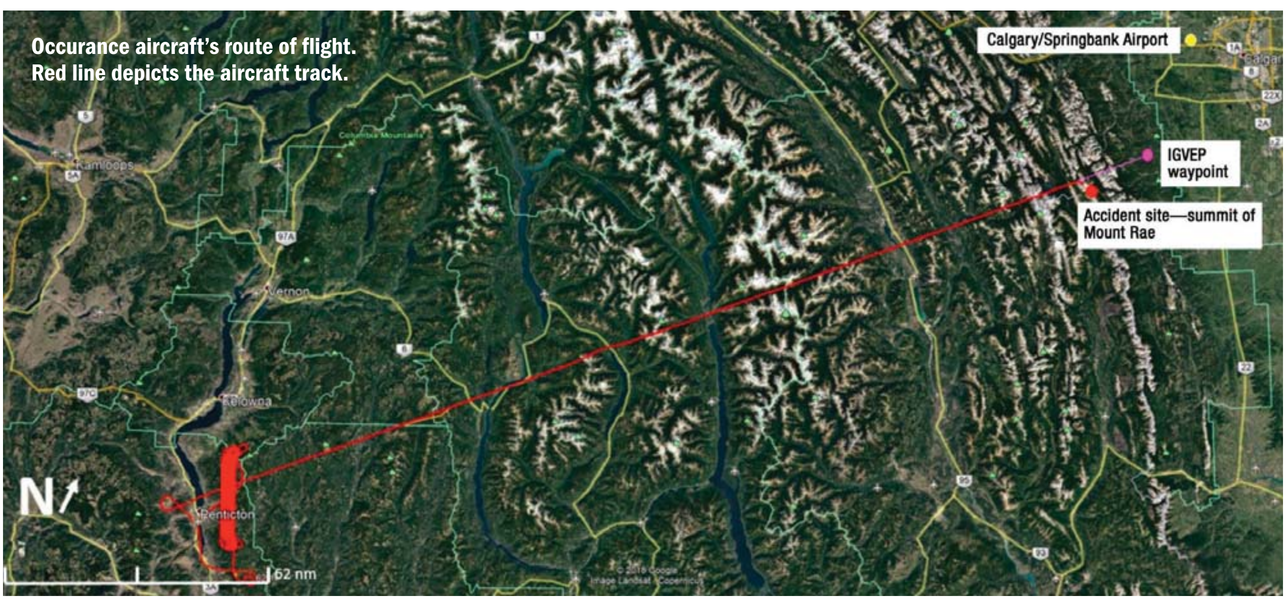
Spin Recovery

The airplane flight manual (AFM) for the Piper PA-31 Navajo and the Aries Aviation standard operating procedures — Aries was the aircraft operator — do not describe spin-recovery procedures for the airplane, nor are such descriptions required by regulation. Indeed, there are no certification requirements to demonstrate spins in a multiengine aircraft.

However, Transport Canada advises the following spin-recovery procedure for small aircraft if no data are available from the manufacturer. In summary, the steps are:

❶ Close the throttles/power to idle.
❷ Neutralize the ailerons.
❸ Apply full opposite rudder to the direction of the spin.
❹ Move the control column briskly forward.
❺ Maintain these control inputs until rotation stops.
❻ Neutralize rudder.
❼ Recover from the resulting dive.

These steps are universal and should be discussed in upset training by all check airmen. BCA



Occurance aircraft's route of flight. Red line depicts the aircraft track.

TRANSPORT SAFETY BOARD

(It should be noted that the recorded images and voice communications were privileged in accordance with the Canadian Transportation Accident Investigation and Safety Board Act, because the Appaero System Vision 1000 was installed such that it was not intended to be controlled by the operating personnel on the flight deck of the aircraft. Nevertheless, the flight path data, audio files and image files retrieved from the system enabled the investigators to better understand the underlying factors that contributed to the accident.)

Aries Aviation had installed the Appaero flight data monitoring (FDM) system in the aircraft on March 12, 2018. The unit is a self-contained flight data recording system that only requires power and ground leads from the aircraft's electrical system to operate. The information captured by the Vision 1000 includes:

- ▶ Attitude data (pitch, roll, yaw, etc.).
- ▶ WAAS GPS position and altitude.
- ▶ Cockpit imaging.
- ▶ Ambient audio.
- ▶ Intercom system audio for crew and ATC communications.

When the system was set up in the aircraft, the imaging provided by the camera included the entire left side and center of the instrument panel and the power-lever quadrant. However, sometime after being installed, the unit had been bumped inadvertently, which altered the recorded field of vision. The pitch information recorded by the unit also was inaccurate.

At the time of the accident, only the four engine instruments at the top of the center panel were visible, along with a portion of the left instrument panel, and a significant view out the cockpit windshields. Because the power-lever quadrant was no longer being recorded by the FDM system, the investigators were unable to determine the positions of both engine controls just before and during the accident sequence.

The Vision 1000 unit was damaged in the crash, but all 8 gigabytes (GB) of data were recovered, including audio and images for the last 2.6 hr. of the flight, as well as 200 flight hours of inertial data.

Insufficient O_2 at Altitude

The investigation into the loss of Aries Aviation International's Piper PA-31 Navajo C-FNCI along with its pilot and a survey technician on Aug. 1, 2018, prompted Canada's Transportation Safety Board (TSB) staff to do a deep dive into the literature on hypoxia. It seemed nearly certain that exposure to hypoxia and hyperventilation by the single pilot were prime causal factors in this case.

"Normoxia" is the state in which a physiologically adequate supply of oxygen is available to a body's tissues, whether in quantity or molecular concentration. When the level of oxygen available is below that requirement, a state of "hypoxia" exists, according to Ernsting's Aviation and Space Medicine.

The TSB expands the subject explaining, there are different types of hypoxia, all of which involve different mechanisms of oxygen deprivation. Hypoxic hypoxia is the most common type related to flight; it can occur in flight above certain altitudes, because as barometric pressure falls, breathing ambient air will result in a fall of the partial pressure, and thus the molecular content, of the oxygen in the lungs. This results in individuals experiencing a reduction in the oxygen tension in their inspired gas and that situation, ultimately, has a detrimental effect on their performance.

However, the severity and onset of hypoxia vary, depending on a multitude of factors. The altitude and onset rate affect hypoxia. For example, ascending slowly to 13,000 ft. may produce a slow onset of symptoms; however, rapid decompression at 30,000 ft. can be fatal within minutes.

The effects of hypoxia also vary depending on personal conditions such as individuals' health and fitness and their use of medications or alcohol, as well as on the activity or tasks in which the persons are engaged and how significantly the activity affects their respiration rate.

Studies have highlighted the typical symptoms of hypoxia, but results vary depending on participant characteristics, the test environment and the actual test conducted. Thus, it is impossible to accurately assign a cause-and-effect value to a specific altitude. However, typical effects on human physiology and performance of an ascent from 7,000 ft. to 15,000 ft. without supplementary oxygen include the following:

Physiological responses — In a resting person, the TSB found that "ascent to an altitude of 10,000 ft. ASL produces a fall in the partial pressure of oxygen in the lung alveoli but only a slight fall in the percentage saturation of hemoglobin with oxygen. However, above 10,000 ft., the percentage saturation of hemoglobin falls quickly. Thus, for a period of time at this altitude, the body's physiology initially compensates for the change in oxygen pressure. However, the heart rate increases by a small percentage immediately when breathing air at an altitude above 6,000 to 8,000 ft. and by about 10% to 15% at 15,000 ft., with an associated rise in systolic blood pressure and a shift in blood distribution away from the skin and toward the heart and brain. Above 15,000 ft., normal physiological mechanisms no longer offer compensatory protection, and a pilot may start to experience headache, dizziness, 'air hunger' [gasping for air] and fatigue."

Performance detriments — The brain normally uses a substantial amount of oxygen and, therefore, is very susceptible to a reduction in oxygen pressure. As altitude increases, it suffers a gradual degradation in thinking, memory, judgment, muscular coordination and reaction time. Hearing decreases and peripheral vision narrows as the visual field darkens. Specifically, novel tasks are the most difficult to carry out,

The JPI EDM-790 engine-data analyzer also had nonvolatile memory, which the TSB downloaded and analyzed. The data recovered consisted of the following for both engines:
▶ Exhaust-gas temperature (EGT) at the turbocharger.
▶ EGT for each cylinder.
▶ Cylinder-head temperature for each cylinder.
▶ Fuel flow.
▶ Oil temperature.
▶ Outside air temperature.

Analysis

The Navajo had been deployed to the Okanagan Valley on July 18, 2018, for survey activities — flying over selected areas at 3,600 ft. AGL at a ground speed of 150 kt. For each flight, a survey technician sat in the cabin of the aircraft and operated the survey equipment; the pilot flew from the left front seat. Each survey mission averaged 6 hr. of flight time and was typically conducted between 0800 and 1600 local time.

On Aug. 1, the aircraft departed Penticton Airport at 1026 with full fuel and began survey operations at 1034 to the east of the airport. The survey portion of the flight lasted for 2 hr. with the aircraft flown at 10,000 ft. for the final hour.

Once the survey was completed, the pilot air-filed an IFR flight plan to Calgary. ATC issued a clearance for the pilot to climb to and maintain 15,000 ft. and to proceed directly to the IGVEP waypoint.

During the climb through 11,000 ft., the pilot selected the autopilot ON and switched the fuel selectors from INBOARD to OUTBOARD. Shortly after the aircraft reached 15,000 ft., at 1256, the pilot selected the fuel pumps ON in accordance with the AFM and left them ON for the rest of the flight.

He selected the autopilot altitude hold (ALT) mode, then assisted the survey technician in activating the portable oxygen system. Two minutes later, the pilot put an oxygen mask up to his face, then, a few seconds later, he put it down.

At 1328, the autopilot ALT mode disengaged for an undetermined reason. Over the following 47 sec., the aircraft

and even learned and practiced tasks become more challenging to execute.

Once a pilot reaches around 15,000 ft., performance detriments will become more pronounced for more demanding tasks, such as manual flying or emergency handling, which requires conceptual reasoning, use of short- or long-term memory, decision making, critical judgment, quicker reaction time and/or hand-eye coordination with muscular coordination. In fact, by 15,000 ft., a pilot may experience restrictions to the visual field, a 25% decrement in memory capacity, and a decrement in hand-eye coordination of 20% to 30% with fine tremors in the hand, making it more and more difficult to hold a control in a fixed position. A pilot's ability to judge airspeed, heading and orientation, as well as to deal with inflight emergencies, becomes progressively more impaired around this altitude.

Inability to detect hypoxic symptoms — Although certain hypoxia effects may become more noticeable than others as an aircraft ascends, associated changes to a pilot's sense of self, motivation, willpower and wellness often overshadow the ability to identify performance degradation in themselves. In fact, a pilot who is in a hypoxic state may actually experience euphoria. Even sensory effects, such as darkening of the visual field, may become noticeable to individuals only after they begin to revert to normal (i.e., after using oxygen or descending to a lower altitude).

Respiration, Hypoxia and Hyperventilation

As explained in Human Performance and Limitations in Aviation, "The most powerful stimulus to respiration is caused by the body's perception of an increase in carbon dioxide tension, rather than its perception of a reduction in the oxygen tension in the blood." As a pilot ascends, his or her respiration rate may therefore increase. However, a pilot may end up eliminating too much carbon dioxide (without breathing in adequate oxygen supplies), and the hypoxia may subsequently lead to hyperventilation, a condition in which individuals' increased respiration rate causes them to exhale more than they inhale.

Other symptoms of hyperventilation include lightheadedness, dizziness, tingling and, potentially, spasms and contractions in the extremities. Some hypoxia studies have also noted that it is not always clear whether these effects are due to hypoxia or to the associated hyperventilation. Aviation medicine texts also advise that, if pilots experience hyperventilation, they should suspect hypoxia as an initiating condition.

Anxiety and stress can also lead to an increase in respiration rate and hyperventilation. Although these can occur in any pilot, hypoxic pilots may be more likely than others to experience stress and anxiety situationally, for example, upon perception of difficulties with task performance. If an individual begins to hyperventilate, the rapid breathing often produces more anxiety, resulting in an uncontrolled cycle unless intervention occurs. A pilot may therefore be vulnerable to hyperventilation if he or she is hypoxic, and may be especially vulnerable if he or she is both hypoxic and stressed.

Much of the TSB's information on hypoxia came from these sources:
▶ Simon Fraser University, Environmental Medicine and Physiology Unit, High-Altitude Indoctrination Program, at https://www.sfu.ca/science/faculty-support/facilities-services/empu/indoctrination_program.html
▶ D. P. Gradwell and D. J. Rainford, Ernsting's Aviation and Space Medicine, 5th Edition.
▶ D. Campbell and M. Bagshaw, Human Performance and Limitations in Aviation, 3rd Edition. BCA

started to climb from 15,000 ft. to 15,400 ft. It then started a descent, reaching a peak vertical speed of 3,200 fpm and an acceleration of 0.5 G. After 9 sec. of descent, the aircraft leveled off at 15,000 ft. (with an acceleration of 1.7 G) and the pilot re-engaged the ALT mode.

At 1330:55, ATC instructed the pilot to descend to 14,000 ft. At 1331, the pilot switched the fuel tanks from the OUTBOARD to the INBOARD position in accordance with the AFM, selected PITCH mode on the autopilot, and began the descent to 14,000 ft. The aircraft entered cloud during the descent and leveled off at 14,000 ft. 90 sec. later, at which point the pilot engaged the ALT mode.

At 1333, ATC asked the pilot for his indicated airspeed (IAS), but the pilot read back the altitude of 14,000 ft. ATC, once again, asked for the IAS, but this time the pilot read back the ground speed of 170 kt. instead; the actual IAS was 140 kt. ATC then asked the pilot to slow to 150 kt. indicated airspeed (KIAS) and to descend to 13,000 ft.

A few seconds later, the manifold pressure (MP) on both engines decreased, which resulted in the left MP gauge indicating an MP of 18 inHg and a fuel flow of 22 gal. per hr. (gph), and the right engine indicating an MP of 15 inHg and a fuel flow of 14 gph.

After the power reduction, the autopilot ALT mode disengaged. The navigation and pitch mode, as well as the flight director mode, remained ON. The aircraft's airspeed decreased to below the single-engine inoperative best rate-of-climb speed (Vyse) of 97 KIAS, and the aircraft maintained an altitude of 13,900 ft. The airspeed reached 91 KIAS, and the stall horn began to sound intermittently.

Then, the IAS began to increase as the MP for the left engine increased to 34 in. Hg with a fuel flow of 38 gph. At the same time, the right MP gauge indicated 20 inHg and a fuel flow of less than 10 gph. The aircraft began a brief descent, and the airspeed increased to 100 KIAS.

At 1334:40 the aircraft deviated to the right (south) of the intended track, and its altitude decreased to 13,500 ft. It then began to climb, and the IAS began to decrease below Vyse once again. At 1335:43, ATC called the pilot to confirm that he was going to the IGVEP waypoint. The stall warning horn was sounding continuously at this time. The pilot replied that there was a problem with the right engine. Shortly afterward, the airspeed decreased to 71 KIAS, and the aircraft departed controlled flight and entered a right-hand spin.

The Navajo exited the clouds at 13,300 ft. Shortly afterward, the engine fuel-flow monitors indicated idle fuel flow, or about 4.5 gph, for each engine. Commensurate with the power reduction and decrease in airspeed, the rpm of both engines decreased. When the right engine reached 700 rpm, the right-alternator failure (R ALT INOP) warning light illuminated on the annunciator panel, followed immediately by both the left and right pneumatic-source failure (L PNEU INOP and R PNEU INOP) warning lights. As the airspeed increased to 110 KIAS in the spin, the rpm of both engines also increased. When the aircraft reached 110 KIAS, the right alternator-failure warning light went out, followed by the right and then the left pneumatic-source failure warning lights.

As the aircraft descended through 11,500 ft., ATC asked the pilot to report

Accidents in Brief

Compiled by Jessica A. Salerno

Selected accidents and incidents in October/September 2019. The following NTSB information is preliminary.

October 5 — About 1637 EDT, a Piper Aerostar 602P (N326CW) departed from Kokomo Municipal Airport (OKK), Kokomo, Indiana, and crashed in a field about 3.6 mi. south of the airport. The airplane was destroyed by impact forces. The airline transport pilot was killed in the accident. The Aerostar was registered to Indiana Paging Network Inc., and was operated by the pilot under Part 91 as a business flight that was not operating on a flight plan. It was VFR for the flight when departing from OKK.

On the day of the accident, the flight departed from Peter O Knight Airport (TPF), Tampa, Florida, about 0645 and arrived at OKK about 1027. The purpose of the flight was for the pilot, who was employed by In Flight Review, Inc, based in Tampa, Florida, to provide Piper PA-42 Cheyenne recurrent training to a customer based at OKK.

According to the airport employee who fueled the airplane, he asked the pilot of N326CW, while on approach to the airport, if he wanted jet fuel, and the pilot said "yes." He said the he asked the pilot if he wanted jet fuel because the airplane looked like a jet airplane. When the airplane arrived, the employee pulled the Jet A fuel truck out and parked it in front of the airplane while the pilot was still inside the airplane. The employee said that he asked the pilot again if he was wanted jet fuel, and the pilot said "yes." The employee fueled the airplane with about 163 gal. of Jet A from the fuel truck. The employee said that he was able to orientate the different shaped nozzle (relative to the 100LL fuel truck nozzle) from the Jet A fuel truck by positioning it 90 deg. over the wing fuel tank filler necks and about 45 deg. over the fuselage filler necks. He said the he initially spilled about one gallon of fuel during refueling and adjusted his technique so subsequent fuel spillage was minimal.

The Jet A fuel truck had "JET A" on its left, right, and rear sides.

The employee that was inside the FBO building about 1620 heard the engines start. After the engines started, the engines sounded "typical." He said that he did not hear any radio transmissions from the pilot during his departure and did not hear an engine run-up.

The pilot, who received recurrent training from the accident pilot, stated the accident pilot began training right away beginning about 1045. They completed training and it was after 1630 when the pilot drove the accident pilot to N326CW. The pilot said the accident pilot visually checked the fuel tanks of the airplane and gave a "thumbs-up" to the pilot. The pilot did not stay for the remainder of the accident pilot's preflight and drove off. The pilot heard the engines start and "they sounded normal." The pilot did not see the takeoff.

A witness stated that she saw a "low flying" airplane flying from north to south. The airplane made a "sharp left turn" to the east. The left wing "dipped low" and his situation. The pilot declared an emergency. The aircraft continued spinning, and, during the spin, the pilot occasionally input full left and partial right aileron on the control column. The aircraft did not recover. It completed 7.5 revolutions before colliding with terrain at 10,000 ft., near the peak of Mount Rae, at 1336:17.

Investigators who had looked at both the video and engine recorder outputs said "it was clear that the incident began when the right engine was developing less power than the left as the pilot began his decent from 15,000 ft."

The analysis of engine monitoring data recorded before the accident flight found that a significant fuel flow discrepancy (split) between the left and the right engines had started on July 8, 2018. Before this date, the fuel flows were fairly evenly matched between both engines (within a couple of gph). Further analysis of the data found that the right engine fuel-flow information was representative of the actual operating conditions. A review of the aircraft's maintenance records indicated no maintenance actions that would have caused this discrepancy.

The TSB Engineering Laboratory examined the engine parameter data in support of the aircraft performance analysis. What follows is a summary of the observations from the engine data from the beginning of the power asymmetry and the loss of control.

On the day of the occurrence, before 1334:09, the parameters of the engines were well matched. The largest difference was in the indicated fuel flow (FFI), with the right engine's flow being higher than the left engine's flow by about 2 to 3 gph — approximately 10%.

After 1334:09, the FFI and indicated manifold pressure (MPI) of both engines began decreasing; however, the right-engine flow fell more quickly. Furthermore, the indicated right-engine exhaust-gas temperature (EGTI) and the recorded right-engine exhaust-gas temperature (EGTR) began to decrease, whereas, in the left engine, these parameters remained relatively steady.

Within 10 sec., the right-engine FFI and MPI increased momentarily. The right-engine FFI then fell toward the minimum levels (the gauge minimum being 10 gph), and the right-engine MPI fell to about 15 inHg. At the same time, the left-engine FFI and MPI increased.

Unlike the right-engine FFI, the right-engine recorded fuel flow (FFR) did not fall toward minimum levels, remaining between 18 and 20 gph. (It had been about 24 gph before the drop in power level.) This disparity between the right-engine FFI and FFR generally continued until the end of the flight. FFI is measured at the fuel servo by a direct-reading pressure gauge calibrated in gph. FFR is measured by a vane-type fuel-flow sensor installed between the engine-driven fuel pump and the fuel servo.

In consultation with the manufacturer of the engine data monitor, the investigation determined "the most likely explanation for a sudden disparity in fuel-flow readings between the two systems is air being introduced into the engine fuel supply. As the viscosity of an air/fuel mixture is significantly lower than that of aviation gasoline alone, it flows through the fuel supply system faster, accounting for the higher FFR reading."

The left-engine FFI then increased to higher levels than before the drop in

she then lost sight of the airplane but when she approached the intersection near the accident site, she saw the airplane on the ground.

Post-accident examination of the airplane revealed the airplane wreckage path was about 328 ft. in length along an approximate heading of 046 deg. on a dry and hard surfaced fallow bean field. Components of the left side of the airplane were near the southwestern portion of the wreckage path. The wreckage and the wreckage path displayed features consistent with an accelerated stall.

The examination revealed the presence of a clear liquid consistent in color and order with that of Jet A in a fuselage tank and in the fuel lines leading to the fuel manifolds of both engines. Several of the engine spark plugs exhibited damage consistent with detonation.

▶ **September 28 — About 1930 EDT,** an Enstrom F-28F helicopter (N380SH) was heavily damaged when it impacted terrain and vehicles during an approach to a helipad at the Bloomsburg Fair in Bloomsburg, Pennsylvania. The commercial pilot sustained serious injuries and the two passengers received minor injuries. The helicopter was operated by J&J Shop HeliAir LLC under the Part 91 as a local sightseeing flight. Night VFR prevailed, and no flight plan was filed for the local flight that originated about 1920.

Surveillance video captured the final 19 seconds of the flight, which showed the helicopter approaching the helipad in a forward-moving hover. It then pitched up and simultaneously began a right yaw (clockwise turn). The helicopter subsequently completed two and a half descending spins before impacting vehicles and terrain.

According to an FAA inspector who examined the helicopter at the accident site, the helicopter came to rest on its left side. The fuselage, tail boom, main and tail rotors sustained substantial damage. The fuel cap remained secured and a faint odor of fuel was present at the accident site. The passenger doors were not installed. The inspector reported that the operator held an FAA Letter of Authorization to conduct commercial air tour operations under Title 14 CFR Part 91.147.

According to FAA airman records, the pilot held a commercial pilot certificate with ratings for helicopter and airplane single-engine land. His most recent FAA second-class medical certificate was issued in March 2019 and at that time, he reported a total of 8,400 flight hours.

According to FAA airworthiness records, the three-seat helicopter was powered by a Lycoming HIO-360-F1AD, 225-hp engine.

At 1954, the weather conditions reported at Williamsport Regional Airport, Williamsport, Pennsylvania, which was located about 25 mi. from the accident site, included calm wind, visibility 10 sm, clear skies, temperature 22C, and dew point 19C. A wind sock that was visible in the surveillance video was consistent with calm at the time of the accident.

▶ **September 23 — About 2045 CDT, a** Cessna 150G (N4658X) crashed near Prairie Grove, Arkansas. The private pilot, the sole occupant, was killed, and the airplane was substantially damaged.

power level (27 versus 22 gph), and the left-engine MPI increased but was still slightly lower than before the drop in power level (22 inHg versus 24 inHg). When the airspeed dropped below 110 KIAS, the right-propeller rpm began to fall below 2,300.

The pilot likely experienced some degree of hypoxia in this occurrence, said TSB investigators. "Based on the results of controlled research on hypoxia in humans, the investigation concluded that, during the ascent to and continued flight at 15,000 ft. without supplementary oxygen, the occurrence pilot may have experienced headache, dizziness, air hunger and fatigue, as well as gradual degradations in thinking, memory, judgment and muscular coordination.

"His reactions would also have slowed down. His hearing capacity may have started to decrease, and his peripheral vision may have narrowed as the visual field darkened. The pilot may have found it more and more difficult to perform tasks using working memory or to judge airspeed, heading and orientation. However, due to the slow and gradual onset of symptoms and the probable associated sense of well-being, it is unlikely these effects were noticeable to the pilot." (See the "Insufficient O_2 at Altitude" sidebar.)

While the aircraft was at 15,000 ft., the autopilot ALT mode disengaged and the aircraft ascended to 15,400 ft., about 400 ft. above the cleared altitude. "The pilot did not immediately respond to this involuntary ascent. When he did respond, his response was unusually aggressive. A few minutes later, ATC requested the pilot's indicated airspeed. After a delay, the pilot responded with an altitude reading. ATC requested his indicated airspeed again, but the pilot responded with the ground speed this time. This performance could be indicative of degradations in thinking, memory and judgment, and more specifically of difficulty with working-memory tasks due to hypoxia," said the TSB.

The pilot did not continuously use oxygen above 13,000 ft. and likely became hypoxic as the aircraft climbed to and maintained an altitude of 15,000 ft. "The pilot did not recognize his symptoms or take action to restore his supply of oxygen, resulting in degradation of his ability to manage normal flying tasks in an effective and timely manner," said the Safety Board.

"To maintain situational awareness during the asymmetric flight condition and to respond appropriately to this condition, the pilot needed to perceive the critical elements of the flight environment and comprehend quickly what they meant.

"Although the engine gauge parameters differed between left and right engines, the airspeed decreased, the heading changed, and the aircraft deviated from the intended track, there were no aural or visual cautions or warnings of an engine-power loss. The aircraft more or less maintained its course and airspeed during this initial stage of the emergency.

"The rapid increase in the pilot's breathing [recorded by the Appaero device] indicates the pilot may have realized that something was wrong; however, his response was slow and inappropriate. Specifically, the response to the asymmetric power condition was delayed, and the memory-based tasks associated with the single-engine emergency checklist were not performed," said the TSB.

Accidents in Brief

The Cessna was registered to Wingnut Enterprises LLC, and operated by Tango Thirty One Aero Club under Part 91 as a personal flight. Dark night, VFR conditions prevailed for the flight, which operated without a flight plan. The cross-country flight originated from Drake Field (FYV), Fayetteville, Arkansas, with the destination of Aero Country Airport (T31), McKinney, Texas. According to preliminary information obtained from the Federal Aviation Administration, the airplane departed FYV and requested flight following to T31. Shortly after departure, the airplane descended from radar coverage. An Alert Notice was issued for the airplane.

A nearby landowner reported hearing a low flying airplane followed by the sound of an impact. They smelled fuel but could not locate the wreckage in the dark. They notified first responders, and the airplane was later located. The airplane crashed into a lightly wooded, hilly area. Initial impact signatures were consistent with the airplane colliding with trees and impacting terrain in a nose low attitude.

▶ **September 21 — About 1825 CDT, a** Cessna A185F amphibian floatplane, Canadian registered C-GOZJ, was destroyed when it impacted terrain shortly after takeoff from Conroe North Houston Regional Airport (CXO) in Conroe, Texas. The two Canadian licensed, single-engine land, private pilots were fatally injured. It was VFR for the private flight that was conducted under Part 91, and no flight plan had been filed. The airplane was based at CXO and departed at 1824 local.

According to a witness at Galaxy FBO, he was sitting in the office when he saw the single- engine airplane with floats taking-off on Runway 14, heading straight ahead. It appeared like a normal climb, with no flaps down. The airplane engine had a backfire sound, like a loud "pop! pop!" He stated it sounded as though the engine was "powering down," after a few seconds, he heard the sound of the engine "powering back up. It sounded like power was being put in to help the aircraft try to climb." About that time, he heard the pilot radio the tower "we have a fuel problem; we are going to return to the airport." He ran outside and took a golf cart to the edge of the arrival canopy. Looking toward the end of Runway 32, he saw a glimpse of the airplane's tail straight up, then it disappeared behind the trees, and light layer of smoke followed.

▶ **September 20 — About 1230 CDT,** a Cessna 208B (N895SF) was heavily damaged during a hard landing at Pepperell Airport (26MA), Pepperell, Massachusetts. The commercial pilot and passenger were not injured. It was VFR, and no flight plan was filed for the skydiving flight that departed at 1215. The airplane was privately owned and operated under FAR Part 91.

According to the pilot, he was flying 10 skydivers and one passenger up to an altitude of 10,500 ft. MSL. After the skydivers departed the airplane, the pilot returned to the airport and made a normal approach to land on Runway 24. When

"As a result of hypoxia-related cognitive and perceptual degradations, the pilot was unable to maintain effective control of the aircraft or to respond appropriately to the asymmetric power condition."

Regs and Findings

The TSB report on this accident points out that "the use of oxygen is necessary to prevent and relieve inflight oxygen deprivation [hypoxia]. Upon use, individuals will often return to a normal functioning state, although the speed and degree of recovery depend on how severely hypoxic they were. Continued use of supplementary oxygen is required at altitude to avoid returning to a hypoxic state."

Canada's CARs stipulate that, for unpressurized aircraft such as the Navajo, a supply of oxygen be available for the flight crew and at least one passenger for flights exceeding 30 min. at cabin-pressure altitudes above 10,000 ft. but not exceeding 13,000 ft. When the aircraft is operating at cabin-pressure altitudes above 13,000 ft., a supply of oxygen must be available for all persons and used.

Aries Aviation requires pilots to take recurrent theoretical training on high-altitude physiology every three years. The pilot's most recent training was on July 19, 2018. Theoretical training includes awareness of physiology in low-pressure environments, including respiration and hypoxia; other factors associated with rapid loss of pressurization, such as cabin temperature change and noise; and required actions. Since the accident, Aries has beefed up its hypoxia training and SOPs.

The TSB made these findings as to causes and contributing factors of the accident:

(1) The pilot did not continuously use oxygen above 13,000 ft. and likely became hypoxic as the aircraft climbed to 15,000 ft. The pilot did not recognize his symptoms or take action to restore his supply of oxygen.

(2) As a result of hypoxia-related cognitive and perceptual degradations, the pilot was unable to maintain effective control of the aircraft or to respond appropriately to the asymmetric power condition.

(3) The aircraft departed controlled flight and entered a spin to the right because the airspeed was below both the published minimum control speed in the air and the stall speed, and because there was a significant power asymmetry, a high angle of attack, and significant asymmetric drag from the windmilling propeller of the right engine.

(4) When the aircraft exited cloud, the pilot completed only one of the seven spin-recovery steps — he reduced the power to idle. As the aircraft continued to descend, the pilot took no further recovery action, except to respond to air traffic control and inform the controller that there was an emergency. (See "Spin Recovery" sidebar.)

Finally, the Safety Board remarked that the flight path data, audio files and image files retrieved from the Appaero system enabled the investigators to better understand the underlying factors that contributed to the accident.

We certainly agree that new-technology FDR/CVR-type devices should be installed in all working aircraft. The information they collect can make curate and, ultimately, save lives and aircraft. **BCA**

the airplane was about 10-15 ft. above the runway, he thought he encountered a sudden downdraft and the airplane just "dropped" out of the air and landed hard on the grass runway. The nose landing gear fractured off as the airplane slid to the right side of the runway and crossed the asphalt parallel runway. The airplane then hit a small tree on the right wing that spun the airplane around. The left wing hit the ground and bent the last three feet of the wing tip up.

▶ **September 19 — About 1020 PDT, a** Cessna 182H (N1891X) crashed in mountainous terrain about 6 mi. southwest of Nixon, Nevada. The private pilot and passenger were killed, and the airplane was destroyed. The Cessna was registered to T Craft Aero Club, and operated by the pilot as a Part 91 personal flight. It was VFR and no flight plan was filed. The flight originated from Lake Tahoe Airport (TVL), South Lake Tahoe, California about 0945 and was destined for Nampa Municipal Airport (MAN), Nampa, Idaho.

Preliminary radar data showed the airplane on a southerly track after takeoff followed by a left turn toward the northeast. The airplane continued in that general direction until about Interstate 80 and then continued on a north-northwest heading. The track paralleled a mountain ridgeline until it made a right 180-deg. turn and ended.

The nearest weather reporting station was the Reno-Tahoe International Airport (RNO), about 22 nm southwest of the accident site. At 0955 wind was reported as 050 at 5 kt., few clouds at 3,500 ft., scattered clouds at 5,000 ft., broken 8,500 ft., and broken at 20,000 ft.

▶ **September 18 — At 0731 EDT a** Beech V35TC (N5438U) impacted terrain about 1/4-mi. short of Runway 09 at Madison County Airport (UYF), London, Ohio. The private pilot was killed. The airplane was destroyed by impact forces and post-impact fire.

The airplane was registered to and operated by the pilot Part 91 as a personal flight. It was VFR at the accident site and at the time of the accident. No flight plan had been filed. The flight originated from Apple Airstrip (OOH7), Piqua, Ohio, about 0715 and was destined for UFY.

A dash camera video from a passing motorist captured the accident and showed the airplane turning from left base to final approach and descending to the ground. Examination of the wreckage disclosed the flaps were set at 20 deg. and the landing gear was extended.

▶ **September 17 — About 1230 EDT, a** Robinson R44 (N827JE) operated by Rowland Air Chem LLC, was heavily damaged during a forced landing near Sardis, Georgia. The commercial pilot was seriously injured. The aerial application flight was conducted under Part 137. VFR conditions prevailed and no flight plan was filed for the local flight that departed a staging area in Sardis, Georgia, about 1220. The pilot reported that he was flying about 100 ft. AGL applying spray when he heard a "pop," followed by alarms and lights activating in the cockpit. The helicopter then lost engine power and the pilot performed an autorotation. During the autorotation, the helicopter hit trees and terrain. **BCA**

Gulfstream Unveils a New Flagship

The G700 aims to lead the ultimate jet set

PHOTOGRAPHY COURTESY OF GULFSTREAM AEROSPACE

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

Carefully concealed in a research and development hangar at its Savannah, Georgia, headquarters campus, the first of what Gulfstream has designated the G700 awaits its first flight. This newest Gulfstream model is a stretched derivative of the G650ER, making it the largest, heaviest, roomiest, most luxurious, very likely the longest-range, and, at $75 million per, one of the most-expensive business jets yet built by the U.S. manufacturer. Quite clearly, it's intended to wrest the lead from Bombardier's 7,700-nm Global 7500 flagship, currently the world's biggest and farthest flying purpose-built business aircraft.

With four or perhaps five aircraft dedicated to the flight test program, the G700 is targeted to get its type certification and enter service in 2022.

The G700 shares the G650ER's 6.3-ft.-high, 8.2-ft.-wide cabin cross-section. It has a 10-ft. longer fuselage that makes possible a fourth, 8.75-ft.-long living area in the main cabin, plus a larger forward galley and a roomier aft lavatory. Two additional wide oval cabin windows are added to each side of the fuselage for a total of 20 transparencies flooding the interior with ambient light. Gulfstream claims the aircraft features the tallest, widest and longest cabin in business aviation.

Compared to the G650ER, the interior is being reconfigured for better space utilization up front. The forward lavatory is being relocated from behind the main cabin door to a new compartment just aft of the cockpit to cabin bulkhead on the copilot's side. The move makes possible a larger, left-side crew rest compartment with two signature oval windows. Some customers may wish to configure the space as a fifth living area instead of a crew rest compartment, as shown in Gulfstream's G700 full-scale sales mockup that was on static display at the NBAA's annual Business Aviation Convention and Exhibition in Las Vegas in October.

Depending upon choice of interior layout, the right-side galley has as much as 10 ft. of counter space, illuminated by two cabin windows. Galley cabinetry will offer close to 50% more storage volume than that of the G650's split, left- and right-side galley sections. A comparatively large refrigerator is mounted under the work counter on the aft side. A second refrigerator is optional. A stacked pair of ovens is mounted in a cabinet just forward of the crew rest compartment.

A typical cabin layout will feature a forward, four-chair club section, an entertainment section with an 80-in., three-place divan facing a pop-up, 32-in. ultra-high-definition monitor in a credenza, a four-seat plus two-seat dining room and a fully enclosed, aft master stateroom with 46-in.-wide bed flanked by an occasional use bench seat. The aft lavatory may be equipped with an optional shower.

Cabin chairs are being redesigned for the new aircraft. Customers can choose different foam densities and ergonomic features to make the seats more comfortable for individual passengers — an important consideration since flights may last as long as 15 hr., or more. The chair backs are fitted with hard exterior shells that eliminate stretching and sagging of seat back leathers and fabrics as the chairs are repeatedly reclined and positioned upright. The standard chairs are manually actuated. One or two motorized chairs are available as options.

The sidewall arm ledges are wider than those in the G650. The redesign makes room for individual storage compartments with 5-volt USB power outlets to charge personal electronic devices. The ledges will not have individual seat IFE monitors. Instead, telescoping docking stations for tablet devices pop up from them. Dedicated switches have been added to overhead passenger service units to control lights and to the arm ledges to control window shades and table lights. Cabin systems also can be controlled using a mobile app.

Gone are the motorized foldout tray tables. G650 customers said they were too unreliable. The G700's manually operated tables should be more durable. Similar to the Global 7500, the G700 will have a six-seat dining area with four chairs in a conference grouping and two facing chairs across the aisle. Interior designers are especially proud of the new pivoting, folding and extending table system in the area. They note that it extends into a wall-to-wall dining table surface in less than 20 sec. without the need to install or remove and store an extension leaf.

The G700 retains the G650ER's four Type IV over-wing emergency exits. They permit a wide variety of cabin configurations, including flexible placement of bulkheads between seating areas, that fully comply with emergency exit access regulations. For instance, the main, four-section living area may be moved forward 52.5 in., one window frame length, to provide room for an extended aft lavatory with shower. Most competitive large-cabin business aircraft have a single emergency exit that restricts how cabins are configured.

The 10.69-psi pressurization system will provide the lowest cabin altitudes of any current production business aircraft, the same as the G500, G600 and G650 series. At the G700's FL 450 mid-cruise flight level, cabin altitude will be 4,060 ft. and at the aircraft's FL 510 certified max flight level, cabin altitude will be 4,850 ft. Gulfstream is confident that it can meet or beat the G650's impressively low interior sound levels — 47.6 dB speech interference level at Mach 0.85 long-range cruise and 49 dB SIL at Mach 0.90 high-speed cruise. No other business aircraft can boast lower noise levels.

The cabin wash light system is designed to harmonize with natural circadian rhythms. Using closely spaced white and amber LEDs, it automatically adjusts color temperature and brightness as a function of aircraft position to simulate dawn, daylight and dusk conditions. The illumination brightness between each of the cabin zones can be varied, as well.

Honeywell's Jet ConneX Ka-band satcom will be a no-cost option and it should be popular. It provides up to 15 Mbps download speeds, supporting most importantly, Wi-Fi calling through passengers' mobile phones.

Flight deck features dual Collins Aerospace HGS-6200 HUDs with both synthetic and enhanced vision.

Modified GVI frame, GVII Tech

Gulfstream plans to seek type approval for the G700 as an amendment to the FAA T00015AT GVI type certificate, as it will retain most of the aerodynamics, structural properties and systems of the G650/G650ER. While the fuselage is stretched 10.1 ft., the wing, empennage and landing gear are virtually unchanged. New winglets will improve lift-to-drag performance and add 3.4 ft. to span. Subtle changes to the wet wing fuel cells will increase fuel capacity by 1,200 lb. Projected basic operating weight will increase from 54,500 lb. to 56,000 lb.

Two Rolls-Royce Pearl 700 turbofans, highly evolved Pearl-family variants of the G650's BR700-725 powerplants, will each provide 18,250 lb./thrust with 3-5% better specific fuel consumption, reduced nitrous oxide emissions with 35% margins to CAEP VI limits and lower than Stage 5 noise levels. The engine features a 51.8-in. blisk fan, nearly 2 in. larger than that of the BR725, a 10-stage compressor, two-stage, shroudless

Private aft lavatory is available with marble veneer floors and counters. Shower is optional.

Six-seat dining area has table that may be extended from wall to wall in 20 seconds without the need for a removable leaf.

high-pressure turbine and four-stage low-pressure turbine, one more stage than that of the BR725. The bypass ratio should be higher than 6.5:1 and overall pressure ratio is expected to exceed 50:1. The Pearl 700 fits inside virtually the same external nacelle contours of the BR725 and it uses most of the same aircraft interfaces, including bleed air, electrical and hydraulic systems.

Expect G700 systems to be adapted from the G650ER. It will use virtually the same 1,283-sq-ft. wing, albeit with more advanced and more outboard canted winglets to reduce drag. Optimized for Mach 0.855 long-range cruise, the wing has 33 deg. of sweep at quarter chord, a supercritical airfoil and a modest aspect ratio just under 8:1. The longer fuselage provides more space between the trailing edge of the wing and the engine nacelles, a design characteristic likely to reduce interference drag.

The cabin pressurization system uses 100% fresh bleed air supplied by the APU or propulsion engines. The cockpit and cabin will have four temperature control zones. Bleed air is also used for wing and nacelle anti-ice protection. AC electrical power from main engine and APU generators is used for heavy electrical loads, such as motors, heaters and battery chargers. A ram air turbine will provide emergency AC power. DC power, supplied by transformer rectifier units, along with the battery chargers in certain conditions, is used for other loads. NiCad main and emergency batteries, respectively, provide power for APU starting and the auxiliary hydraulic pump, plus backup power for the fly-by-wire (FBW) system and the third set of flight control actuators.

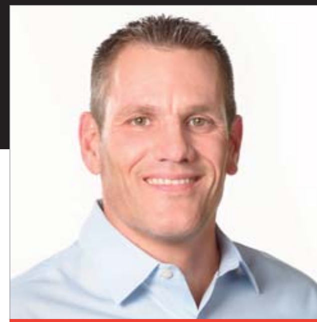
The quad-redundant FBW system uses dual Thales Canada main flight control computers, BAe Systems active sidesticks and Parker actuators. A fifth FBW channel is provided by a backup flight control computer. Four Collins Aerospace SmartProbes provide pitot, static, angle-of-attack and sideslip air data to the flight control system.

Pilots type-rated in the G650 will not be automatically qualified to fly the G700 even though the latter shares many G650 systems. Rather, they'll have to be GVII type-rated because the G700 shares the Symmetry flight deck with the G500 and G600. This likely will be Gulfstream's plan for future aircraft, a common type rating but with differences training. The system uses nine touchscreen controllers on the flight deck, plus a 10th in the galley annex. Symmetry is highly integrated with aircraft systems, slashing the length of checklists and making it possible for the aircraft to be launched in 10 min. or less from the time the crew first switches on battery power.

Aboard the G700, Symmetry uses the G650's digital flight control architecture outside of the flight deck. Company officials, though, comment that the flight control actuators will be upgraded to make them more immune to the weather.

Forward right side galley has 10-ft. counter and 50% more storage space than aboard G650ER. Left side may be configured as a fifth living area, as shown here, or equipped with a full length crew rest compartment with two windows and a lay-flat berth.

FAST FIVE WITH HONEYWELL



STEVE SLIJEPCEVIC
President, Electronic Solutions

Steve Slijepcevic leads Honeywell Aerospace's Electronic Solutions business, which includes integrated avionics; navigation, safety and surveillance solutions; flight management systems; flight controls and synthetic vision display technology; manned and unmanned and satellite applications and space businesses.

Q. How long has Honeywell been in the weather radar business?

A. We introduced our first x-band radar in 1954. We've brought new technologies to our products for seven decades and now offer a line of radar called IntuVue, the first in the industry to offer a 3D display of weather to significantly improve hazard detection and avoidance. Our newest version, the RDR-7000 Weather Radar System, comes to market in 2020 for business aircraft, helicopters, regional air transport, and military aircraft and can detect weather from zero to 60,000 feet altitude and out to 320 nautical miles in front of the airplane. Also, in the spirit of firsts, the RDR-7000 can detect turbulence up to 60 nautical miles. In addition to detecting typical storm cells, our weather radar detects hail, lightning, and wind shear.

Q. How does Honeywell differentiate itself in the weather radar business?

A. The key differentiator is our detection—vertically up to 60,000 feet altitude. We can tell pilots how tall a storm cell is, and the pilot can then determine the optimum flight path around that cell. The system is fully automated, so the pilot does not have to intervene to move the antenna. We also can detect wind shear at 5 to 10 nautical miles out, a terrific safety capability.

We received an email from a pilot a couple of months back, flying through the Midwest one stormy day. She was able, through our system, to know the cell exceeded 45,000 feet in altitude and knew she couldn't fly above that and had to go around. That image of weather is unique.

Q. What is Honeywell doing to drive weather detection technology forward to keep people and aircraft safe?

A. In the context of the IntuVue RDR-7000 Weather Radar, the system is specifically designed to replace weather radar systems on smaller aircraft, such as business aviation and light helicopters. This system will be one of the only lightweight radar systems (at 16 pounds) able to see turbulence 60 nautical miles ahead.

We also launched the IntuVue RDR-84K at OshKosh and will begin deliveries with general aviation customers before the end of 2019. While most radars use one beam of radar, the IntuVue RDR-84K uses multiple beams to identify several things simultaneously, in a system that weighs just 2 pounds.

Q. What do you see in terms of the future for this type of technology?

A. Whether an aircraft is controlled by a remote pilot, a virtual pilot autonomously, or a pilot on board, the IntuVue RDR-84K identifies weather, other flying objects without transponders, the ground and objects on the ground. Because this full capability comes in a 2-pound system, several RDR-84K radar sensors can be mounted on a single aircraft to provide sensing for the front, sides, below and to the rear of the aircraft—all connected—to simultaneously see potential hazards. It paints a much more comprehensive picture for the virtual or on-board pilot. And we have this technology flying on an urban air mobility prototype.

Q. How does weather link to Honeywell's overall connected aircraft goals?

A. Our scientists have made an art of studying water droplets and their patterns. We have the software, hardware (antenna and sensor) and weather expertise that support a pilot with a full, connected weather readout. We stitch together a much more comprehensive picture. Typically, our accuracy at 93% exceeds that of traditional weather forecasting.

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Dual Collins HGS6200-series HUDs are standard, along with a third-generation, high-resolution, cryogenically cooled InSb EVS camera that is tuned to detect infrared heat sources, but not visible light. For now, Gulfstream is not changing over to a multi-spectral microbolometer EVS camera that can detect visible light as have Bombardier and Dassault with their latest technologies. Similar to the capabilities offered by Bombardier and Dassault, the HUD will also display SVS and/or EVS imagery. A rocker switch on each sidestick will select or deselect SVS and EVS imagery on the HUD. Notably, angle-of-attack is displayed in the HUD.

Gulfstream's predictive landing performance feature will be standard. It looks at ground speed, flight path vector and touchdown point, runway condition, and manual or auto-brake performance to predict and display on both the PFD and HUD where the aircraft will stop on the available runway. If any of those parameters changes so that the aircraft cannot stop on the pavement, it alerts the crew. If the pilots elect to continue the approach and a safe landing cannot be made, a prominent red banner appears in the center of the PFD and an aural alert sounds "GO AROUND." The go-around alert and warnings are recorded for later review by company flight operations.

The new aircraft is being equipped with the GVII's electrical and data concentration network, a GE Aviation system that made its debut on the Boeing 787 Dreamliner. Four avionics full-duplex switched ethernet (AFDX) boxes form the heart of the system. They connect to a series of 10 or more remote data concentrators (RDCs), essentially the "brains" of the system, by means of an ultra-high-speed ARINC 664 communications network. A664 operates at nearly 1,000 times the speed of traditional A429 communications.

The RDCs are connected to various aircraft and cabin management systems by means of relatively short wire runs and they also provide secondary power management functions, including electronic circuit breakers. The upside is elimination of hundreds of feet of wiring and dozens of mechanical circuit breakers, thus shrinking aircraft weight by 100 lb. or more. Perhaps the largest benefit is the elimination of a bulky modular avionics unit, mounted in a large rack behind the copilot. This makes room for relocating the forward lavatory from the left side of the aircraft to a compartment directly behind the copilot.

Entertainment area has pop-up 32-inch ultra HD 4K, dozens of surround sound acoustic transducers in cabin walls and a three-place divan, certified for full time occupancy.

Modest Performance Estimates

Gulfstream projects the G700's maximum range to be 7,500 nm at Mach 0.85 and 6,400 nm at Mach 0.90. Company president Mark Burns says customers say they don't need a new aircraft with longer range than the G650ER.

But Gulfstream also claims the G700 will be the longest-range purpose-built business aircraft to enter production. And the company is unlikely to offer a new flagship aircraft with less range than the 7,700-nm Bombardier Global 7500. With more efficient Pearl 700 turbofans, new high-speed winglets and 1,200 lb. more fuel than the G650ER, it will be no surprise if actual range is closer to 7,800 to 8,000 nm, according to industry sources.

Similarly, Gulfstream conservatively projects sea-level, standard-day takeoff field length to be 6,250 ft. In contrast, the G650ER requires 6,299 ft. of runway at MTOW at sea level and 11,139 ft. when departing *BCA*'s 5,000-ft.-elevation, ISA+20C airport. The aircraft has a slightly better thrust-to-weight ratio than the G650ER but also a higher wing loading. The G700's final runway performance numbers are likely to be better than those of the G650ER, in our opinion, mainly because of its newer-technology engines.

Gulfstream primarily is positioning the G700 as luxury lifestyle air transportation for high-net-worth individuals and their families, as shown by the configuration of the sales mockup on display at NBAA 2019. The galley has a fifth living area, including a lounge seat. The main cabin has sitting, entertainment, dining and stateroom areas. Its comfort and convenience features are virtually unsurpassed.

But the interior configuration is modular. There are dozens of different layouts available to buyers. Corporate flight departments, for instance, might choose to configure the cabin with three, four-chair club sections and an aft stateroom with left- and right-side divans. Pairs of facing chairs and the twin divans would accommodate four passengers in lay-flat berths on overnight missions. Corporate operators are likely to insist upon fitting their aircraft with forward crew rest areas in place of the galley lounge.

Regardless of who buys the aircraft, it's going to shrink travel time between an impressive number of city pairs. It will be able to fly from New York to Beijing, Tokyo, Muscat or Lucknow in 12.5 hr. Singapore to San Francisco, Paris to Perth, Miami to Mumbai are 15.5 hr. apart.

Many operators likely will fly the G700 on the same length missions as the G650ER. The extra $3.5 million buys nearly 25% more room in the main cabin, more standard features including Ka-band connectivity and a considerably more capable avionics suite. This is the most comfortable and capable Gulfstream yet.

Above all, Gulfstream intends the G700 to be the new leader in top-end business jets, offering longer range, a larger interior, lower cabin sound levels and better pressurization than anything built in Bordeaux or Montreal. However, this isn't the end of this three-way race. It's only a status report in late 2019. Expect Bombardier and Dassault to up their games in the coming months. The final outcome determining long-term winners and losers is anybody's guess. **BCA**

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Eurocontrol, Business Aviation & More Part II

The daily changes of **keeping the ever increasing transborder flow flowing** – efficiently and safely while **minimizing impact on the environment.**

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

The operational heart of the European Organization for the Safety of Air Navigation, or Eurocontrol, is the "Network Manager," committed to provide four main functions for the air traffic control coordinator's 41 national and two extra-European stakeholders:

▶ Airspace design and route planning.

▶ Air Traffic Flow and Capacity Management (ATFCM).

▶ Management of scarce resources, such as secondary surveillance radar (SSR) codes and radio frequencies.

▶ Support to EU crisis management through the European Aviation Crisis Coordination Cell (EACCC).

The Network Manager Operations Center, which enables flow and capacity management, is contained in a large, secured room equipped with dozens of computer terminals and huge video displays on the walls sequestered in the Eurocontrol headquarters. Some 152 people work in the center daily to maintain safety, keep traffic flowing and strive to mitigate delays.

Italian Giovanni Lenti heads up Eurocontrol's Network Manager Operations Center.

The center's activities are divided into three "domains" that correspond to the services Eurocontrol provides. The first is Airspace Data, whose 22 experts are vested with creating a daily 3-D network of routes, airspace, points, airports and free-route airspace. In essence, Airspace Data maintains the route and airspace structure of the network and its capacity.

The second service is the Integrated Flight Planning System. IFPS collects, treats, checks vs. the network airspace structure and distributes the flight plans of all flights departing, arriving or overflying European airspace, amounting to an average of 30,200 a day. (On July 26, a record 37,288 flights were processed.)

Number three is the Flow-Management Service. "By running flow management, we provide safety by ensuring that the capacities of airports and all the radar sectors are not exceeded by monitoring them in coordination with the ANSPs [Air Navigation Service Providers, or the Eurocontrol member states' ATC organizations]," explained Network Operations Chief Giovanni Lenti. "This is a major challenge, as sector and airport arrival capacities are often exceeded because air traffic is increasing year on year. Last year, we recorded 11.1 million flights, a 3.8% increase over 2017." This year, as of late June, a traffic increase of 1.8%, or 500 more flights in the network (by daily average), was in progress.

"Unfortunately, the network today is affected by a widespread lack of traffic controllers in certain core areas that is creating bottlenecks and significant ground delays for the operators," Lenti continued. "In 2018, we have recorded, because of the imbalance between the demand and the capacity available, 25.6 million min. of ATFM delay. Each minute costs an operator €100, totaling €2.5 billion per year."

In reality, the flow control delays are necessary to maintain a high standard of safety, protecting controllers from traffic overloads and risk of loss of separation. "This is our raison d'etre," Lenti said. "On the other side, we are committed to mitigating the impact of the network's lack of capacity by saving

Fund an Angel Cocktail Reception

On October 23, the second night of NBAA-BACE, business aviation leaders gathered at the Fund an Angel Cocktail Reception to support the critical work of Corporate Angel Network (CAN). Proceeds go directly to supporting CAN's mission of transporting cancer patients to treatment centers throughout the country. Thank you to everyone who helped make the event such a great success.

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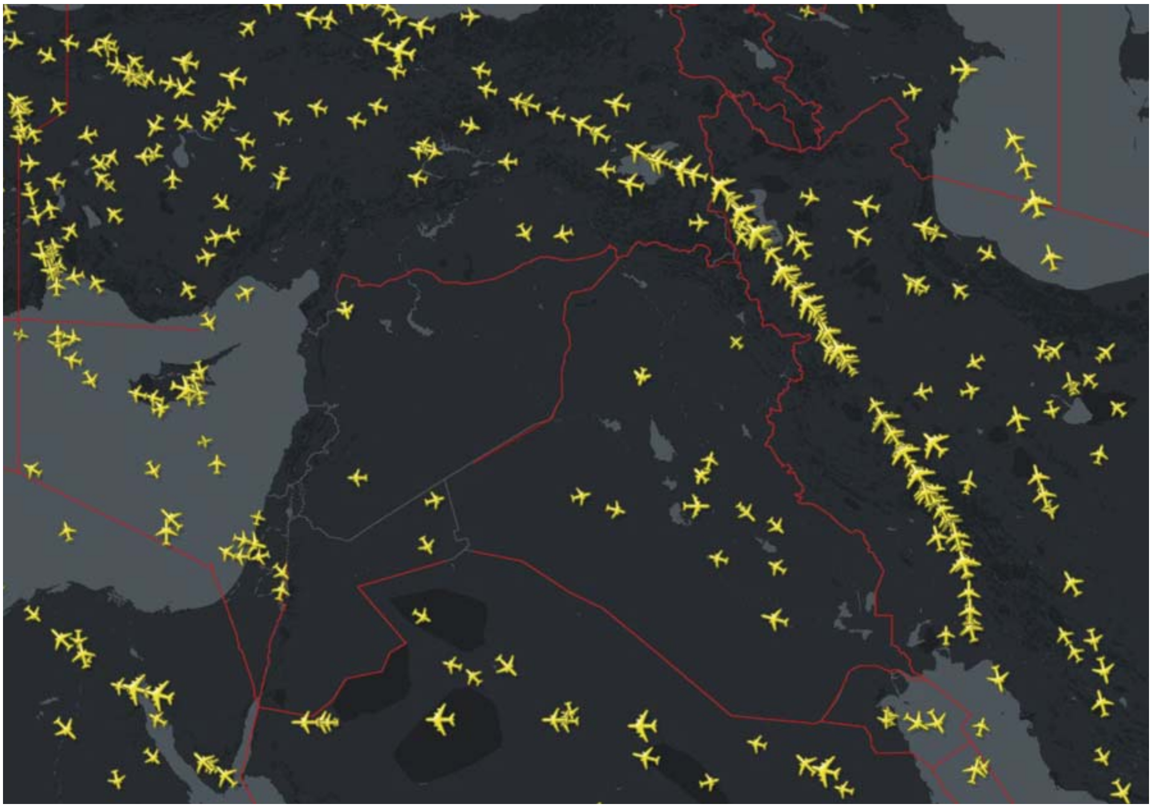

ATFM delays with different techniques in collaboration with the stakeholders."

The lack of capacity of 2019 was well known in advance, so the Network Manager prepared a seven-point plan for the summer, the most important of which was the "Enhanced Network Manager/ANSP plan", which went into force on April 25. It aimed to offload the congested areas by removing up to 1,000 flights per day, rerouting or level-capping (*i.e.,* holding flights) at lower altitudes for a few minutes outside congested sectors. This was expected to save 10-15 million min. of

Securing Eurocontrol

Considering the immense importance that Eurocontrol holds in enabling the unimpeded flow of European aviation, it is logical that the organization would represent a target to terrorists and other malefactors. Since the operation is so heavily supported by cybertechnology, it also stands to reason that hacking and cyberterrorism would be a primary threat to its operations.

"What we do here is to mainly protect the organization and the aviation stakeholders — the 43 state members, their air navigation service providers [ANSPs] and the airport operators of those states — by helping them to respond to cyberattacks and to inform them of potential cyberattacks," explained Patrick Mana, Eurocontrol's cybersecurity manager. "We provide some support to airlines but in a limited manner, as our area of competence is mainly air traffic management."

If an attack occurs in one member state and that state's ANSP informs Eurocontrol, then all the other member states are informed, when relevant, so they can proactively protect themselves. "In the case of a cyber incident somewhere," Mana said, "we are ready to help them react to it. So far, we have not detected a major attack on ATM systems in Europe — unless it's happened in a state and was not shared."

What keeps Mana up at 2:00 in the morning staring at the ceiling? Here's a sampling:

▶ State-sponsored attacks with cyberweapons to disrupt aviation — and there have been cases, such as China attacking Vietnam. "Most states capable of doing this have unlimited resources, and if they want to find holes, they will," he said.

▶ Cybercrimes, including elaborate "phishing" attempts, as at Bristol, where flight information systems were hacked.

▶ "Hacktivism," or hacking infra–

Middle East traffic: On the left is a snap shot of activity on Monday October 23, 2017 versus Friday, June 21, 2019.

delay. "Without this," Lenti pointed out, "at the end of the year, the total amount of delay would be 40 million min."

In 2018, the ops room saved 3.5 million min. of delay by manipulating the slot list — a manual job carried out by the ops center staff. "They are doing an excellent job in order to mitigate delays caused by lack of network capacity, staffing issues, bad weather and other reasons that may cause an ATFM delay to operators," Lenti observed.

Crisis Management, Too

Then there is the ops center's role in crisis management. "A relevant part of our job is support to the [ATC] network for disruption and crisis," Lenti said. Examples include the Iranian shoot-down of the U.S. Global Hawk drone this June, the Brussels Airport attack in 2016, the Malaysian Air Boeing 777 shoot-down in the Ukraine in 2014, the Icelandic volcano eruption in 2010, and other unexpected events that may heavily impact the network, such as strikes, or a technical failure, like a radar net going down.

"In 2018, our flow management system crashed for 5 hr. on April 3, and we reverted to a contingency procedural plan coordinated with the ANSPs that made sure that no overloads were experienced and safety was maintained," Lenti said. "In case of a failure, we have well-tested contingency plans that are fully coordinated and agreed to by the ANSPs, and believe me, they are efficient and they work."

structure for terrorist or environmental protest purposes.

"For state-sponsored attacks, we have to find out what their methods or techniques are," Mana said, while standing in his department's operations room. "They all have their own ways of doing it. By knowing, we can better protect ourselves, though to a limited extent, by being aware of the methods we call TTPs: tactics, techniques and procedures. And there, it's important to share information."

To that end, Eurocontrol security is connected via an automated network with national cybersecurity centers and those of some aviation stakeholders like IATA (the International Air Transport Association) that are "mature in the field." Less mature stakeholders can be reached via alerts, e-mails, quarterly reports, etc.

"The other approach is to find the holes before they are known and exploited by the hackers," Mana continued. "Here we devise and perform penetration tests — or 'ethical hacking.'" He waved his hand at several young men in the ops room writing code on laptops, presumably to test Eurcontrol's cyberdefenses. "We are also trying to form a network of penetration testers from the aviation industry so they can share good practices and mutualized tools in a 'trusted club.'"

Potential cyberattacks on Eurocontrol could be directed at:

▶ The Control Route Charge Office, or CRCO, which collects user fees, attempting to capture money owed the organization and diverting it to the hackers.

▶ Stopping the Network Manager, which collects all flight plans in Europe and allocates routes and slots, leading to significant reduction of traffic in Europe.

▶ Shutting down the Maastricht Center, which provides service to high-level airspace over "Beelux" (Belgium, Luxembourg, the Netherlands) and Northern Germany.

"Probably the part of aviation that has been attacked so far is the financial aspect and intellectual property rights, in other words, industry secrets. Most reported attacks so far have involved attempts to steal money," Mana concluded. **BCA**

The Persian Gulf drone incident occurred when *BCA* was visiting Eurocontrol in June. It affected European aviation in that a major overflight corridor from the Middle East and Africa crosses north-south through Iranian airspace (worked by Iranian controllers). When a no-fly alert was issued almost as soon as the Global Hawk crashed, the Network Manager sprung into action, moving the overflight route west from Iran to Iraq and rerouting the considerable traffic that plies it. Concern existed that if war broke out over the incident and Iraq became involved, it might be necessary to abandon the route altogether and direct traffic directly west around Iraq and through Egypt, then north across the Mediterranean Sea and into Europe, with consequent range and fuel implications to operators.

The 2010 Icelandic volcano Eyjafjallajökull eruption was another ad hoc crisis that also tested the mettle of the Network Manager. "A massive amount of ash particles was ejected," Lenti recalled, "and the wind spread them into a great part of the European airspace, which almost shut down aviation on the Continent. The London VAAC [Volcanic Ash Advisory Center, one of nine in the world] was continuously monitoring and anticipating the ash dispersion every 6 hr., and we were closing or opening the airspaces accordingly, in order to avoid flights entering the ash clouds with the huge risk of engine damage.

"We had a volcanic ash contingency plan at that time that was immediately applied," he continued, "but it needed to be quickly adapted to the unexpected magnitude of the eruption. After each crisis there is a post-ops and lessons-learned meeting to evaluate our performance and determine how we could improve." The Network Manager has become "quite good" at that," Lenti said.

Wanted: More Controllers Needed: Airspace Reorganization

The European airspace network encompasses 1,750 elementary radar sectors spread among the Eurocontrol state members and two associate members. "There is a widespread air traffic controller shortage in Europe," Lenti said, "so unfortunately it is not possible to man all the sectors to accommodate the increasing traffic demand with no ground delay. So, we can say that the main reason for the ground delays in Europe today is the lack of controllers in certain key ANSPs."

While several ANSPs are now rushing to recruit more, it takes four years to develop a fully validated controller. Thus the ongoing situation of high summer ground delays for operators flying through congested airspace or arriving at congested airports is expected to last another three to four years until the controller population is adequate to handle the traffic demand. As Lenti noted, there is no point to improving airspace structure absent the human resources available to man the sectors.

So, this goes hand-in-hand with airspace reorganization. Lenti sees a pressing and overdue need to redraw the entirety of European airspace, which has remained essentially unchanged over the last 20 years, except for the implementation of free route airspace above 31,000 ft., "running now at full speed," according to Lenti. "Despite the overall number of IFR flights growing

Eurocontrol and Climate Change

"We've been working this subject for more than 10 years because we saw it coming." The "subject" that Eurocontrol's environmental unit chief, Andrew Watt, is talking about is climate change and its impact on air traffic management.

"Sometimes we have the option for taking a long-term view," he explained to *BCA*. "The biggest risk in the very-long-term perspective is rising sea level and its impact on coastal structure — this is a decades-long issue." Note that in many coastal cities around the world, major airports are sited at sea level or close to it. In the San Francisco Bay Area, for example, two of the three major international airports — San Francisco (KSFO) and Oakland (KOAK) — are located, respectively, at 13 and 9 ft. MSL. (The third, San Jose (KSJC), is safely above the Bay waters at 62 ft. elevation.) New York's JFK International Airport sits at 13 ft.

"There is a greater frequency of storms now," Watt continued, "and ATM flow management delays due to weather increased significantly between 2017 and 2018. Storm systems can be quite disruptive."

Also, meteorologists are seeing changes to the jet stream affecting North Atlantic operations with consequent impact on arrivals in Western Europe. "It is becoming more variable," Watt said. "There are less steep temperature gradients between polar and equatorial regions, and warming of the polar region is resulting in meandering, making the jet stream less predictable. We are also seeing periods of record jet stream speeds, so that tailwinds between North America and Europe are becoming stronger, and aircraft are achieving higher ground speeds and arriving sooner."

As many popular airports in Europe have nighttime curfews, early arrivals create a problem for controllers of what to do with them, such as putting them into holding, asking them to slow earlier than foreseen, or sending them to acceptable reliever airports. The corollary to this is going the other way — flying west — with higher headwinds, requiring heavier fuel loads to accommodate longer times aloft, or redirecting them northward, also requiring more fuel.

Clear air turbulence is also on the increase. "What climate scientists have seen is that with the warming, there is more water vapor in the atmosphere," Watt said. "For every 1 deg. C increase in temperature, there is an increase of 7% water." As a result, more intense bursts of thunderstorm activity will result from the warmer, wetter atmosphere, as the energy has to be released quickly. (See related article "It's Getting Bumpier," on page 56)

from 7.2 million movements in 1997 to 11 million in 2018, there is still a constant gap through the years between traffic growth and available network capacity."

While overall network capacity has improved, it has not been enough to absorb the continuing traffic increase. "We need to redesign the structure of the European airspace," Lenti explained, "taking into consideration the current and future traffic flow patterns [that] have changed in the last 20 years as well as accommodating a new generation of aircraft flying at higher levels, the political situation at European borders and beyond, heavily influencing traffic distribution in Europe, and other key criteria." It is expected that a totally redesigned system would remain in service for the next 30 to 40 years.

A piece of this is "resectorization," as explained by Razvan Bucuroiu, Eurocontrol's Network Strategy and Development head. "What we are seeing today is that the constraints we have through fixed boundaries induce unnecessary workload to ATC because, in some cases, the limits of the sectors are not designed on the basis of operational requirements but by existing boundaries. All the technical and legal tools exist today to implement sectors based on traffic flows if the possibilities offered by air traffic service delegation agreements will be fully implemented. Boundary constraints can kill up to 30% of a sector's capacity. We have some sectors where they are handling up to 100 aircraft an hour, while we have areas with similar complexity that handle half that. What we want is to bring everyone to this higher level of performance."

Another improvement involves money: the "unit rates," or route charges, need to be harmonized given that each European state assesses a different unit rate. "Operators tend to fly the cheaper route even if this entails a longer flying time," Lenti complained.

Flight delays can't be discussed without factoring in the impact of weather. "The next current and future challenge is weather," Leni said. In 2018 in Europe, weather was accountable for 7.9 million min. of ground delays. "Global climate change or not," Lenti insisted, "we are observing a progressive intensification and duration of the weather phenomena affecting aviation."

> While several ANSPs are now rushing to recruit more, it takes four years to develop **a fully validated controller.**

The Network Manager achieved an unprecedented success in 2018. A collaboration with a number of national meteorological offices resulted in a single weather forecast covering the operating areas of the southeast U.K., Germany, northeast of France, the Netherlands and Belgium. "This gives us a unique view of the weather forecast for the next day and creates awareness of the weather threat among the ANSPs, encouraging a coordination process and possibly a common delay mitigation action," Lenti said. "So welcome to the 2019 cross-border weather initiative. The final scope is to have a unique European airspace forecast for all."

How National Sovereignty Holds Eurocontrol Back

While Eurocontrol has a lot of strength because it is an operational organization — "We run the network," Brennan noted — it still must attend to the challenge of convincing its member state ATC providers to do what has to be done to operate the network efficiently and modernize the system. In its present arrangement and bylaws, Eurocontrol cannot require its members to do anything; it can try to convince, even coerce, them, but it has no authority to force them or apply political pressure. The issue of national sovereignty plays into this, impinging on the necessities already discussed of airspace reorganization, resectorization, and the hiring and training of more controllers.

It also affects upgrades for the modernization of the ATC system, such as ADS-B, both the installation of ground stations and equipage by operators, a key element of the SESAR modernization initiative. "In Europe the service providers are not mandated by regulation to equip with ADS-B ground stations," said Christos Rekkas, who heads Eurocontrol's surveillance and code unit. And this raised concern by airspace users who, naturally, wanted more certainty about the commitment of ANSPs to provide ADS-B benefits for them.

Now, despite the lack of a mandate, some countries have voluntarily deployed hundreds of ADS-B ground stations, mostly as part of multilateration systems but also as standalone facilities. "The airspace users were not sure that, when equipped, their avionics equipment would be operationally fully used by these stations or that the states would provide the benefits that were promised," Rekkas said. "The service providers, on the other hand, want the operators to be 100% equipped to avoid mixed traffic. This chicken-and-egg conundrum created a bit of discussion, to be sure."

And while the Eurocontrol member states were not required to build ADS-B networks, operators were mandated by EASA to retrofit their aircraft with ADS-B In/Out avionics, originally by Dec. 7, 2017. Another concern of the operators was that the avionics solutions for some configurations were not available well in advance of the mandated deadline. Consequently, the mandate

In this changing operating environment, Watt's advice to business aviation operators is to, "Be aware and make sure that the business aviation community is represented at ICAO on the environment committee — they're already there, but don't allow that participation to drop. Be engaged. You fly to many more airports than commercial operators.

"In the medium to long term," he continued, "we may have to accommodate shifting traffic patterns because of higher ambient temperatures driving holiday makers to seek out cooler destinations in the summer. Similarly in the winter, there is less snow and ice, resulting in less skiing, leading to shorter seasons. We did a survey last year of the European aviation industry and its readiness to cope with climate change, and there are more organizations that now recognize the issue. Many organizations have adaptation plans in place and others are preparing them." **BCA** was delayed until June 7, 2020.

"Despite these issues," Rekkas claimed, "there are reasons to remain positive. By the current mandate date, we will reach 75% equipage of the fleet; today we are approaching 40%. The SESAR deployment manager in partnership with Eurocontrol works with the stakeholders toward a synchronized air-ground ADS-B implementation.

"On the airborne side," he continued, "we need provisions to accommodate the percentage not ready by the due date; there are discussions currently with EASA and the European Commission with respect to these provisions, and we expect clarity by Q4 2019." (If the 25% is not equipped, these operators would be breaching the E.U. regulation and, thus, are asking for an exemption.)

The unequipped group claims that in some cases the equipment has not been available — or was but later than what was expected; another reason put forth is that some aircraft have to be phased out shortly after the mandate date, and there's no business case for equipping them. And finally, for some old aircraft, the cost for retrofitting would be disproportionate to the amount of time in service the airframes would have remaining.

"On the ground side," Rekkas said, "the number of ADS-B ground stations we have is standing at around 1,000 among Eurocontrol's 41 [European] member states [which include the E.U.'s 28 plus Norway, Iceland and Switzerland and 10 more that are not E.U. members]. The countries that are equipped but not yet operational are willing to use their systems operationally when aircraft equipage approaches 100%."

> Lenti sees a pressing and overdue need to redraw the entirety of European **airspace, which has remained essentially unchanged . . .**

And what about Aireon and its space-based ADS-B service, which is signing users all over the world? "We are interested significantly in areas without surveillance coverage," Rekkas said. "While Continental countries are full of surveillance systems — where space-based ADS-B could be interesting as a backup or gap filler — the countries in remote areas, in the polar regions, areas of the Mediterranean and the North Atlantic would be interested in going directly to space-based ADS-B if the price and performance are right." But, of course, it would be entirely voluntary at this time.

As mentioned, the inability to get all of Eurocontrol's stakeholders on the same page has also affected the larger issue of completing the SESAR program, elements of which were deeded to Eurocontrol for oversight. Philippe Merlo, senior director at Eurocontrol, said, "We have many new solutions available in our catalogue, meaning that the feasibility of these solutions has been proven — efficiency, safety and cost benefit. The problem today is more with the deployment.

"We have a deployment manager but have not been very successful in the deployment because [the stakeholders] have opted for fragmented deployment," Marlo continued, "and when you try to integrate the new technology in 41 different states with 41 different implementation programs, it cannot work like that. We are trying to get closer to restarting European program management but cannot succeed without a steering mechanism." Eurocontrol had good cooperation with development of the technology, but sovereignty of airspace remains a complicating factor. "Generally, there is agreement that we need to cooperate," Merlo observed, "but the difficulty is how and who is the leader. So, here we are trying to adopt a neutral position — not bully — and convince them to use us to help, then accelerate and facilitate the deployment. I think our case is becoming better and better."

Call in the 'Wise Persons'

To address Eurocontrol's lack of authority to require its member states to comply with network policies and rules, the European Commission formed a "wise persons" group to look at the future of the European sky up to 2030. This spring, the group's first report was published, recommending that the Eurocontrol Network Manager be conferred executive power to give it the strength to dynamically change traffic over routes, airspace and in other ways in the manner of the FAA Command Center in Virginia.

"Because states will not give up their national sovereignty for airspace, the conclusion is that a network approach is the best way to run European airspace, Eurocontrol's director general, Eamonn Brennan, stated. "In the FAA Command Center, they have 51%, the final say, and that is what we're looking for in European airspace with good collaborative decision-making procedures in place." **BCA**

Saving Fuel and CO_2

"In a perfect world, if all flights started descent from top of descent [*i.e.,* with no step-downs] we would save 340,000 tons of fuel per year and 1.1 million tons of CO_2 in Europe. But we can't do that at the moment."

So observed Andrew Watt, Eurocontrol's environment unit chief, who is enamored with the concept of continuous rate descents as a means of saving fuel and reducing carbon emissions. Eurocontrol is measuring climbs and descents as a means of tracking time spent in level flight for the purpose of estimating fuel burn and emissions released that can be saved if level flight were reduced.

"We have a task force with stakeholders represented with the aim to publish at the end of the year a joint action plan with the industry on how to increase the occurrence of continuous climb and descent that minimizes level flight," Watt said. "We reason that ATM can influence about 6% of aviation's emissions in Europe, a small portion, but the numbers are still quite big. This is one area where we can make big gains within that 6%." **BCA**

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AVIATION WEEK NETWORK

Citation Longitude Gets its Papers

And it's off to a **strong start**

PHOTOS COURTESY OF TEXTRON (4)

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

The long awaited and now type certified super-midsize Citation Longitude is entering a crowded market niche, but its prospects appear bright because NetJets intends to buy up to 175 aircraft. And Textron Aviation has a large installed based of Citation customers looking to move up to larger, more capable airplanes in the family. The FAA held up full certification of the aircraft for nearly ten months in large part because Textron had to prove the aircraft meets FAR §25.981 fuel tank explosion prevention requirements without needing a fuel system redesign.

"This is great news for the Textron Aviation team and their stakeholders," says Rolland Vincent, president of the Plano, Texas, consulting firm bearing his name. "Textron is in a good position to deliver the first batch of aircraft. We understand that they have 25 to 30 near-ready Longitudes to get into the hands of customers and we are forecasting about eight shipments this year." Vincent believes Textron will settle into a three-aircraft per month production rate and sustain it over the next few years.

"NetJets will prove the airplane and drive up the reliability numbers to benefit all customers, similar to what has been seen with the Latitude," Vincent says. NetJets typically flies fractional ownership aircraft two to three times

The cockpit features Garmin G500 touch-screen avionics. The optional Garmin HUD and Elbit EVS are slated for 2020 approval.

The Longitude's flat-floor cabin has the same lean 6.4 ft. wide by 6.0 ft. tall cross section as Citation Latitude.

as much as individual operators. In July 2019, the firm took delivery of its 100th Latitude and it has placed firm orders for 35 more. With about half of the Latitude fleet under NetJets' control, bugs are being ironed out and dispatch reliability rates are soaring.

Longitude is Textron Aviation's first business jet with trans-Atlantic range, able to fly four passengers 3,500 nm or eight passengers 3,422 nm at Mach 0.80. The flat-floor cabin has the same lean 6.4 ft. wide by 6.0 ft. tall cross section as Citation Latitude, but it's essentially as long as the class-leading Bombardier Challenger 350. Notably, there are no altitude restrictions barring access to the 112-cu.-ft. aft baggage compartment, which boasts the largest volume and heaviest weight capacity in its class.

Assuming a manufacturer's spec basic operating weight of 23,600 lb., the aircraft has a 1,600 lb. tanks-full payload. It typically will carry eight passengers in forward and aft four-chair club sections. Converting facing chairs into lay-flat berths allows the aircraft to sleep four on overnight flights. A three-place divan, replacing the left, aft pair of facing chairs, will be a $125,000 option. An extra side-facing chair, across from the main entry door, also will be optional.

Passenger fatigue will be minimized on long flights. Cabin altitude will be 5,950 ft. at the aircraft's 45,000-ft. maximum cruising altitude. Textron claims that the 67 dBA interior sound level is the lowest in the super-midsize business aircraft class.

Reliability of the aircraft should be excellent. The Longitude is powered by class-leading 7,600-lb. thrust Honeywell HTF7700L turbofans, the cockpit features Garmin G500 touch-screen avionics and the aircraft borrows some of the best features of Hawker 4000, including basic wing aerodynamics.

With the list price of $27 million without options, the Longitude is the most expensive aircraft in the super-midsize class.

The delay in certification enabled Textron Aviation to develop and certify most of the operational capabilities that typically are deferred when a new business jet goes into production. When Longitude enters service later this year, it will have operational synthetic vision PFDs, auto-throttles, FANS1/A+, XM satellite radio weather, LPV approach approval and electronic charts, among other advanced features. The optional Garmin HUD and Elbit EVS are slated for approval in 2020. Estimated price is about $600,000.

With the list price of $27 million without options, Longitude is the most expensive aircraft in the super-midsize class. "This is a crowded space and Textron doesn't have the longest range and most modern aircraft in class," says Vincent. He believes the market price for super mids is "a lot closer to $20 million" than $27 million considering actual sales prices of Embraer 500/Praetor 600 and Bombardier Challenger 350.

"But the Cessna Citation brand is well regarded and ubiquitous in business aviation. It's nice that Textron finally has a horse of this size and performance in the Citation stable, one that will provide loyal customers with a pathway to stay in the production family rather than flee to, or grow with, the competition," adds Vincent. "Textron needs to build a base of super midsize customers before a [4,500-nm range] Hemisphere, or much more likely its next iteration, comes to life." **BCA**

It's Getting Bumpier

Shifting jet stream patterns **are impacting aviation**

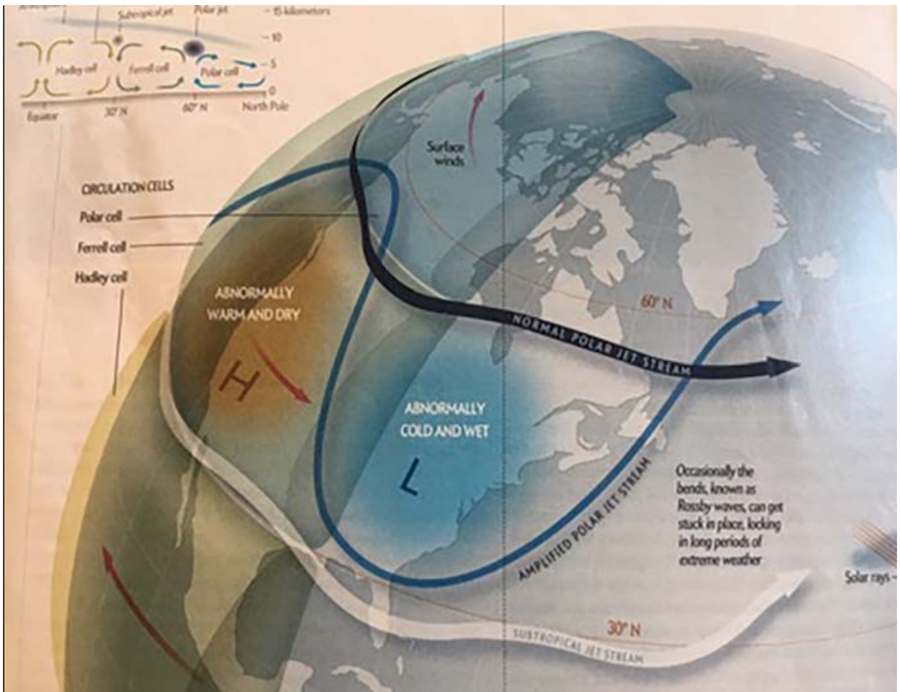
BY **PATRICK VEILLETTE** jumprsaway@aol.com

Unseen to the naked eye and often undetectable electronically, clear air turbulence (CAT) often strikes without warning and can toss unbuckled passengers, cabin crew and objects around, sometimes violently. In the U.S. alone, the financial tally for such upsets runs $200+ million annually, and doesn't account for the pain and loss of productivity that results, nor the time lost to aircraft inspection and maintenance.

According to NTSB Senior Meteorologist Donald Eick, turbulence has caused more serious injuries to passengers than any other class of accident. Indeed, 71% of FAR Part 121 air carrier weather-related accidents between 2000 and 2011 were due in part to turbulence, and a quarter of such accidents were tied directly to CAT. In an average year, U.S. airlines experience "significant turbulence" incidents and/or accidents resulting in 14 serious injuries and 69 minor injuries.

An important source of CAT is strong wind shear, which is prevalent especially within the atmospheric jet streams. In the Northern Hemisphere, there are two jet streams, the polar and the subtropical.

The former is the dividing line between colder, polar air and warmer, tropical air. During the summer, the polar jet moves well north, often north of 45 deg. latitude. In the winter it can dip as far south as 25 deg. latitude with outbreaks of polar and even arctic air. Its location and strength are highly variable due to the influence of many different factors from the ocean to the stratosphere. The layout of continents, mountain chains and ocean surface temperatures means that the North Atlantic jet stream is distinct from those in the North Pacific and much of the Southern Hemisphere. The actions of the Pacific and Atlantic jet streams will depend to some extent on the differing responses of their respective ocean basins to climatic changes. Thus, the forecasting of jet stream location, direction and strength is not as precise as needed, especially when planning long-range flights.



The North Atlantic flight corridor between Europe and North America is one of the world's busiest, with approximately 600 crossings each day.

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The height of the Northern Hemisphere's polar jet stream averages around 30,000 ft., but the core sometimes drops to 25,000 ft. or even lower. The polar jet stream in each hemisphere is created and sustained by the temperature difference between the cold poles and the warm tropics. Since the temperature gradient between the air over the polar region versus the mid-latitudes is greater in the winter, that's when the speed of the polar jet is stronger.

Textbooks and other sources often depict a jet stream as a solid line, giving pilots the impression that its winds are continuous. In fact, the speeds vary considerably along the stream's axis and are neither constant nor always flowing in a west-to-east direction. Areas of stronger winds, or "jet streaks," are found where temperature differences at high altitudes are the strongest and are often referred to as "upper level fronts." These jet streaks have the highest potential for wind shear and maximum turbulence. Jet streak regions move along the jet stream's axis, although at speeds much slower than the winds themselves.

The speed of the jet stream over North America and Europe can reach 200 kt. in the winter but can reach 300 kt., particularly over Southeast Asia.

Typical behavior for the jet stream in the middle latitudes is a mild bending from north to south and then back to the north, not unlike a sine wave. These bends are called "planetary" or Rosby waves and typically progress across the U.S. in three to five days. However, there has been a sizable increase in the amplitude of troughs and ridges in the polar jet since 2000. In addition, these waves are moving slower across the earth, sometimes stopping in place for weeks and bringing long periods of uncommon weather.

Also, these jet streams in both hemispheres are forecast to strengthen at aircraft cruising altitudes. According to the ICAO report "Clear-Air Turbulence in a Changing Climate," the troposphere over the tropics is projected to warm more than the surface in part because a warmer atmosphere has a higher water vapor concentration. In polar regions, the tropospheric impact is to be less pronounced because there is less water vapor present, but changes in atmospheric heat transport and significant climatic feedbacks associated with changes to sea ice and clouds do result in a strong surface warming. The increased heat stored in the Arctic Ocean owing to sea-ice loss is released into the atmosphere in early winter. The troposphere and stratosphere warm unevenly in response to climatic alteration. The stratosphere, by contrast, cools in response to the increased greenhouse gases.

Despite any skepticism, these atmospheric modifications are already being observed and are affecting aviation because prevailing jet stream wind velocity and patterns are altering optimal flight routes, increasing flight times and overall fuel consumption, and creating more CAT.

To better understand these effects, consider the example of making a roundtrip across the North Atlantic from New York's JFK International Airport (KJFK) to London's Heathrow (EGLL). The North Atlantic flight corridor between Europe and North America is one of the world's busiest, with approximately 600 crossings each day, which means there is plenty of historical data to compare recent activity.

While a great circle route minimizes the distance between the two airports, it's more economical to minimize the flight time, which means taking advantage of tailwinds for eastbound flights and minimizing headwinds when going west. For a long-haul flight such as this, a Wind Optimal Route (WOR) trajectory depends on the prevailing jet stream position and strength.

There is a weather phenomenon over the North Atlantic that greatly influences the upper atmosphere and thus the WOR calculations. The North Atlantic Oscillation (NAO) is one of the most prominent climate anomalies composed of a north-south dipole pattern of pressure variances, especially in winter. In the positive phase of the NAO, stronger pressure gradients between the persistent subtropical high and Icelandic low lead to a higher-latitude position of the jet stream. The dominant jet stream shifts northward directly to northwestern Europe (See Figure 1). Weaker pressure gradients in the negative phase of the NAO shift the stream farther south and closer to southern Europe. This interannual variability of the persistent high- and low-pressure systems in the North Atlantic creates different wind-optimized trajectories.

A team led by Dr. Jung Hoon Kim of the Cooperative Institute for Research in the Atmosphere at Colorado State University investigated how upper-level jet stream characteristics associated with the NOA would impact transatlantic WORs. The researchers studied the differences when a positive NAO phase dominated (December 2004 through February 2005) versus a negative NAO phase (December 2009 through February 2010.)

In making a roundtrip between America and Europe during those periods, an aircraft would have experienced a greater total travel time between eastbound and westbound routes in the +NAO phase than in the -NAO phase because the prevailing westerly jet stream along the great circle route is stronger in the positive phase. However, the shorter eastbound and longer westbound times do not cancel out, resulting in an increase of roundtrip time. Eastbound routes in the positive phase are faster because the distances are shorter and tailwinds stronger. Conversely, westbound routes in a negative NAO phase are faster because the distances are shorter and headwinds weaker. (See Figure 1 opposite page.)

In general, CAT is strongest on the cold/low pressure side of the jet stream (the north side in the Northern Hemisphere), next to and just underneath the axis of the jet stream. Aircraft utilizing jet streams often experience light to moderate turbulence for much of the flight. On the cyclonic side of the jet axis you will find a lower tropopause with sinking dry air that could be of stratospheric origin. The border of the high cirrus clouds in the warm airmass and the lower clouds in the cold airmass are a good indicator for the jet axis.

On Feb. 18-19, 2019, a Virgin Atlantic Boeing 787-9 flying from Los Angeles International Airport (KLAX) to Heathrow reached a record-setting ground speed of 801 mph while at FL 350 over Pennsylvania, thanks to the 240-mph push from the winter jet stream. The flight arrived 48 min. early.

According to Dr. Paul Williams, professor of meteorology at the U.K.'s University of Reading, early arrivals of eastbound flights due to brisk jet stream pushes will become more common. He applied scientifically accepted models on warming to transatlantic flight data between New York and London and calculated that the average tailwind component at cruising altitudes would increase by 14.8%, from 47.9 mph to 55 mph. Although the great circle journey time in still air is 6 hr., 9 min., the calculations for eastbound flights cut transit time by half an hour, to 5 hr., 38 min. That is relatively good news.

However, the average westbound journey time is predicted to be half an hour longer at 6 hr., 40 min. Another important finding from Williams' study is that westbound journey times exhibit significantly more day-to-day variability than eastbound journey times. The probability of a westbound crossing taking over 7 hr. nearly doubles from 8.6% to 15.3%, suggesting that delayed arrivals in North America will become increasingly common.

The changes in the velocity and pattern of the mid-latitude jet stream are also predicted to increase CAT. Climate modeling studies indicate the volume of airspace containing moderate-or-greater turbulence on winter transatlantic routes will increase by 40% to 170%. If proven, this will have serious consequences for aviation.

While that range is admittedly rather wide, the variables that factor into the computations are complex and numerous. Everything in nature, whether it be metal strength or the temperature of the atmosphere, displays variations in its behavior. The complex equations attempt to model as many of the known important factors as possible. This is "state of the art" science thoroughly scrutinized by the leading scientists in these academic fields and accepted for publication in peer-reviewed journals.

Kim points out that eastbound optimized routes are faster but have higher probabilities of encountering CAT because they are closer to the jet streams.

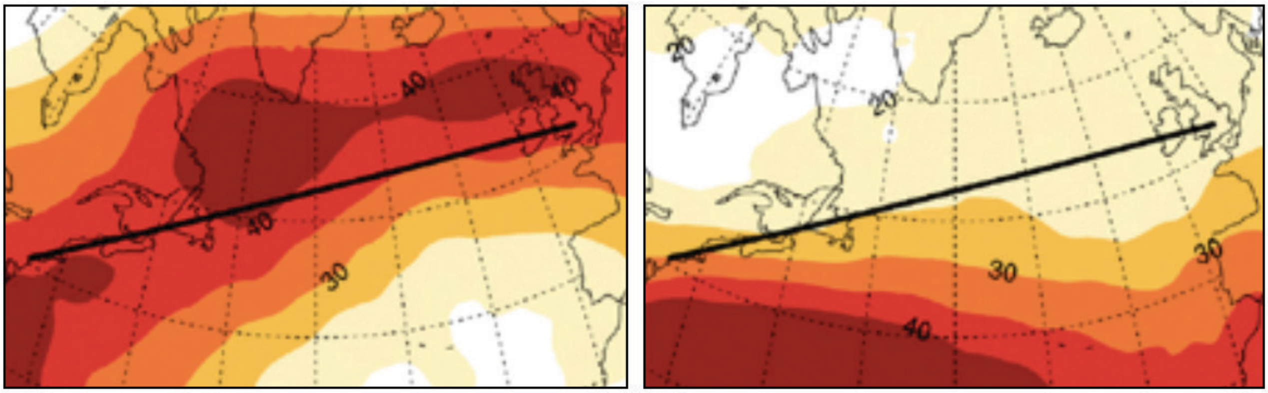
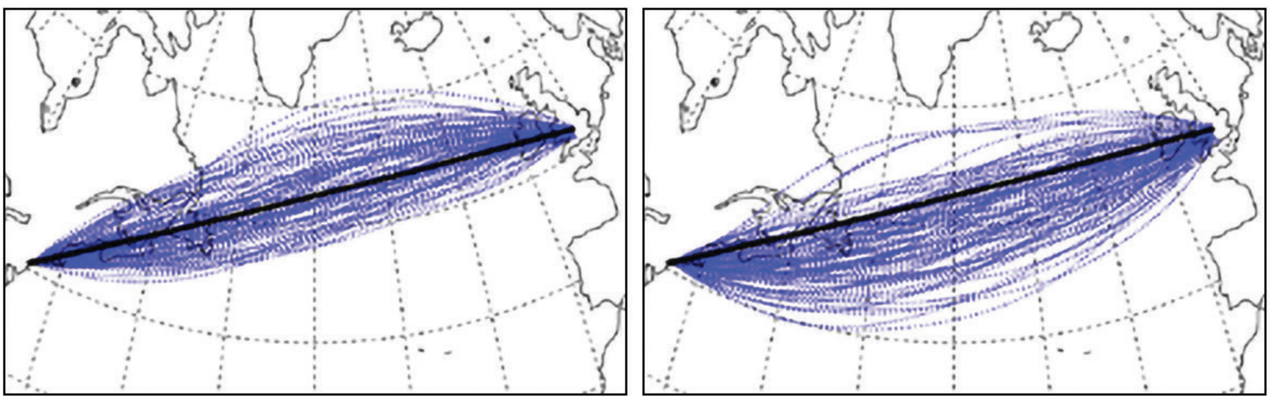
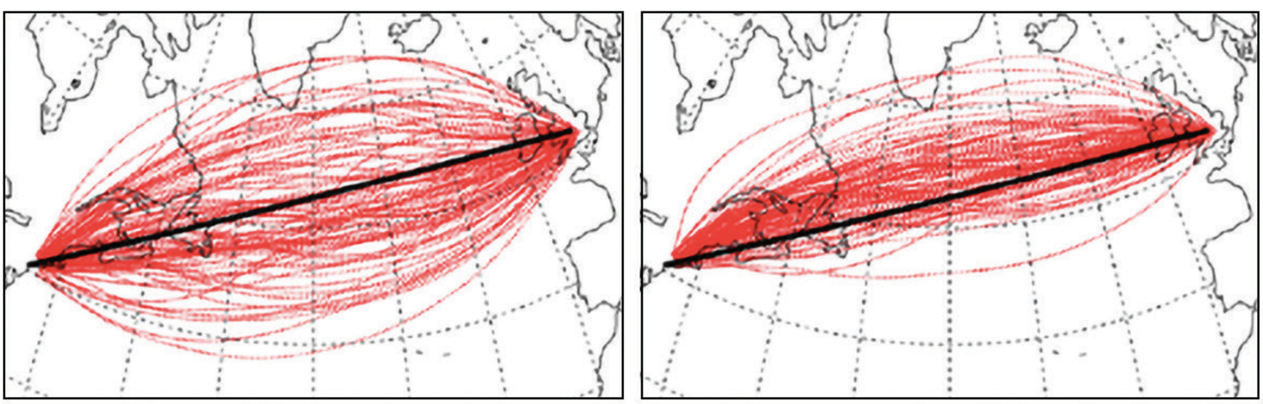


Figure 1: The left figure illustrates the average wind speeds (shadings from 10 to 50 m/s, equivalent to 19.4 to 97.2 kt.) from December 2004 through February 2005 when a positive NAO dominated. The right figure illustrates the average wind speeds from December 2009 through February 2010 when a negative NAO dominated. Notice the distinct high-speed band at higher latitudes in the left figure during a "positive" NAO, whereas higher jet stream speeds shift farther south during periods of "negative" NAO. The dark black line indicates the great circle route between JFK and LHR. These variations in the high-speed winds over the North Atlantic have a direct influence on the choice for Wind Optimized Routing.

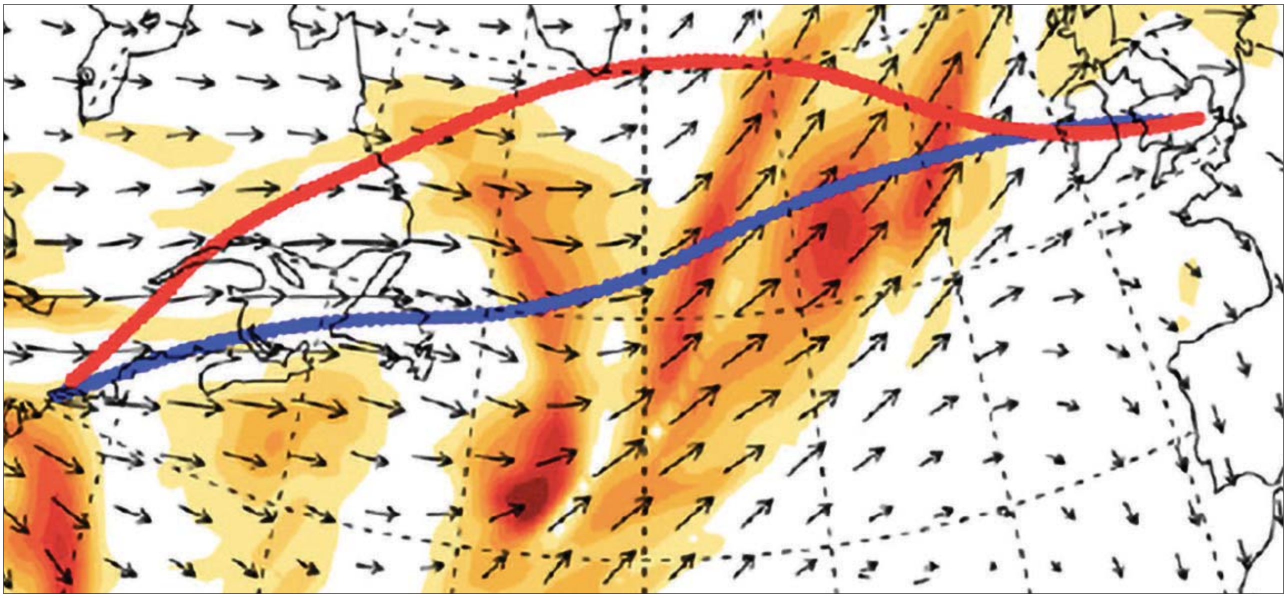


The eastbound optimized routes from JFK to LHR usually follow the prevailing westerly jet stream to maximize tailwinds, thereby reducing total travel time and fuel consumption. The eastbound optimized routes were closer to the great circle route between JFK and LHR (a black reference line) during northerly shifted jet stream phases (December 2004 to February 2005), shown in the left panel. The right panel depicts the eastbound wind optimized routes during a southerly shifted jet stream phase (December 2009 to February 2010).



The westbound optimized routes from LHR to JFK avoid the prevailing westerly jet stream to minimize their headwinds. In the positive NAO phase when the jet stream has shifted northward, the westbound optimized routes deviate southward or northward to avoid the strong jet stream dominating along the great circle route. However, in the negative NAO phase with a southerly shifted jet stream, the westbound optimized routes are mostly around the northern part of the great circle route.

BOTH PAGES: JUNG HOON KIM ET AL., "IMPACT OF THE NORTH ATLANTIC OSCILLATION ON TRANSATLANTIC FLIGHT ROUTES AND CLEAR-AIR TURBULENCE," JOURNAL OF APPLIED METEOROLOGY AND CLIMATOLOGY, MARCH 2016



The blue line represents the wind optimized route on Jan. 3, 2005, for eastbound travel. The red line represents the westbound wind optimized route. This occurred during a positive NAO phase. The shading represents turbulence. Even though the eastbound route with its tailwind had a total flight time of 321 min., it encountered higher CAT potential areas for a longer period of time. The westbound optimized route, which detours northward near the southern tip of Greenland to avoid the prevailing westerly and southwesterly jet flow for a total of 417 min. flight time, minimizes its headwind and passes through less area with higher CAT potential.

This is especially the case near the cyclonic shear side of the streams in the northern part of the great circle route in the positive NAO period, and in the southern part of the great circle route during a negative NAO cycle.

Eastbound optimized routes during a negative NAO phase have the highest chance of encountering CAT because

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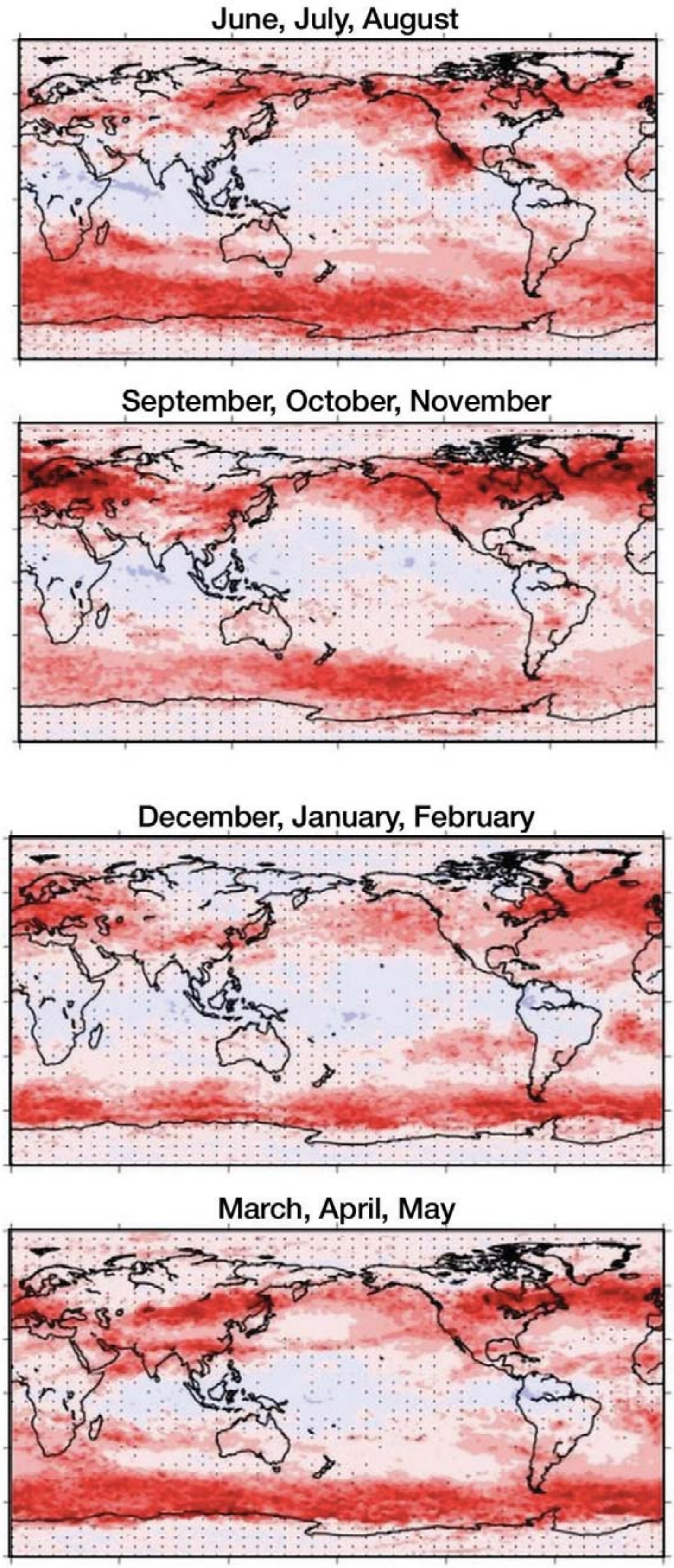


ABOVE IMAGES: LUKE N. STORER, PAUL D. WILLIAMS, MANOJ M. JOSHI, "GLOBAL RESPONSE OF CLEAR AIR TURBULENCE TO CLIMATE CHANGE," GEOPHYSICAL RESEARCH LETTERS, VOL. 44, ISSUE 19, OCTOBER 2017

The illustrations to the left are predictions of seasonal variation in turbulence intensity. The North Atlantic, North America, North Pacific and Europe will see a significant increase in severe turbulence that could cause more problems in the future. Severe turbulence in the future will be as frequent as moderate turbulence historically. Moderate turbulence will become as frequent in the summer as it has done historically in winter.

most trajectories tend to pass directly to the cyclonic shear side of the southerly shifted jet stream. This information can be used in aviation to understand how the predicted upper-level teleconnection weather patterns can be translated to make for safe and efficient transatlantic flight. (See illustration above.)

A study titled "Global Response of Clear Air Turbulence to Climate Change," published in the October 2017 issue of Geophysical Research Letters, found that the busiest flight routes, such as those in the Northern Hemisphere, would see the largest increase in turbulence and that severe turbulence will become as frequent as moderate turbulence historically. The study also found moderate turbulence will become as frequent in the summer as it has done historically in winter. This is significant because although CAT is more likely in winter, the study maintains it's likely to become much more of a year-round phenomenon.

This predicted increase in CAT highlights the importance for improving turbulence forecasting and helping crews avoid threatening areas or at least ensuring all aboard are belted before the encounter. As Williams points out, these changes to the upper atmosphere won't necessarily cause more inflight injuries because recent advances in atmospheric modeling and inflight data collection have improved forecast accuracy, improving the odds of avoidance. One of these tools is the Turbulence Auto-PIREP System (TAPS) being developed under the NASA Turbulence Prediction and Warning System (TPAWS) program, which generates real-time, automatic reports of hazardous turbulence.

FAA Advisory Circular 120-88A, "Preventing Injuries Caused by Turbulence," strongly endorses the use of seat belts during a turbulence encounter. The fact is that from 1980-2003, only four people received serious injuries during turbulence when seated with seat belts fastened.

Despite advances by the meteorological science community to better forecast turbulence associated with the jet stream, recent CAT incidents underscore the significance of the threat posed. Specifically, a Turkish Airlines flight to New York on March 9, 2019, sent 30 injured persons to the hospital as a result of severe turbulence encounter. Four months later, an Air Canada flight from Vancouver to Sydney had to divert to Honolulu when 30 people were injured in turbulence.

Given the suddenness of onset and our current inability to accurately detect CAT with sufficient warning, it just makes good sense to buckle up and stay that way. BCA

Useful Videos

A useful visual tool to see the predicted behavior of the jet stream over the North Atlantic can be seen at ***https://www.netweather.tv/charts-and-data/jetstream.*** This provides the latest jet stream forecast right out to 16 days in 3-hr. timesteps.

NASA has placed a video on-line that illustrates the bending waves in the jet stream. It can be found at ***http://www.eumetrain.org/data/3/304/media/flash/jet_stream.mp4***

For Further Information:

▶ Paul D. Williams, Department of Meteorology, University of Reading, U.K. "Increased Light, Moderate and Severe Clear Air Turbulence in Response to Climate Change." Advances in Atmospheric Sciences, Vol. 34, May 2017, pp. 576-586.

▶ Williams, "Transatlantic Flight Times and Climate Change." Environmental Research Letters 11, 2016, 024008.

▶ Jung Hoon Kim et al. "Impact of the North Atlantic Oscillation on Transatlantic Flight Routes and Clear-Air Turbulence." Journal of Applied Meteorology and Climatology, March 2016.

▶ Melissa Gervais, Jeffrey Shaman, Yochanan Kushnir. "Impacts of the North Atlantic Warming Hole in Future Climate Projections: Mean Atmospheric Circulation and the North Atlantic Jet." Journal of Climate, 2019; DOI: 10.1175/JCLI-D-18-0647.1.

▶ Luke N. Storer, Paul D. Williams, Manoj M. Joshi. "Global Response of Clear Air Turbulence to Climate Change." Geophysical Research Letters, Vol. 44, Issue 19, October 2017.

▶ FAA Advisory Circular 120-88A, "Preventing Injuries Caused by Turbulence," Jan. 19, 2006.

▶ Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile. "Wind Gradients and Turbulence." Incidents in Air Transport, No. 5, December 2006. BCA

North Atlantic Warming Hole Impacts Jet Stream

Most climate models seem to agree that the Pacific jet stream is going to shift poleward, but there is a lot of variability in predictions for the Atlantic. Some of this variability might be caused within an area of rotating ocean currents just south of Greenland where a lack of warming is causing colder sea-surface temperatures. This is called the North Atlantic Warming Hole (NAWH) and is linked to a slowdown of the large system of ocean currents that carry warm water from the tropics northward into the North Atlantic. It is thought to be caused by an influx of fresh water coming from melting arctic sea ice flowing into the Labrador Sea, which changes the currents and overall leads to surface cooling in the region south of Greenland.

Dr. Melissa Gervais, assistant professor of meteorology and atmospheric science at Pennsylvania State University, found that this region can have a large influence on the jet stream. "These changes in sea surface temperature patterns occur as the result of changes in ocean circulation and could have a significant impact on atmospheric circulation and the North Atlantic storm track in the future," writes Gervais.

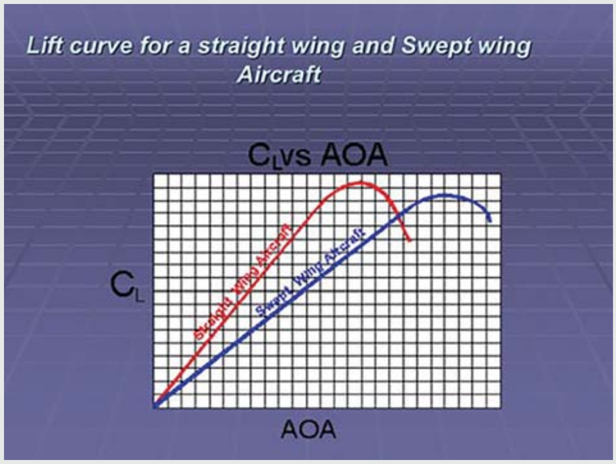
But if this oceanic area is cooling then why does its name suggest warming? Gervais explains that use of the word "hole" implies the lack of warming.

To investigate whether and how the development of the NAWH impacts the jet stream, her team conducted a series of atmospheric model experiments using a state-of-the-art computer simulation of the Earth's past, present and future climate. Their results indicated that the NAWH plays an important role in mid-latitude atmospheric circulation changes. It seems to be elongating the jet stream even farther and shifting it more northward. The study's results also revealed that in addition to the role of the tropics and arctic influencing the jet stream, it is necessary to consider how this warming hole is going to influence the jet stream over the North Atlantic. The NAWH might be a significant factor in the strength and location of the jet stream in one of the busiest air corridors in the aviation industry.

How will aviation benefit from this type of research? As teams led by atmospheric scientists such as Gervais continue to search for these inter-related factors in our environment, the sophisticated computer models used to predict the weather will be updated, thus rendering more accurate near-term weather predictions. BCA

Business Aircraft and Turbulence

Turbulence reports must be carefully evaluated because one citing moderate turbulence encountered by a Boeing 757 would translate into a much worse experience in a King Air.

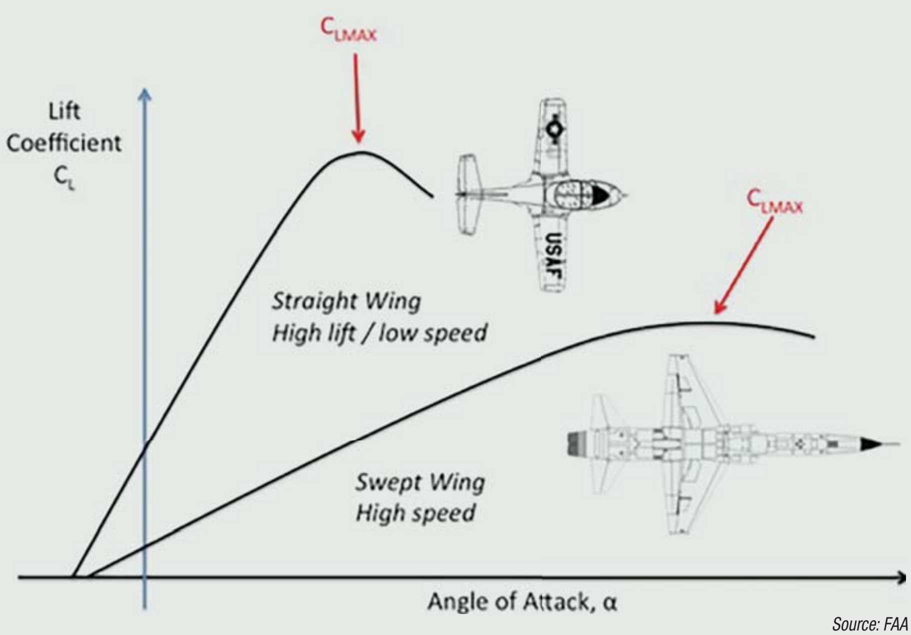


Why? In general, business aircraft are lighter and have lower wing loading than a commercial jet, and many have relatively little wing sweep, all of which increase the gust load factor and thus the amount of turbulence felt.

For starters, basic physics tells us that the same gust will have less influence (i.e., less acceleration) on a heavier aircraft than a lighter one. As you can imagine, a kite with a relatively large amount of surface area but little mass is highly susceptible to the slightest whims of winds, whereas a brick has much greater mass for its surface area and is impervious to gusts. In aeronautical engineering we quantify the relationship between an object's mass and surface area. "Wing loading" involves an aircraft's weight divided by its wing surface area and the turbulence induced on an aircraft is directly proportional to that calculation. For example, the wing loading of a Cessna Longitude is 73.9 lb./sq. ft. By comparison, the wing loading of the Boeing 737-900 is 138 lb./sq. ft. If all other factors are equal, an aircraft with half the wing loading would encounter twice the jolt.

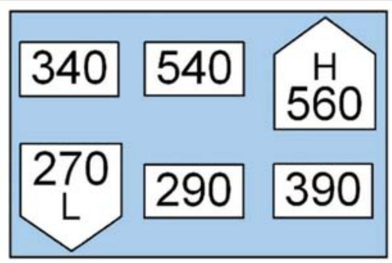
Another design feature that influences an aircraft's response to vertical gusts in turbulence is the lift curve slope of the wing's design. This slope is partly a function of the airfoil sections chosen by the designers as well as the wing's sweep angle. Due to the increase in spanwise flow across a swept wing and the greater effects of the outboard vortices on the induced flow around the wingtips, such wings are not as efficient at creating lift as a straight wing design.

So, how does this relate to turbulence? If a vertical gust (i.e., turbulence) strikes a straight wing, it creates a larger increment in additional lift than when on a swept wing. Thus, aircraft with highly swept wings (more than 25 deg. of sweep) can zip through a turbulence airmass feeling relatively small bumps whereas an aircraft of equivalent wing loading but with straight wings would have a rougher ride. **BCA**

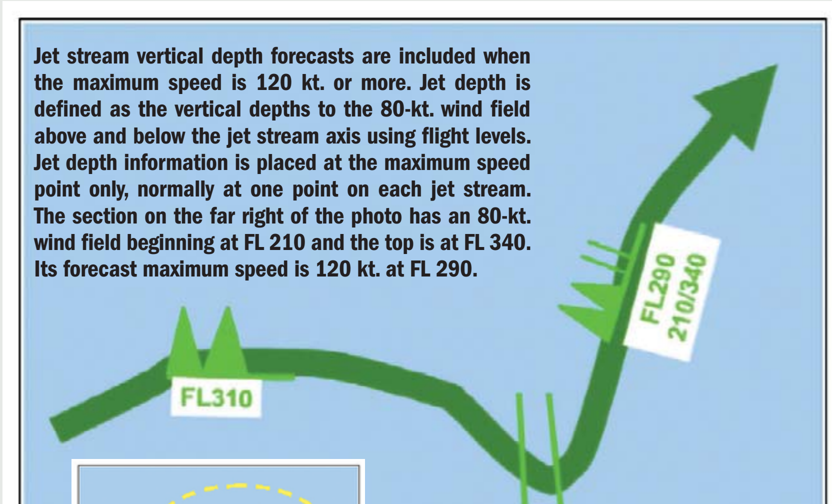


Source: FAA

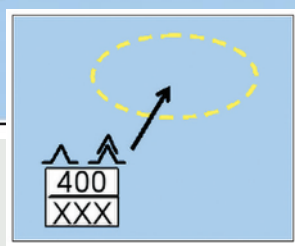
Understanding Important Symbols on High level SIGWX charts



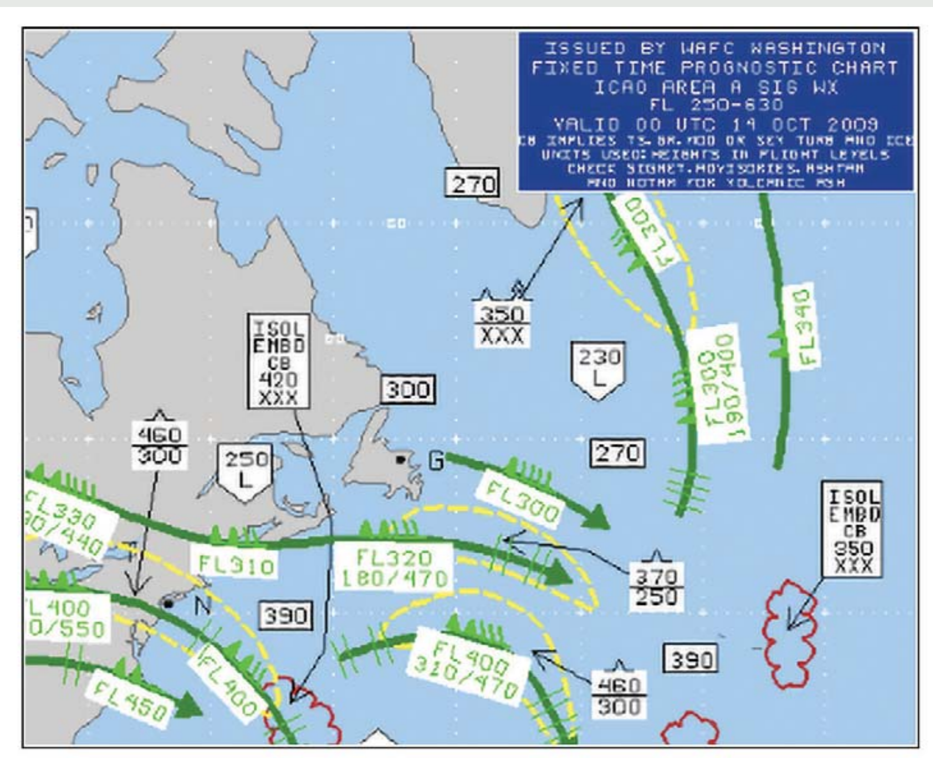
Tropopause heights are plotted at selected locations. The heights are enclosed in rectangles and plotted in hundreds of feet MSL. Centers of high and low tropopause heights are enclosed in polygons. Remember that important changes in the atmosphere occur at the tropopause (temperature lapse rates, winds, turbulence, concentration of ozone, elevated levels of ultraviolet radiation due to operating altitudes in the upper reaches troposphere and lower stratosphere etc.)



Jet stream vertical depth forecasts are included when the maximum speed is 120 kt. or more. Jet depth is defined as the vertical depths to the 80-kt. wind field above and below the jet stream axis using flight levels. Jet depth information is placed at the maximum speed point only, normally at one point on each jet stream. The section on the far right of the photo has an 80-kt. wind field beginning at FL 210 and the top is at FL 340. Its forecast maximum speed is 120 kt. at FL 290.



Moderate to severe turbulence from FL 400 to below the lower limit of the prog chart (FL 250)



High-level SIGWX charts are valid at specific fixed times: 0000, 0600, 1200 and 1800 UTC. They show significant en-route weather phenomena over a range of flight levels from 250 to 630, and associated surface weather features. CAT is strongest on the cold/low pressure side of the jet stream (the north side in the Northern Hemisphere), next to and just underneath the axis of the jet stream. This chart illustrates an area of moderate to severe turbulence from below FL 250 to FL 350 along the jet stream just south of Greenland. Nearby the jet stream is forecast to be 120 kt. at FL 300. The tropopause drops to a low height of FL 230 south of Greenland.

ABOVE IMAGES: FAA ADVISORY CIRCULAR 00-45H, "AVIATION WEATHER SERVICES," JAN. 8, 2018

Impact on Flight Planning

When an aircraft flies through turbulence, the abrupt changes in velocity and direction of the freestream airflow can momentarily cause a change in the angle of attack (AOA), which in turn causes a change in the wing's lift and is felt as turbulence. In transonic flight this rapid AOA change would also increase the onset of buffet. In general, it is true that today's modern aircraft have much more generous "buffet margins" than those of earlier generations. However, high-altitude turbulence has the potential to create a high-altitude "coffin corner" in the flight envelope.

Proper use of buffet boundary/maneuver capability charts are one of the tools pilots and dispatchers should use to determine the maximum altitude that can be flown safely. Pilots also need to know what speed to maintain for peak buffet resistance, and whether the engines can produce enough thrust to maintain airspeed. The forgoing highlights the need to update pilot training on high-altitude aerodynamics, aircraft performance and handling, and the interaction with high-altitude weather phenomena.

For flight planning purposes, the maximum altitude at which an airplane can be operated is the lowest of the maximum certified altitude, the thrust limited altitude (the altitude at which sufficient thrust is available to provide a specific minimum rate of climb), or the buffet/maneuver limited altitude (which is the altitude at which a specific maneuver margin exists prior to buffet onset.) Buffet margins are far smaller when turbulence is present. At the maximum allowed cruising altitude, based on the 1.3 G margin, a gust (or any other maneuver) with a load factor of 1.3 will cause buffet onset.

Obviously, the turbulence contained within the jet stream at high altitude can exceed these limits. If moderate-or-greater turbulence is encountered, it may be necessary to descend to a lower flight level where the Mach buffet margins are sufficient. This in turn brings a cascading series of changes in aircraft performance to include fuel consumption, ground speed, etc., all of which can have a significant effect on the continuation of the flight.

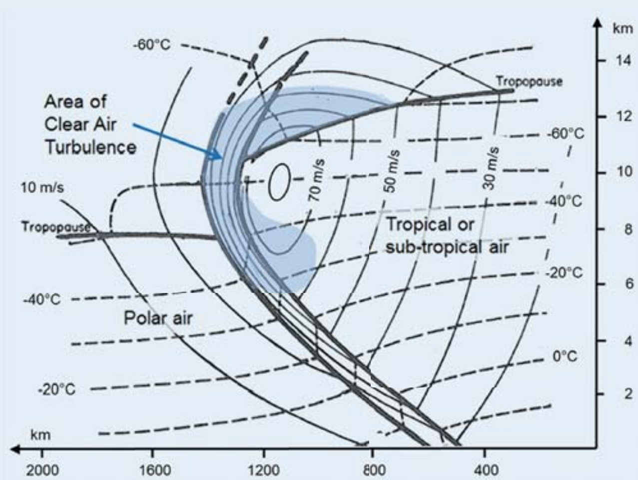
Fortunately, the prediction of the jet stream's position is getting more accurate, in part due to real-time weather data collection from appropriately equipped high-altitude aircraft. Such forecasting requires powerful computers and lots of observational data collected from land, sea and air sources and satellites. Collectively, all of these sensors and gauges produce more than 1 million weather-related observations every day.

Recent aircraft-based observations have made a significant contribution to upper-air monitoring of the atmosphere. The use of the aircraft platform for the automated collection of meteorological data has been considerably enhanced and expanded so as to provide more accurate, more timely and, most importantly, a much greater volume of upper-air data in support of data users and meteorological applications. This includes support for weather-related forecasting and monitoring for the aviation industry.

The chief source of aircraft-based observations supporting the Global Observing System and the World Weather Watch Program are derived from the Aircraft Meteorological DAta Relay (AMDAR) system. The onboard component of the AMDAR system is essentially an avionics software application that utilizes existing onboard sensors and navigation, communications and computer systems to automatically collect and compile meteorological data and then transmit it to the ground in real time as the aircraft flies.

These weather observations stream into super-computers housed at the National Centers for Environmental Prediction (NCEP), located in Camp Springs, Maryland, which uses complex mathematical models to predict how weather conditions might change over time. This system has helped increase the near-term accuracy of weather forecasts, to include the position of the jet stream.

Given that the future atmosphere is likely to contain larger regions of moderate or greater turbulence, flights could be dispatched at lighter weights or planned for lower altitudes. Prudence suggests that flight plans of the future more closely look at the likelihood of encountering clear air turbulence and consider the effect on lengthened flight times and fuel consumption that could result. **BCA**



Source: FAA

About Wind Gradients

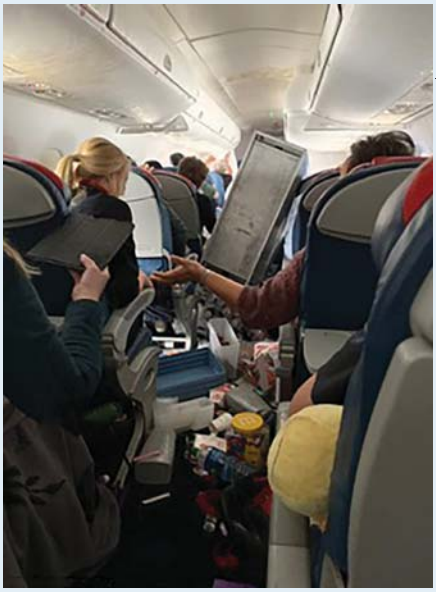
Flight crews encountering a jet stream will experience large wind gradients that can cause aircraft control difficulties. A 13-year-old report by France's Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) analyzed an incident that aptly illustrates this problem.

The investigation focused on a Boeing 737-500 that was flying from Lyon to Paris. The planned route entered an area of predicted moderate turbulence that extended from FL 200 to FL 420, centered on the jet stream. The forecast charts showed a wind from the north, about 30 kt. at FL 100, 110 kt. at FL 180 and 145 kt. at FL 300. A SIGMET mentioned moderate to severe turbulence between FL 180 and FL 380 on the route, valid until the time of takeoff.

After passing through FL 100 and climbing toward FL 200, the copilot, who was the pilot flying (PF), activated the autopilot in LNAV and VNAV modes and entered the en-route climb speed value of 325 kt. in the FMS. The crew heard the controller remark that the crew of another aircraft had reached FL 220 although it had only been cleared to climb to FL 200. That flight crew explained that the autopilot had not captured FL 200. (Hint: Continue reading and you'll see why this was a forewarning.)

While passing through FL 170, the captain, the pilot monitoring (PM), noted that the airspeed was approaching Vmo (340 kt.), or 15 kt. above the selected speed. A nose-up pitch input was made on the control column, causing selection of the Command Wheel Steering Pitch mode (CWS maneuvers the aircraft in response to control pressures applied to the control wheel or column.) The airplane was then flying manually in pitch.

Despite this action, the speed remained abnormally high and continued to increase, and turbulence was felt. At FL 191, the altitude warning indicated that the aircraft was approaching the desired altitude. The pitch was 17 deg. nose-up and the actual vertical speed was nearly 11,000 fpm (no, that isn't a typo . . . it comes straight from the incident report!), although the VSI readout was limited to 6,000 fpm. The captain immediately pushed on the control column, selected the recommended turbulence penetration speed of 280 kt. on the mode control panel and pulled the throttles toward the rear stop. The airplane crossed FL 200 with 14 deg. of nose-up pitch. The captain applied further pitch-down inputs, causing a vertical acceleration of -0.15 G. Three flight attendants in the aft cabin were lifted, struck the ceiling and fell down, injuring themselves slightly. The airplane descended after reaching FL 207. This sequence lasted 28 sec.



JOE JUSTICE/SCRUM INC.

Turbulence aboard Delta Air Lines Flight 5763 is indicative of bumpier rides in the future and the potential for serious injuries when unbuckled passengers and flight attendants are jolted around the cabin or unrestrained heavy items become dangerous projectiles.

Further analysis revealed that the aircraft encountered a significant wind gradient within the jet stream. The headwind increased by 100 kt. in just 63 sec., increasing from 40 kt. at FL 140 to 140 kt. at FL 190. During the last 16 sec. of this period the headwind was increasing at the rate of 3 kt./sec.

The captain did not expect a wind gradient of such amplitude and was surprised by the increase in speed. His first analysis of the aircraft's high airspeed was a lack of reactivity of the autopilot, which he then overrode. This did not have the desired effect. While the captain was checking the results of his pitch-up action on the airspeed indicator, he did not notice that the pitch, vertical speed and altitude indications were becoming incompatible with a stabilized level-off at the authorized flight level.

Aviation charts were changed on Feb. 8, 2005, as a result of Amendment 74 to Annex 3 (ICAO-Meteorological Service for International Air Navigation) to show the minimum and maximum altitude in relation to the jet stream next to the strength symbols. This representation makes it possible to know the depth of the jet stream and identify possible wind gradients. The weather chart representation of a significant wind gradient remains difficult, especially when a steep wind gradient occurs over a narrow altitude band.

The BEA report also reminded readers that a radio announcement on experiencing significant meteorological conditions can inform ATC and other aircraft of the phenomenon, allowing others in the airspace to anticipate these conditions. **BCA**

Gulfstream G600

Worthy successor to the G550

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

New York to Tokyo, Sofia to San Diego, London to Singapore in no more than 13.5 hr.

PHOTOGRAPHY COURTESY GULFSTREAM AEROSPACE

Faster, higher, roomier, quieter and, surprisingly, less expensive are five ways to differentiate the $60 million 6,500-nm-range G600 from the G550 in Gulfstream's top-end product line-up. It's the second and larger, longer-range member of the GVII family that also includes the 5,200-nm-range G500, Gulfstream's replacement for the G450. Gulfstream officials, however, are keeping the G550 in limited production mainly because of long-term special missions applications and government orders.

The G550's evolutionary roots can be traced back a half century to the first Gulfstream built by Grumman in Bethpage, Long Island, New York. The turbofan members of that first generation 20th century Gulfstream family were designed to cruise most efficiently at Mach 0.75 to 0.80, entirely appropriate for the era of sporty fedoras, two-tone convertibles and avocado appliances.

The G600, in contrast, is designed for the pace of life in the 21st century. Its economy cruise speed is Mach 0.85/488 KTAS, now the standard for most next-generation large-cabin business aircraft, as well as the latest long-range Airbuses and Boeings. It can fly 6,500 nm carrying eight passengers at that speed, enabling it to fly nonstop between New York and Tokyo, Sofia and San Diego or London and Singapore in no more than 13.5 hr.

Push the G600 up to its Mach 0.90 high-speed cruise and it can dash between Paris and Phoenix, São Paulo and Denver or Taipei and Berlin in less than 11 hr. Typical for new Gulfstreams, no competitive business aircraft can match the G600 for fuel efficiency at those speeds and ranges.

The G600's cabin, similar to that of its G500 sibling, typically is configured with three, 8.75-ft.-long living areas, including a forward four-chair club section, a center four-seat conference grouping and aft private stateroom. Each living area has a pair of windows on each side and each of those transparencies is 16% larger in area than those of the G550. The window pairs are 7 in. farther apart than aboard the G550, adding an equivalent increment to the length of each living area.

The interior has 7 in. more cabin and floor width, plus 2 in. more height in the center aisle compared to the G550. Both the G600 and G500 have non-circular fuselages inspired by the G650. The cross-sections have compound curves with relatively sharp radii at the top and bottom to provide the most hip, shoulder and seated head room for the least increase in frontal drag compared to the G550. This allows for wider chairs and aisles than offered by the G550.

The G600 is 7-in. wider than the G550 with 7-in. more leg room in each cabin section, plus 16% larger signature wide oval cabin windows also used in the G650. The aft private stateroom has a fold-out sofa sleeper and a pair of facing chairs.

The G600's interior is 3.7 ft. longer than that of the G500, making room for a forward crew rest compartment and a longer, more capacious galley. But Gulfstream offers a variety of floor plans, including ones with four passenger living areas and no crew rest compartment.

The G500 and G600 introduce Gulfstream's signature Symmetry flight deck, quite clearly a radical departure from any cockpit design ever introduced by the Savannah manufacturer. GVII series jets are the first civil aircraft to be equipped with active sidesticks — devices that are electrically back-driven so that they appear to be mechanically linked. Move one and the other moves as though the two are tied together. These inceptors thus provide visual and tactile feedback of cross-side and autopilot inputs to the flight controls.

Symmetry is a paradigm shift. Civil aviation's first active sidesticks and 10 touchscreens control avionics, systems and cabin management equipment.

The sidesticks also provide stall warning stick shaker tactile and dynamic aircraft load feedback. In the unlikely event that the active feedback system fails, the sidestick reverts to a conventional passive mode. Further, if there's input disagreement between the two, priority goes to the stick on the left.

The aircraft also has 10 touchscreen controllers that slash the number of physical switches in the cockpit. Many functions are automated and there is more redundancy to improve dispatch reliability. The touchscreen control units have the intuitive graphic user interface of tablet computers, but with fewer screen icons and much shallower menus. However, it takes time to get accustomed to the tactile differences between the Symmetry touchscreen interface and consumer-grade PDAs. Symmetry touchscreens use resistive, rather than capacitive, touch response, so it takes a firm, steady finger press to activate the desired function. Left, right, up and down swipe motions provide immediate access to each phase of flight, flight plan progress, notes and audio control windows. The touchscreens replace the multifunction control/display units found in older Gulfstreams.

Symmetry also embraces GE Aviation's Data Concentration Network (DCN) that links most aircraft systems through remotely mounted nodes distributed throughout the airframe. The nodes concentrate data and then communicate with each other using an ARINC 664 local area network, a communications protocol that's up to 1,000 times faster than ARINC 429. The DCN distributes computing chores, shortens wire runs, automates systems operations, and sends and receives maintenance messages. This is a highly redundant, aircraft grade local area network, one that's considerably more flexible, adaptable and resilient than old-style ARINC 429 network architectures. It eliminates hundreds of feet of wires, dozens of physical circuit breakers and myriad switches.

GVII Structure and Systems

While the Symmetry flight deck and data concentration network break new ground, GVII aircraft retain Gulfstream's traditional aluminum, semi-monocoque construction for the primary airframe. Compared to the G550, parts count is virtually slashed in half because of major use of milled and machined components instead of hand-tooled and assembled bits and pieces.

Steel alloy, stainless steel and titanium are used where needed for stress concentration or heat shielding, such as for the fire resistant APU compartment in the tail. Composites are used for the horizontal stabilizer, fairings, main landing gear doors, rudder and elevators, nose and tail radomes, rear pressure bulkhead and winglets, among other areas.

The wing airfoil is adapted from that of the G650, being a

Interior is 3.7-ft. longer than the G500, making room for forward crew rest and larger galley (not shown). High capacity, front and rear vacuum toilets are standard. Chairs are larger and plusher than in the G550. Cabin altitude and sound levels are lowest is this class.

conventional super-critical design with a 0.87 to 0.88 drag divergence Mach number depending upon lift coefficient, among other variables. The longest-range cruise speed is actually Mach 0.78 to Mach 0.82. But the fuel savings for slowing below Mach 0.85 are almost negligible. The wing is built in-house in a new 220,000-sq.-ft. facility at the company's Savannah/Hilton Head International Airport (KSAV) headquarters and manufacturing campus in Georgia, rather than being outsourced as with past models.

The 10.69-psi pressurization system provides a 4,060-ft. cabin altitude at FL 450 and a 4,850-ft. cabin altitude at FL 510. No other large-cabin business jet offers a lower cabin altitude. Access to the aft baggage compartment is available up to FL 450, or 4,000 ft. higher than in the G550. All cabin air is freshly supplied by dual air-cycle machine packs. The system has enough capacity either to warm the cabin from -40C to 27C or to cool it from 50C to 24C in less than 30 min. The system has three-zone temperature controls, plus enhanced cooling flow to the equipment racks. Notably, the pressure recovery outflow valve is on the side of the fuselage to ease access for removal and replacement without having to move the right electrical equipment rack behind the copilot.

Using noise isolation techniques adapted from parent company General Dynamics Electric Boat division, Gulfstream now claims that the G600 has the quietest cabin in its class.

All interior and exterior lights use long-life LEDs, including landing taxi and navigation lights, along with strobes, beacons, wingtip clearance, recognition, logo, utility and ice inspection lights.

Ice protection systems are conventional. Windshields, side and cabin windows, along with air data probes are electrically heated. The wing leading edges and engine inlets use conditioned bleed air for anti-icing.

The tailcone section houses the Honeywell HTG400G APU, an upgraded version of the RE220 APU, dual air-conditioning packs, hydraulic reservoirs, main batteries and other equipment.

GVII aircraft have an electrically controlled, hydraulically actuated, 3.0-ft.-wide by 6.2-ft.-high airstair design main entry door with lighted steps. Two of the seven windows on each side of the aircraft are mounted in 26-in.-high by 32-in.-wide over-wing emergency exits. The baggage compartment has a 2.9-ft.-high by 3.3-ft.-wide external access door below the left engine nacelle.

The three-axis, digital fly-by-wire (FBW) flight control system is adapted and improved from the G650, having dual, two-channel Thales flight control computers (FCCs) that host normal, alternate and direct law modes, along with its separate three-axis backup flight control unit that provides direct law mode.

The primary flight control surfaces move by both conventional hydraulic actuators and hybrid actuators that normally use aircraft hydraulic pressure or self-contained 28 VDC electrically powered hydraulic pumps as a backup. If both the aircraft's electrical and hydraulic power systems are inoperative, a 28 VDC emergency battery powers the flight control computer "brains" and a separate 28-volt, 53-amp-hour emergency battery provides power to the hybrid backup actuators for "brawn."

The wing flaps, with 0-deg., 10-deg., 20-deg. and 39-deg. positions, are actuated by a hydraulic motor driving torque tubes, gearboxes and jackscrews. The trimmable horizontal stabilizer is electrically actuated.

As with the G500, the primary electrical system is powered by 40-kVA engine-driven AC generators, along with a

40-kVA APU generator that can supply electrical power up to 45,000 ft. A 15-kVA ram-air turbine provides emergency AC power. AC mainly is used for pumps, heaters and battery chargers. Most other loads, including virtually all of the FBW components, are DC-powered, supplied by five transformer-rectifier units. Main and emergency batteries provide APU starting and backup DC power to essential systems. Dual 115-VAC/60-Hz power converters are available for plug-in appliances and laptops.

Dual 3,025-psi hydraulic systems, primarily powered by left and right engine-driven pumps, supply the FBW flight control actuators, wheel brakes, landing gear, wing flaps, nosewheel steering, main cabin door and thrust reversers. A right-to-left power transfer unit assures that critical systems remain powered in the event of a single-side failure. A DC-powered aux pump provides pressure to operate the main cabin door, inboard wheel brakes, nosewheel steering, flaps and landing gear if the engine-driven pumps are inoperative. A storage reservoir with internal pump in the tailcone allows the systems to be replenished as needed during layovers.

A set of DC-powered electric backup hydraulic actuators (EBHAs) provides a third level of redundancy for the primary flight controls. Should all other DC power sources fail, emergency batteries provide power for the EBHAs and other FBW components, including the main flight control computers.

All fuel is stored in left and right wet wing tanks. DC-powered main and alternate fuel boost pumps are automatically activated as needed. Jet pumps transfer fuel from the outer wing sections to the feeder tanks. A heated fuel recirculation system, using excess fuel from the engine-driven pumps and warmed by engine oil, assures that wing fuel remains liquid at temperatures below 10C. Refuel time is approximately 26 min.

Symmetry flight deck will be standard in all future Gulfstreams, opening the way for a common pilot type rating in upcoming models. PFDs feature full synthetic vision, including representations of runways, taxiways, airport signage and buildings.

Other details about GVII series aircraft systems and interior features are contained in *BCA*'s November 2016 G500 pilot report (page 24).

Flying Impressions

On the eve of this year's annual NBAA gathering, we strapped into the left seat of G600 serial number 73009 on Gulfstream's ramp in Savannah, accompanied by Eric Holmberg, senior experimental test pilot, as instructor pilot and Scott Evans, director of demonstration and corporate flight operations, as safety pilot on the jump seat.

As Gulfstream's factory demonstrator, the aircraft was loaded with options including Honeywell's Jet Wave Ka-band satcom system, fully enclosed aft stateroom with bed, front and rear electrically actuated pocket doors and numerous galley upgrades. Its BOW with three crewmembers is 51,170 lb., which is actually 300 lb. less than the weight Gulfstream quoted *BCA* for the average equipped G600 listed in the June 2019 *Purchase Planning Handbook*.

We especially looked forward to the flight as it would provide insights into the design of a future Gulfstream product described elsewhere in this issue. The GVII flight deck, control layout and FBW form the foundation for a common pilot type rating in upcoming Gulfstream aircraft.

Up front, immediately we were reminded of our first impression of the G500's Symmetry flight deck. Compared to older Gulfstreams we've flown, dozens of switches, knobs and buttons, plus more than half of the physical circuit breakers, have been eliminated. The touchscreen controls provide access to virtual circuit breakers in the secondary power distribution system. Systems are well integrated, automating many tasks

Cabinetry with gentle complex curves is Gulfstream's strong suit. No manufacturer can top the firm's craftmanship, in our opinion. Credenza across from four-chair conference grouping has storage drawers, two wine coolers, entertainment media storage and swing-up, HD inflight entertainment monitor.

that formerly required pilot actions. Starting the APU, for instance, automatically activates the left main fuel pump, turns on the navigation lights and configures the electrical and bleed air systems as required. Those actions are shown on system screens.

The electronic checklist function is fully integrated with aircraft systems. Flow the checks and completion of each item is shown on the checklist. Uncompleted checklist items are easy to spot and fix.

While the touchscreens have a comparatively intuitive user interface, pilots accustomed to older design cockpits will benefit from practicing with the devices for each phase of flight at FlightSafety International's Savannah learning center or at desktop simulators. As noted, they're far from being airborne clones of consumer-grade tablet computers. Practice not only will familiarize pilots with touchscreen functionality, but it will allow them to adapt to the push-wait-release icon activation conventions created to prevent inadvertent button pushes.

Flight planning on the touchscreen is done by phase of flight, similar to that of Dassault's EASy or Bombardier's Vision flight decks. We found the point-and-press touchscreen interface to offer better hand-eye coordination than the cursor control format used by other manufacturers. The G600 still has CCDs on the center pedestal for certain point-and-click functions on screen.

Pre-start chores are quick and the check flow is left to right. The overhead panel left-to-right flow, for example, is just: APU fire test, main and emergency batteries on, cockpit lights adjust, APU on and galley power on. GVII aircraft are designed to transition from cold iron to taxi in 10 min. or less. It would take us longer because this was only our second flight in this family of aircraft.

The final FMS software load was not yet installed, so Evans manually computed takeoff data for the flight using Gulfstream's mobile performance app for tablet devices. With 150 lb. of equipment and 14,000 lb. of fuel, ramp weight was 65,290 lb. We used 65,000 lb. as our estimated takeoff weight. The OAT was 35C, Savannah's elevation is about 25 ft. and the wind was out of the north at 6 kt. Using flaps 20 deg., computed speeds were 118 KIAS for V1 decision speed and rotation, 128 KIAS for V_2 takeoff safety speed. Takeoff field length was 4,001 ft. on 9,351-ft.-long Runway 10. We had enough fuel to fly to Salt Lake City or Phoenix, had the mission required it.

Taxiing out, it was quite apparent that Symmetry's advanced synthetic vision PFD graphics provide a leap forward in situational awareness. The exocentric or above-the-aircraft view shows taxiway, intersection and runway labels in proper colors, plus yellow boundary and hold-short lines, building shapes and centerline stripes. Unlike other synthetic vision systems with which we've flown, Symmetry's synthetic vision doesn't leave you apparently taxiing off pavement when you're not on a runway.

At very light operating weights, the aircraft tends to accelerate at idle thrust. We found it useful to extend one thrust reverser to stabilize speed, as we didn't want to ride the brakes. Up to 40 deg. of nosewheel steering is available through the rudder pedals, diminishing with ground speed increase. For very tight turns, the tiller commands up to 82 deg. of steering authority.

Once cleared for takeoff, we advanced the thrust levers and armed the autothrottles. As the levers move forward, the PFDs automatically switch from exocentric to egocentric, or inside-the-aircraft, view. The lightly loaded aircraft accelerated swiftly and we were airborne well before crossing the Taxiway A intersection.

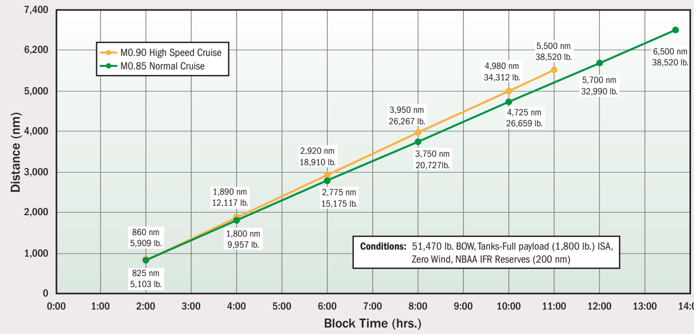
Aft lavatory has ample storage for warm clothes and linens. Access is available to aft baggage compartment through a door in the rear up to 45,000 ft.

Gulfstream G600 Performance

These graphs are designed to illustrate the performance of the Gulfstream G600 under a variety of range, payload, speed and density altitude conditions. Ben Debry's team of Gulfstream sales engineers provided the data for all three charts, based mainly upon computer projections for production aircraft. All data are preliminary. Do not use these data alone for flight planning purposes because they do not take into account ATC delays, and less than optimum routings and altitudes, along with other factors that can alter actual aircraft performance.

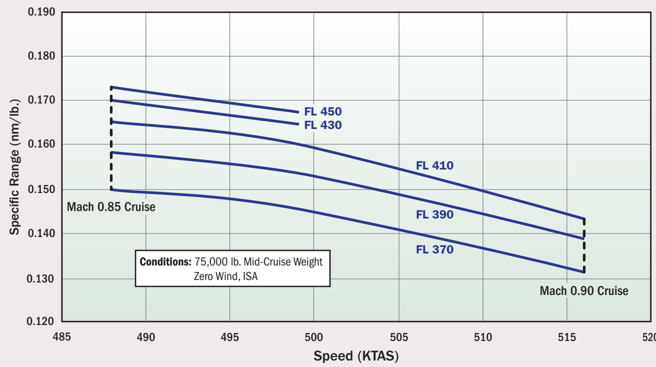
Time and Fuel versus Distance

This graph shows the relationship distance flown, block time and fuel consumption for a typically equipped aircraft having a 51,470-lb. BOW and carrying an 1,800-lb. payload. The fuel and distance points were individually computed at 2-hr. intervals by Gulfstream. Normal cruise speed is Mach 0.85. High-speed cruise is Mach 0.90. The G600 should be able to fly 1,000-nm farther at long-range cruise than at high-speed cruise. Gulfstream officials believe that most operators will cruise the aircraft at Mach 0.87 to 0.88 on all but the longest range missions.



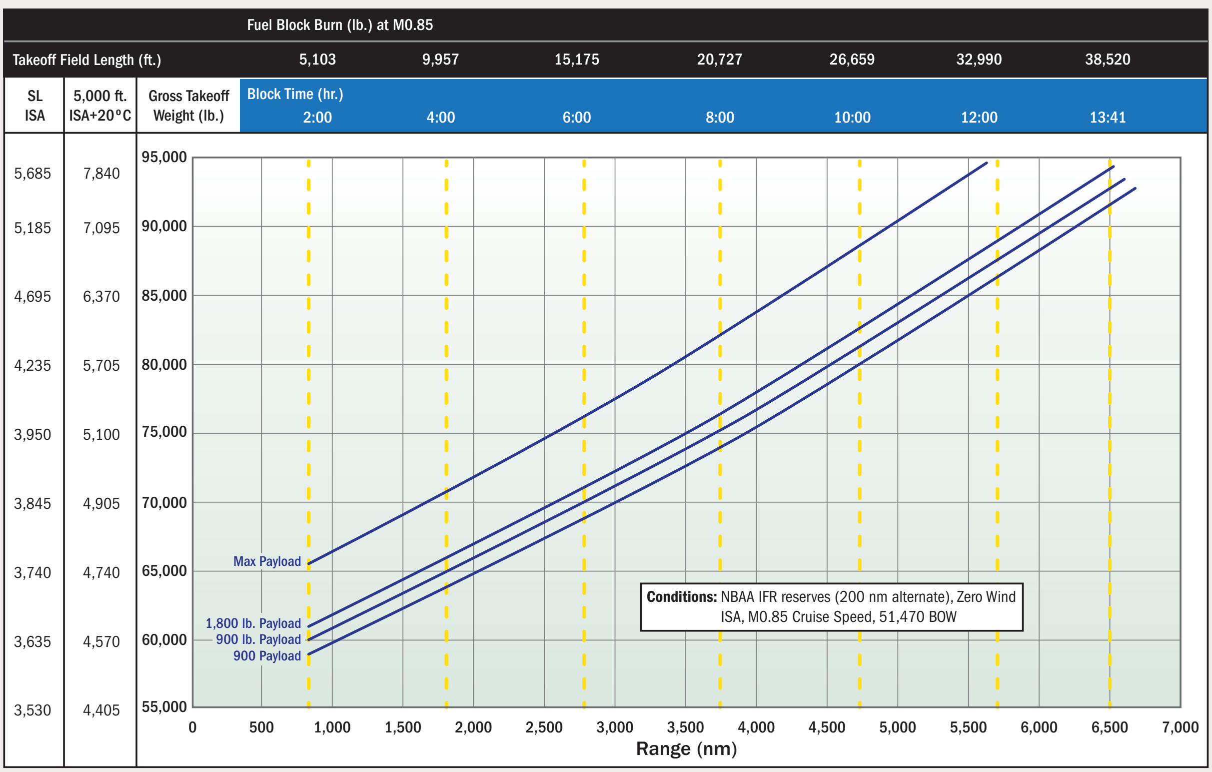
Specific Range — Mid-Range Weight, ISA

This graph shows the relationship between cruise speed and fuel consumption for the G600 at representative cruise altitudes for a 75,000-lb., mid-weight aircraft, based upon Gulfstream's performance projections. The data indicate that FL 450 is the optimum for fuel efficiency at Mach 0.85 cruise at this weight. Performance data we recorded during our demo flight indicate that production aircraft should meet or beat Gulfstream's performance projections.



Range/Payload Profile

The purpose of this graph is to provide simulations of various trips under a variety of payload and two airport density altitude conditions, with the goal of flying the longest distance at Mach 0.85. Each of the four payload/range lines was plotted from multiple points. Do not use these for flight planning as they are gross approximations of actual aircraft performance. The dashed hourly cruise lines were computed individually at two hour intervals and they assume an 1,800-lb. payload. Each of the takeoff field lengths assumes the optimum flap configuration for the best blend of runway and one-engine-inoperative climb performance. When departing *BCA*'s 5,000-ft. elevation, ISA+20C airport, there is no weight-altitude-temperature restriction. The aircraft can depart at maximum takeoff weight.



Gulfstream G600 Specifications

***BCA* Equipped Price**	$57,900,000
Characteristics	
Wing Loading	81.5
Power Loading	3.02
Noise (EPNdB)	88.3/78.3/91.3
Seating	4+16/19
Dimensions (ft./m)	
External	
Length	96.1/29.3
Height	25.3/7.7
Span	94.1/28.7
Internal	
Length	51.3/15.6
Height	6.2/1.9
Width (maximum)	7.6/2.3
Width (floor)	6.1/1.9
Thrust	
Engine	2 PW815GA
Output/Flat Rating OAT°C	15,680 lb. ea./ISA+15C
TBO	OC
Weights (lb./kg)	
Max Ramp	95,000/43,092
Max Takeoff	94,600/42,910
Max Landing	76,800/34,836
Zero Fuel	57,440/26,055c
BOW	51,470/23,347
Max Payload	5,970/2,708
Useful Load	43,530/19,745
Executive Payload	1,600/726
Max Fuel	41,730/18,929
Payload with Max Fuel	1,800/816
Fuel with Max Payload	37,560/17,037
Fuel with Executive Payload	41,730/18,929
Limits	
MMO	0.925
FL/VMO	FL 350/340
PSI	10.7
Climb	
Time to FL 370	18 min.
FAR 25 OEI Rate (FPM)	NA
FAR 25 OEI Gradient (ft./nm)	NA
Ceilings (ft./meters)	
Certificated	51,000/15,545
All-Engine Service	43,000/13,106
Engine-Out Service	NA/NA
Sea Level Cabin	NA/NA
Certification	FAR Part 25, 2019

Gulfstream, similar to Bombardier and Boeing, among a few other manufacturers, uses speed stable flight control law. As the aircraft accelerates or decelerates, pitch trim inputs are needed. A four-way trim switch on top of the control stick is available for this task. Or the red autopilot disconnect button atop the stick can be pressed momentarily to reset the neutral trim speed.

Embraer displays a cyan-colored caret on the PFD airspeed scale to indicate the neutral trim speed. But aboard GVII aircraft, this useful information is only available on the navigation display. In our opinion, Symmetry could benefit from this situational awareness cue, particularly if it were displayed next to both the PFD and the HUD airspeed tapes. Also, it's easy to overcontrol the aircraft by inadvertently moving the sidestick when using the trim switch or autopilot disconnect button.

Gulfstream also has its own EFIS color conventions and they're not necessarily consistent. Blue, for example, might indicate a system available for activation, or a system in standby because the desired function cannot be supported, or the position of an ECS trim air value. Magenta is used to indicate pilot-selected barometric setting, landing gear in transition or available thrust limit. Green also can indicate a pilot-entered value, but blue also indicates a pilot-selected interior temperature.

For optimum situational awareness, we find it preferable to display all pilot-selected values in cyan, all computer-generated targets or values in magenta, all active modes in green and all standby modes in white. Yellow is reserved for cross-side references, amber for caution and red for warning.

Symmetry also doesn't have a touch-control steering function activated by a button on the sidestick. This means that all autopilot functions must be programmed by using the glareshield control panel switches and knobs or inputs to the FMS.

Eastbound and once clear of crossing north-south air traffic, our climb to cruise altitude was approved. Using a 300 KIAS/Mach 0.85 climb schedule in mostly ISA+10C to ISA+15C conditions, the aircraft reached FL 430 in 23 min. after takeoff while burning 1,800 lb. of fuel. The OAT dropped to ISA or below as we climbed above FL 400.

Afternoon thunderstorms were starting to build over the Atlantic Ocean in Warning Area 139, so there was plenty of minor turbulence to bias cruise performance checks. At a weight of 62,300 lb., the aircraft cruised at Mach 0.90, equivalent to 512 KTAS in ISA-3C conditions while burning 2,960 lb./hr. The Aircraft Operating Manual predicted value was close to 3,100 lb./hr. for the same weight, speed, altitude and OAT.

Up at FL 470, we set Mach 0.85 for long-range cruise. At a weight of 62,000 lb. and in ISA-10C conditions, the aircraft cruised at 479 KTAS while burning 2,200 lb./hr. The AOM prediction was 2,309 lb./hr. for the same parameters.

While these cruise performance checks were not scientific, they suggest that the G600 will meet or beat its book performance numbers.

Holmberg then pushed up cruise speed to Mach 0.90. We then stepped out of the left seat briefly to check cabin sound levels at high-speed cruise. The front of the aircraft, including flight deck, galley area and crew rest compartment are relatively quiet at that speed, especially with the hard-shell acoustical curtain pulled over the main entry door.

The main-cabin forward club section and mid conference grouping are considerably quieter. But when the pocket doors between the galley and cabin, and between cabin and stateroom, are closed, sound levels drop even more. Subjectively, the G600 appears to offer the lowest cabin sound levels of any aircraft in its class, most probably at Mach 0.90. However, we've not yet flown the Bombardier Global 6500 so we can't make a comparison.

Sound levels in the aft stateroom, though, are somewhat higher than in the main cabin. Transonic airflow over the wing and/or engine noise may be the cause. Still, the aft cabin section is quieter than those of most other aircraft in this class.

Resuming the left seat, we descended out of the flight levels for air work. On the way down, we intentionally pushed up speed to the Mach 0.925 Mmo redline. This activated the FBW high-speed flight envelope protection and the flight control system eased up nose attitude to keep the aircraft well within its MD demonstrated Mach dive speed limit.

Level at 15,000 ft., we slowed to 250 KIAS for steep turns. The combination of nicely balanced sidestick forces and the flight path vector on the HUD and PFD make it easy to hold altitude. Throttle response was linear and predicable, enabling to hold speed within a few knots.

Approaches to stalls bring out some of the best safety features of Symmetry and the FBW, typical of other large-cabin aircraft we've flown with advanced avionics systems. In the clean configuration and at a weight of 61,200 lb., we slowed the aircraft into the yellow low-speed awareness band of the PFD airspeed scale. This triggered autothrottle engagement as the first phase of low-speed flight envelope protection kicked in.

Overriding the autothrottles, we continued to let the aircraft decelerate. With full aft sidestick at 116 KIAS, equivalent to 95% of CL max (stalling angle of attack), the FBW system eased down the nose. The aircraft remained fully controllable, except that we were descending at 2,500 to 3,000 ft. per minute. As soon as we released sidestick back pressure and pushed up the throttles, the aircraft immediately recovered from the approach to stall.

At a weight of 61,000 lb., approaches to stall behavior and recovery were just as docile at gear up/flaps 20 deg. (94 KIAS, 95% CL max) and gear down/flaps 39 deg. (92 KIAS, 95% CL max).

Returning to Savannah for pattern work, we first flew a normal ILS approach to Runway 10. Symmetry's FBW kit compensates for configuration changes, stabilizing the aircraft. The speed stable control law makes the aircraft respond naturally in pitch. But in turbulence, it's a little difficult to tell if the aircraft is precisely trimmed on speed without frequently checking the neutral trim indication on the MFD.

At a weight of 59,100 lb., VAPP was 117 KIAS and VREF was 112 KIAS. HUD guidance and FBW greatly reduce pilot workload. The large wing is low to the ground in the landing flare, creating generous ground effect lift. Any excess speed over VREF after crossing the threshold delays touchdown. The long-travel trailing-link main landing gear flatter flight crews with very soft arrivals.

Simulated one-engine-inoperative approaches and go-arounds are a little more challenging as the autothrottle system is not available to hold speed or push up the throttle for the go-around. In addition, the FBW system does not have an asymmetric thrust or slip-induced proverse roll compensation, thus it's up to the flight crew to make appropriate pitch, roll and yaw control inputs with thrust changes to keep the aircraft in balanced flight.

Our final landing was a normal, all-engine exercise. While we flared on speed, the aircraft still floated for a few hundred feet. When we touched down, using the lowest setting of autobrakes, the aircraft gently decelerated to taxi speed in less than 3,000 ft. Slowing through 60 kt., the PFD automatically switched from the egocentric to the exocentric view, boosting situational awareness for taxiing to the ramp.

Large forward galley has work counter, coffee and espresso makers, microwave and convection oven, plus generous storage on right side. Left-side galley annex has food chiller, a pair of stacked ice drawers, flatware and crystal compartments plus a dirty dish drawer.

Conclusions

The G600 is the first of a new breed of large-cabin business aircraft designed to fly from most cities in Europe to most cities in North America at nine-tenths the speed of sound. These new models fly 30 to 60 kt. faster than their predecessors and they do it efficiently because of advanced-technology engines, such as the Pratt & Whitney Canada PW800-series turbofans, and highly refined aerodynamics.

The G600 stands apart from competitors because of its flight deck design, active sidesticks and upgraded synthetic vision system, plus its impressively low cabin sound levels, high pressurization and passenger comfort. But this is an aircraft that demands serious flight crew, cabin crew and maintenance technician commitment to learning its nuances, mastering its systems, exploiting its full capabilities. The reward for investing such effort is not only earning status as a GVII maven but also gaining the proficiency to fly and maintain the next generation of even more capable Gulfstream business jets. BCA

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Senior Editor
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Gulfstream G550

Best of the **20th century Gulfstreams**

FOR AS LITTLE AS $15 MILLION, YOU CAN BY A G550 THAT CAN FLY eight passengers 6,700 nm. This second-generation GV went into production in 2003, bringing with it the PlaneView flight deck, improved runway performance and reduced drag at cruise yielding 250-nm more range. The cabin has better interior space utilization because the cabin door is moved two feet forward and water and waste tanks are relocated in the aft fuselage. The cabin has a seventh pair of windows, distinguishing it from first-generation (1997 to 2003) GV jets.

The G550, known to the FAA as the GV-SP, actually is the sixth iteration of the 1967 GII. A series of engine, wing and systems upgrades give this aircraft almost 2.5 times the range of the original model. The G550 remains in limited production and it retails for more than $60 million. But selling prices for new aircraft are very soft, exerting downward pressure on those for used machines.

The G550's typical three-section cabin has four-chair club seating up front, a four-seat conference grouping with credenza in mid-cabin and an aft stateroom with three-seat convertible sofa sleeper on the left and two facing chairs on the right. Most aircraft have forward galleys with work stations split between left and right sides. All have forward and aft vacuum lavatories. Full-time access to the aft baggage compartment is available at FL 410 and below.

The cabin comfortably berths five or six passengers on overnight trips. Inflatable JetBeds for the cabin and forward crew rest compartments are highly desirable upgrades. Packed with galley stores, food and refreshments, it's easy to reach maximum ramp weight with full tanks, a flight attendant and five or six passengers.

Gulfstream quotes 48,700 lb. as the average basic operating weight, providing a 1,700-lb. full fuel payload. Actual BOWs range between 48,103 lb. and 48,800 lb., operators tell *BCA*. But it's easy to balloon up zero fuel weight by 500 to 700 lb. with all the kit needed for long international missions.

The PlaneView flightdeck features, four, 14-in., landscape configuration flat-panel displays with optional synthetic vision PFDs. This was the first Gulfstream to be fitted with cursor control devices. But rather than using track balls in the center console, Gulfstream developed side-wall mounted CCDs with integral arm rests, ergonomically angled handholds and thumb-operated force transducers that control the cursors on screen.

The G550 has a standard Collins HGS-6250 head up guidance system and second-generation Elbit EVS II IR enhanced vision system, significantly improving situational awareness in reduced visibility conditions, according to operators.

Initial cruise altitude is FL 400 or FL 410 on long-range missions. Most operators plan on a first hour fuel burn of 4,500 to 5,000 lb., dropping to 3,000 lb. for the second hour and decreasing to 2,400 lb. for the last hour of the mission. Such generous estimates for fuel burn assure they have ample reserves upon arrival.

Many operators routinely fly their aircraft at Mach 0.83 to 0.85 on missions shorter than 12 hr. Such cruise speeds enable them to fly non-stop between most city pairs in North America and Europe, and one-stop between most cities in the Western Pacific and North America. Anchorage is a popular technical stop between Asia and the U.S. where operators refuel and change flight and cabin crews. On shorter-range missions, crews say they plan on 5,000 lb. for the first hour, 4,000 lb. for the second hour and 3,000 lb. per hour for the remaining hours.

These aircraft are not inexpensive to operate. Budget 500 to 550 gal. per hour for fuel, $700 to $950 per hour for engine reserves and 2.5 maintenance hours per flight hour for inspections, plus another $250 per hour for parts. Having the aircraft enrolled in the Rolls-Royce CorporateCare or JSSI engine care programs is a big plus at resale time. Landing gear overhaul is due at 5,000 cycles, or at about 12,500 to 15,000 hr. based upon typical mission lengths.

GULFSTREAM

With FAA's ADS-B Jan. 1, 2020 deadline less than two months away, G550 buyers should look for aircraft having ASC 84B (Certification Foxtrot) enhanced navigation packages that include WAAS GPS receivers and ASC 105 ADS-B compliant Honeywell Primus II XS-858A Mode S transponders. Also, check time in service since the last 96-month major airframe inspection.

As of June 2019, operators report that Securaplane emergency batteries and chargers, PlaneView advanced graphic modules, main displays and cursor control devices, Parker fuel quantity probes and PPG windshields can be troubleprone.

Compliance with Customer Bulletin 190A also is a must, considering it's likely to become an airworthiness directive. For aircraft in service for 132 months and longer, horizontal stabilizers must be inspected for disbonding of the bottom skin from internal stringers caused by corrosion. If minor disbonding is detected, repairs may be deferred to the next scheduled maintenance inspection. But if extensive disbonding is found, the aircraft may be out of service for 90 days, or more, to accommodate repairs.

The G550's main competitors are the Bombardier Global 6000 with a more spacious cross-section, but less range and higher direct operating costs, and the Dassault Falcon 7X offering a wider but shorter cabin, considerably better fuel efficiency and fly-by-wire flight controls. Considering the G550's price versus performance blend, it's one of the most desirable large-cabin aircraft on the pre-owned market. **BCA**

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

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

▶ **Avia Solutions Group,** Vilnius, Lithuania, appointed **Vygaudas Usackas** as a member of the Board of Directors at the company. Usackas was the former Lithuanian Minister of Foreign Affairs, former EU Ambassador to Afghanistan and Russia Ambassador to the U.S., Mexico and the United Kingdom.

▶ **Bombardier,** Montreal, Canada, announced the appointment of **Christophe Degoumois** as vice president of Sales, International, for Bombardier Business Aircraft, overseeing business jet sales in all regions outside the Americas. Degoumois began his career in business jet sales in 1998, working in aircraft management and air charter sales in Zurich and Geneva.

▶ **Cutter Aviation,** Phoenix, Arizona, promoted **Godfrey Higgs III** to manager of Aircraft Services at Centennial Airport in Denver, Colorado. Higgs is responsible for managing all aspects of maintenance operations, including the successful implementation of maintenance projects and cost-effective utilization of department resources.

GODFREY HIGGS III

SANDRA PHELPS

▶ **Duncan Aviation,** Lincoln, Nebraska, named **Sandra Phelps** as its International Parts & Rotables Sales Representative dedicated to the European Union member states. Phelps will specialize in aircraft parts sales in the European market, managing work orders, parts exchange transactions, and international shipments, including hazardous material. **Rachael Weverka** is transitioning to the Duncan Aviation's modifications sales team in Lincoln, Nebraska, responsible for paint and interior sales for Gulfstream and Embraer aircraft. Weverka previously spent nine years as a designer for Duncan, working on numerous airframes.

MICHELE POSEY

GRAHAM DICKIE

▶ **FlightSafety International,** New York, New York, promoted **Michele Posey** to executive director, Sales. In this new role, Michele will oversee FlightSafety's team of Regional Sales Managers and Directors, and is responsible for business aviation sales activities in North America.

▶ **Flying Colours Corp.,** Peterborough, Ontario, appointed **Graham Dickie** as its new chief financial officer. Based at the company's headquarters in Peterborough, he will be responsible for managing the company's finances, planning and working with senior executive team to manage international growth.

▶ **Gulfstream Aerospace Corp.,** Savannah, Georgia, appointed **Peter Vasconcelos** to regional senior vice president of Sales for the northeastern U.S. and eastern Canada. He is based at Gulfstream's Manhattan Sales and Design center and reports to Scott Neal, Gulfstream's senior vice president of Worldwide sales.

▶ **Gulfstream Aerospace,** Savannah Georgia, announced it has earned a **2019 Sustainability Leadership Award** from Business Intelligence Group for its sustainable aviation fuel (SAF) initiatives. The award recognizes organizations that make sustainability an essential part of their business operations.

▶ **Heli-One,** Rzeszow, Poland, announced **Jacek Baranowski** is joining Heli-One's MRO operation in Rzeszow as general manager. Baranowski has more than 20 years of aviation industry experience, previously holding positions with Bodycote Aerospace & Defense, Seco/Warwick Retech Thermal Equipment Manufacturing China, Wallair Engine Components (Velatia

Gone West

Michael Wayne Dolphin, 73, of Pittsfield, Massachusetts and Ft. Myers, Florida, passed away September 30, 2019 peacefully at home.

Born in Pittsfield on December 30, 1945, Michael was the son of the late Franklyn P. and Dorothy A. Renaud Dolphin.

Michael graduated from Wahconah Regional High School and attended Embry Riddle Aeronautical in Daytona, Florida.

He married the former Marian "Mimi" Heaton on January 16, 1971 at St. Theresa's Church.

Mr. Dolphin was a pilot for over 50 years logging 18,000 hr. of flight time. His career began at Yankee Airlines in Pittsfield where he met the love of his life Mimi while working for her father. From there his career took him to Richmor Aviation in Hudson, New York. Michael's career propelled in the aviation industry when he became president of Jet Systems at the Westchester County Airport in White Plains, NY. He continued to fly recreationally after retirement.

Michael loved spending time with his beloved family; flying, cars and motorcycles, boating and adored dogs. His selfless love and contagious smile touched everyone that came into his life. He held his family and friends near and dear to his heart.

He is survived by his loving wife of 48 years, Marian "Mimi" Dolphin; daughter, Tracey Arasimowicz and husband Edward of Ft. Myers, Florida; son, Todd Dolphin and wife Kristy of Odessa, Florida; sister, Judy Ryan of Lenox, Massachusetts; his beloved grandchildren, Katelyn, Luke, Ryan and Reese; as well as his faithful companion Buddy.

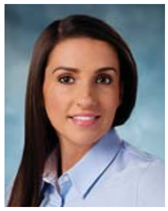
Advertisers' Index

On Duty

Group), GE Aviation, and Listemann Group.

▶ **Jet Aviation,** Zurich, Switzerland, announced **Elouisa Dalli,** senior director Global Communication, as the new Vice president of Marketing & Communications, succeeding **Heinz Abi** who will be retiring after 29 years with Jet Aviation.

▶ **jetAVIVA,** Kansas City, Kansas, has partnered with **Angel Flight Central** to sponsor flight for adults and children seeking life-saving medical treatment and other needs. For every completed aircraft sales transaction, jetAVIVA will sponsor and financially support an Angel Flight mission.



JENIFER ODELL

LOU RAMM

ROBBIE JOHNSON

MIKE DITMEYER

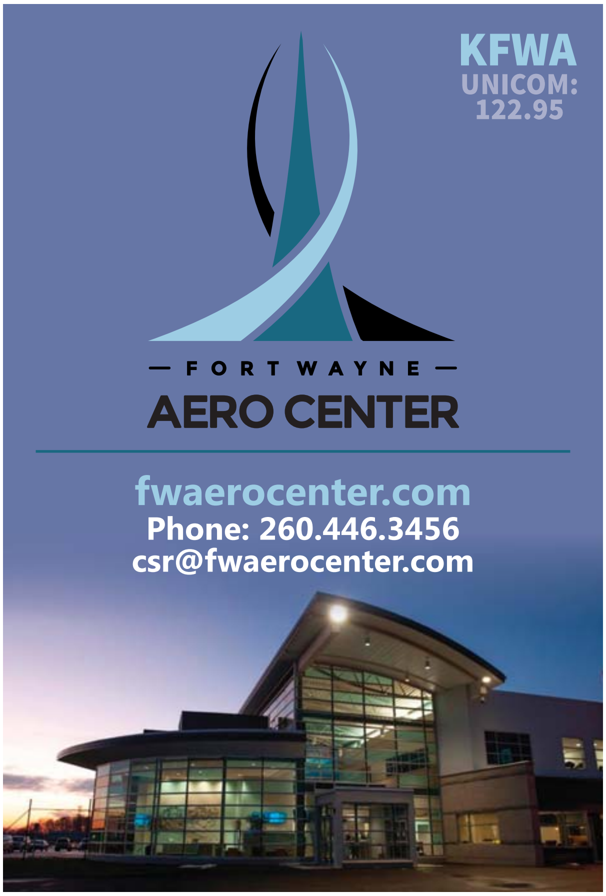
▶ **JetLoan Capital,** Stuart, Florida, announced that the company has added **Jenifer Odell** as their new account representative. Duncan Aviation, Lincoln, Nebraska, announced that **Stefanie Sedam** has joined its Bombardier Airframe Service Sales Team. She will join the Duncan Aviation team at the new, full-service facility in Provo, Utah.

▶ **Medaire,** Tempe, Arizona, named **Hany Bakr** to the newly created role of security director for Europe, Middle East & Africa (EMEA). He will be responsible for assisting clients in managing and mitigating risks to their people, aircraft and operations; as well as support aviation security product development to maintain Medaire's industry leadership.

▶ **Meridian,** Teterboro, New Jersey, announced that **Lou Ramm,** Meridian Air Charter's director of Quality Assurance, was awarded the prestigious Charles Taylor Master Mechanic Award. The award recognizes the lifetime accomplishment of senior mechanics.

▶ **Pentastar Aviation,** Waterford, Michigan, announced they have been recognized for their corporate culture by being named one of Crain's **Detroit Business Cool Places to Work** in Michigan for 2019.

▶ **West Star Aviation,** East Alton, Illinois, named **Robbie Johnson** as the new regional sales manager in the mid-Atlantic sales territory. He has over 22 years of aviation experience as a maintenance technician and program manager with previous positions held at Falcon, MBNA Aviation and Dawn Aero. **Mike Ditmeyer** is the new Gulfstream Operation Manager at the company's Chattanooga, Tennessee, facility. **Jason Cohen** was promoted to Bombardier Global program manager at its Grand Junction (GJT) facility in Colorado. Cohen brings more than 30 years of aviation experience to the new role, including eight years serving on the Bombardier technical sales team for West Star. **BCA**



Advertisement

RIDER JET CENTER

Hangar Space For Sale

Rider Jet Center is offering hangar space for sale at the Hagerstown, Maryland, airport (KHGR). Hangar 65 has 40,000 square feet of floor area, plus a fully-conditioned office area which covers 15,000 square feet over three levels. Plus, there is 5,000 square feet of storage space! The building includes an elevator and two stairways for easy access.

The hangar floor is heated with radiant floor heat and equipped with HSLV fans for the warmer months. The hangar door measures 180 x 44 feet, with a tail door in the center if needed. The hangar also has an epoxy-coated floor and a full deluge sprinkler system for safety.

With over 100 parking spaces available, this hangar is ideal for your FBO or MRO location. To learn more, call Ben Rider at 301-730-4102 or Dave Gochenaur at 301-514-8758.

riderjetcenter.com

https://mrolinks.mro-network.com/product/hangar-space-sale

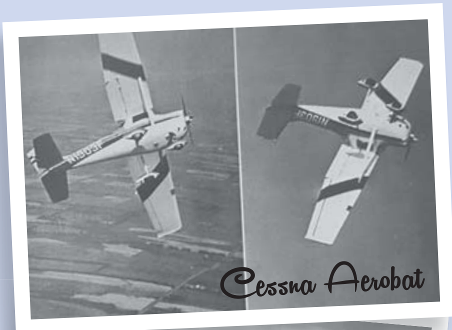
Aftermarket Services
Economic Development /Airports

November 1969 News

Saying, "I want the United States to continue to lead the world in air transport." President Nixon urged continued government participation on the controversial supersonic transport development . . . – *BCA Staff*

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

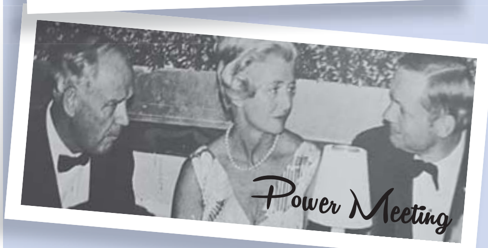
. . . Revised development program will request $96 million in fiscal 1970 funds to be added to the $99 million carryover from the previous $623 million appropriation. Total expenditure of about $1.5 billion by 1974, 85% supported by the government.



Cessna line takes a new turn. Aiming at the growing interest in sport flying, Cessna has introduced the Aerobat, a aerobatic version of the 150. Certificated in the aerobatic category, the Aerobat has load factors from +6 to -3g and can perform barrel, aileron and snap rolls, loops, Cuban eights and Immelmanns. Base price is $10,495.

One of four-of-a kind, this versatile descendant of the Super is snug, fast and economical. And with PC keeping thing level, even the amateur pilot finds it difficult to go astray.

The Cessna Citation prototype differs from the mockup of original shown at the 1968 NBAA Convention Houston, Texas. Tail of mockup was more of a cruciform than that on ing prototype. Also, fuselage has been stretched and engines moved further aft. Nose boom is for test airplanes only.



At a meeting of the Society of Experimental Test Pilots; Charles A. Lindbergh (left); Mrs. Robert Hoover, wife of SETP president, and astronaut Neil Armstrong.

Airport reservation system continuation at five critical airports is being debated within FAA and DOT. FAA figures, comparing August 1969 to August 1968 show that reservations system led to small decreases in total operations and large drops in flight delays at JFK, LGA, EWR and WNA. **B&CA**

THE ARCHIVE

Telephoto lens of photographer Tony Link catches the Aerostar 600 as it drops down for high-speed flyby at June's Reading Air Show. Ted Smith's Aerostar – marked by its midwing, high swept vertical fin and swept horizontal stabilizer — has performance to match its sleek appearance.

In-Flite products Inc announces a major breakthrough in price, weight and operational capability. A telephone for your airplane for only $2,495.

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