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Q2 2023

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Business & Commercial Aviation

Aircraft Purchase Planning Handbook

Pressure on Bizjets in France

AAM Pilot Challenge

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AVIATION WEEK NETWORK
By Informa Markets

Lee Ann Shay
Editor-in-Chief

The Pressure Is On

Business aviation faces headwinds

Is business aviation on a collision course with environmental goals?

One side might say yes. Environmental activists are demonstrating at business aviation events and airports. Private flyers face flight-shaming.

Sustainability pressures on business aviation stand out particularly in France. As Thierry Dubois writes in his article about the state of business aviation in France on page 42, opposition Green Party Deputy Julien Bayou has proposed banning business jets and defines them as "including on-demand flights for 60 passengers or less." Even business jets derived from Airbus and Boeing commercial aircraft platforms usually do not include 60 seats.

Dubois points out that "Additional taxes and use restrictions in the country might be the harbinger of a more stringent framework and disincentives for business aviation throughout the entire European Union."

If sustainable aviation fuel (SAF) was more readily available around the world, that might offset some of the pressure on the industry, but demand outpaces supply and this situation won't change quickly. Daniel Coetzer, CEO of Titan Europe, quoted in Angus Batey's article on SAF in Europe on page 46, notes that "SAF is still very difficult to find; supply is still very unreliable at business aviation airports, unless you want to buy a big stock and keep it—but even then, you're lucky to find it," Ensuring reliable supplies of SAF at airports will take time, but sustainability progress flourishes elsewhere—and not just recently.

The business aviation industry has been proactive on this issue for years—including implementing technologies to reduce fuel burn and emissions. Aviation Partners installed its first winglets on a business jet—the Gulfstream II—in the early 1990s. That was before it formed a joint venture with Boeing. Now, curved wing tips are a regular feature on business and commercial aircraft.

The quest for better performance has steadily continued. In 2009, the Business Aviation Commitment on Climate Change pledged to reduce carbon emissions 50% by 2050.

The National Business Aviation Association (NBAA) recently launched the Sustainable Flight Department Accreditation Program to acknowledge operators who meet or exceed criteria in the following areas: flight, operations, ground support and infrastructure. NBAA is accepting applications (https://bit.ly/41w6Wb9) through May 31.


TEXTRON AVIATION

For those of you attending the European Business Aviation Convention & Exhibition, check out the Sustainability Summit May 23-24 (https://ebace.aero/2023/events/sustainability-summit/) that is a major part of the program.

Advanced air mobility (AAM) operations should launch in the next few years, enabling a new transportation mode for sustainable short hops. The latest developments will be highlighted at Paris Air Mobility (https://aam.aviationweek.com/en/home.html), which takes place on June 19-22 at the Paris Air Show.

So from taking steps to make today's operations greener to developing electric-powered transportation modes, progress is happening. The time for action is now.

Clearly a lot is going on. I hope you enjoy this issue.

Best wishes,
Lee Ann
Leeann.shay@aviationweek.com

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INTERVIEW BY **MICHAEL O. LAVITT**

Five Questions for George Braly

George Braly is co-founder of **General Aviation Modifications, Inc.** (GAMI), which holds a supplementary type certificate for G100UL, the first approved unleaded, 100-octane avgas.

GAMI

1 You've basically had three phases in developing G100UL: Doing the chemistry, winning STS approval and bringing it to market. Which was the most challenging?

The initial figuring out of the chemistry took us less than 15 months. It took basically an additional 11 years to get the FAA approval. It should have taken three or four. There were a number of people inside the FAA who did not want this to happen, because it was being done with a proprietary company specification. And so, they did everything that was possible to slow it down and block it. Thank God, we got a new AIR-1 in June of last year. Lirio Liu [executive director of the FAA Aircraft Certification Service] gets enormous credit for this.

2 Engine and airframe manufacturers want to be sure that 100UL will not cause damage before they agree to honor warranty claims from aircraft owners who use the new fuel. How are you doing on that front?

The only thing the OEMs can do is to try and tell the owners, "If you dare use that fuel, we're going to void your warranties." Well, there are only 2-3% of the aircraft covered under warranty anyway. So, it's an empty threat. But to her credit, Jennifer Miller [senior director of engineering] at Lycoming, during a seminar [March 28] said that "We're not going to automatically deny the warranty of somebody who uses this fuel."

The thing is, it would be catastrophic and self-destructive for the companies to get in the way of the appointment of this fuel on their large population of airplanes in California, which is where the first fuel is going.

3 How are you doing with ramping up production of G100UL with refiners and distributors?

We have a large international company, in Houston, that has agreed to produce the fuel. It produces aviation jet fuel now, and it [can] produce 100 Low Lead (100LL). It knows how to do this. It has the technical capability and the laboratory equipment to do it. It also has the ability to make 500,000-gal. batches or 3 or 4 million-gal. batches. And it has agreed to produce [G100UL]. It has given us a price schedule. We have shared that with the four major existing distributors, AvFuel, World Fuel, Titan and Epic. We gave them the pricing, invited them to send rail cars to Houston, and the fuel would be loaded on their rail cars at that price free on board. The producer sells 80-90% of the 100LL to the FBOs in the airports.

4 There are already unleaded 94-octane substitutes for engines. Others are working on additives that will replace tetraethyl lead in 100-octane avgas. How much competition are you expecting in the higher-octane market over the next three years?

Basically, of the three candidate fuels that are announced, two of them are in PAFI [FAA Piston Engine Aviation Fuels Initiative], which includes the Phillips-Afton effort and the Lyondell-BP Racing effort. Those two fuels are part of the EAGLE (Eliminate Aviation Gasoline Lead Emissions) program. And then Swift Fuels has another program that's kind of one foot in and one foot out of EAGLE. Swift Fuels is going to do an STC [supplemental type certification], but they're also going to get an ASTM specification. The delta between the G100UL and the Swift yield is about 11% [in terms of energy per gallon]. I know this looking at their fuel chemistry because these are laws of physics. When you buy a gallon of gasoline, you're buying so many thousands of BTUs per gallon. It's the energy content. Well, the energy content of [Swift Fuel] is 7% below 100LL and the energy content of [G100UL] is 4% above 100LL on a volumetric basis.

5 Last year the General Aviation Manufacturers Association and some of the companies that represent piston aircraft manufacturers seemed to be leaning toward EAGLE. Has the relationship changed now that you have the STC that applies to every aircraft and engine that uses avgas?

[On March 21] EAGLE participants had an executive committee meeting with all the traditional EAGLE people. And the next day they had a follow-up meeting that was open to the public. One of the slides announced that the Phillips fuel and the Lyondell fuel were undergoing reformulation for deposit control. So, basically right now the EAGLE has no wings. There frankly is not a visible alternative to any knowledgeable fuel chemists that has a viable path to success. **BCA**

Kent S. Jackson
Contributing Editor

Dealing with an Aircraft Tax Audit

The IRS is not here to help you

THE U.S. GOVERNMENT GOES DEEPER INTO DEBT BY THE DAY, and many of the states are broke. Most people don't own aircraft. So, there won't be a populist revolt if the Internal Revenue Service and the state departments of revenue target corporate aviation for audit.

Preparation is the key to surviving a tax audit and receiving a "no change" letter acknowledging that your tax returns were proper. Aircraft operators know that the FAA doesn't believe that an inspection occurred unless the paperwork proves it. The IRS won't believe that you use your aircraft for business unless the paperwork proves it.

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Do you have documents that show the business purpose of every person in every seat on every leg of every trip? That is what the IRS expects. And the IRS expects the records to be kept up contemporaneously, not pulled together a year or more later by the harried flight department after the CFO informs them that an audit is underway.

The flight department can provide a great deal of help to the CFO in maintaining current records to prove the business purpose of every person in every seat on every leg of every trip, because the flight department knows the who, when and where of each flight. But the flight department's knowledge of who flew doesn't always mean it knows the business purpose of why they flew. The company executives must either give the flight department adequate guidance on the business purpose of each person on each trip, or someone in the C-suite must complete that information in the flight records separately as the flights occur.

And of course, there will always be some non-business flights. If someone is not on business, do your records distinguish between an employee entertainment trip (Vegas bachelor party) and a personal trip (Des Moines funeral)? The employee will need to have fringe benefit income added to his/her W-2 form for either trip, but the company will only lose deductions for the entertainment trip.

How do you handle a tax audit today? Sadly, the answer is, a little less politely than in the past. Most companies have learned to treat government inspectors and auditors with at least a modicum of respect because in the past, a little hospitality usually resulted in a less-intensive examination and a better outcome.

A client in the soda business, however, reported this experience: For many years, the company has been visited by a wide variety of government officials performing a wide variety of functions. The company has always had a policy of providing the officials with a clean, well-lighted office to work in, and all of the free soda they could possibly want.

This hospitality backfired when an IRS auditor, who apparently loves root beer, did not want to leave, and kept pursuing new issues and asking for more records to review, so that he could sit and drink root beer in the comfortable private office provided to him.

Be professional and polite, but be in control. It is a security-conscious world today, so, when you insist that the auditor remain in his/her assigned area and not wander the building, and not talk to other employees, you can and should put those requirements in a security context. If you go to the auditor's office, those requirements will be imposed on you, so you can present these restrictions in a non-offensive manner.

Along those same lines, insist that all "Information Document Requests" ("IDR" in IRS parlance) be in writing, and that all communication with the company occur through a designated representative.

What are the hot tax audit topics today? The IRS is attacking depreciation deductions, and its favorite weapons are passive activity, hobby loss and entertainment rules.

The states want "use" tax. Use tax is the evil twin of sales tax. If you buy an aircraft in a tax-free state and bring it home to a state that does impose a sales tax, your state may demand that you pay use tax, even if you have registered the aircraft in Delaware (derisively referred to as the "Delaware Dodge" by state department of revenue auditors). If you have relied on a state tax exemption, make sure that you have documented your compliance with the requirements of the exemption. The states now use FBO tenant lists and FlightAware to establish where an aircraft is actually based.

No audit is fun, but if your company is ready, the auditor will leave and look for a less-prepared victim. **BCA**


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Situation Awareness

William Garvey
Contributing Editor

Final Flag at Reno

The competition for a new home is underway

DESPITE THE NEWS, IT'S LOOKING LIKE THE CHANCE TO DOWN A pulled pork parfait while being serenaded by a screaming chorus of R-1340s, Merlins and IO-540s could well continue.

In March came word that this year's National Championship Air Races, set for Sept. 13-17, will be the last held at Reno-Stead Airport (KRTS). That decision by the Reno-Tahoe Airport Authority was a surprise to many, though not all, and is the culmination of a series of setbacks, some tragic, as well as evolving local demographics.

RARA

Held annually in the "Biggest Little City in the World" since 1964, the races are the largest globally and the only such event in the United States. A combination airshow, street party, trade fair, class reunion, grand bazaar, gape-fest and cacophonous competition, the "World's Fastest Motor Sport" each year draws some 120,000 attendees whose dining, wining, gaming and more richly reward their Renoite hosts.

Tony Logoteta, COO of the Reno Air Race Association (RARA), references a 2019 study by the University of Nevada-Reno that reportedly puts the event's economic impact on the region at $100 million. Even in a tourist town bristling with glistening casinos, that's a big-time jackpot.

So, why would a city of 270,000 spike such an economic engine? For reasons stated and not. The airport authority, which operates both KRTS, a general aviation facility, and airline-served Reno-Tahoe International, cited "challenging economic conditions, rapid area development [and] public safety" among its motivations. Unmentioned was a more onerous money issue and related matters of liability and notoriety.

As to the economic challenges worrying the airports' operator, those exist pretty much everywhere, unfortunately. And while the Reno area is certainly growing, its development is more steady than sizzling.

Regarding the safety of residents and visitors, that's a constant concern among all communities. But the KRTS races raise that to a special level. After all, launching high-performance aircraft in wing-to-wing, high-speed, high-G heats flown close to the ground involves unique risks. Moreover, the machines are operated by pilots, some long past their youth, who are exposed to such conditions infrequently— and possibly only at Reno.

And all this takes place in close proximity to thousands of people watching from grandstands, the tarmac, parking lots, and others who are strolling the vendor midway or consuming show delicacies like deep-fried pickles, corn dogs and peanut butter bombs.

That combination of factors has proven deadly in some years. The worst was 2011, when a P-51 Mustang racer crashed, killing the pilot and ten spectators and seriously injuring another 70. In addition, individual race pilots were killed in accidents last year and in 2014. Trauma and the sudden death of visitors are not occurrences with which any city wants to be identified.

However, since such things do happen, the airport authority had for years added a rider to its regular insurance to cover race days; according to Logoteta, that premium was modest. Meanwhile, by agreement, RARA had to take out its own policy.

However, in 2022 the authority was denied the rider and, accordingly, insisted RARA obtain the extra coverage in addition to its own policy. That added roughly $500,000 to RARA's insurance bill, bringing the total to "just shy of $1.3 million," says Logoteta, and put the races at a financial loss. He expects that figure to increase further for this year's series and hopes it won't exceed 10-15%.

Regardless, the death of Aaron Hogue when his L-29 jet crashed last year seems to have been one tragedy too many. The decision by members of the airport authority to put an end to racing at KRTS—reinforced by the fatal B-17/Kingcobra collision last November at a Dallas airshow—means the facility can return to normal operations year-round, which many airport-based pilots welcome. And although there's speculation that an overnight cargo carrier might begin operations there, a representative for the airport authority said no such invitation has been extended.

Logoteta reports RARA had been exploring other sites for limited races by different aircraft classes as a way of leading up to the national championships. Now that site search has taken on an urgency to find a new home for the big event itself. He says that effort so far "has been pretty encouraging," with several airports and municipalities expressing interest in hosting the championship series.

And while it's possible that a competition could be held in 2024, Logoteta is doubtful that a new location could be made ready by then. More likely, he says, is RARA hosting a regular airshow at KRTS next year and then relaunching the races —complete with grand bazaar, curley fries and a celebratory pork parfait—elsewhere in 2025. **BCA**

Divert!

When faced with an emergency, should you always react quickly?

Depiction of an aircraft engine fire.

SHUTTERSTOCK/LUKAS GOJDA

BY **JAMES ALBRIGHT**

"There I was, at 30 deg. W. Long with one engine on fire, the other engine about to quit, and a load of passengers wondering why the cabin lights had gone dim. Questions were adding up, but there were no answers in sight. The only thing certain was the altimeter, which was unwinding itself quickly as we held on to whatever airspeed we still had.

So goes a recurring nightmare of mine, either a product of all the simulator time in my logbook or the few times where one element of the dream happened in real life. In any other profession, these dreams could be part of a neurosis, a mental condition caused by anxiety and stress. But since I am a pilot, these dreams seem nothing more than "chair flying," mentally preparing myself for what I hope never happens.

While instructing pilots about abnormal procedures when flying in remote or oceanic areas, I find it helpful to go through the "there I was . . ." routine. While it would be impossible to cover every possible scenario, two that I've seen over the years may serve to illustrate a few helpful concepts.

Cabin Smoke

". . . There I was, the cabin filling with smoke and nothing but open ocean in front of me."

It was almost a routine flight, from Anchorage, Alaska to Honolulu. We were flying an Air Force Boeing 707, what we called an EC-135J, with about 20 Navy passengers and an Air Force crew of 10, including three mechanics. It had been a fun week in Alaska, but now everyone looked forward to getting back to Hawaii. We had been airborne for about 30 min., and I was getting ready for my oceanic duties as the crew's co-pilot. But something was nagging me. Oddly, the air felt and tasted oily. I immediately suspected the engines, but the gauges looked perfectly normal. I was about to say something when the navigator beat me to the punch: "Fire!" I saw the cabin filled with dense, acrid smoke. Everything within a few feet of the ceiling was "WOXOF" (ceiling indefinite, visibility zero) but below that it was clear. Now what?

"I'll turn us back to Anchorage," the pilot said, "you get back there and figure it out." I unstrapped, not having a clue what I could do. My first thought was the galley, which was right behind the cockpit, but the steward was seated, and his ovens were off. He shrugged his shoulders, as if this was just another day at the office. I could see the smoke spewing from an overhead duct. I doubled back and turned off the engine bleeds. The smoke stopped almost immediately but I knew our old airplane's cabin leak rate meant our ears would soon be popping. One of the mechanics came forward and said the smoke was almost completely gone but so was our pressurization.

We had to dump over 100,000 lb. of fuel, but 30 min. later we were on the ground. That night at the bar, the second-guessing began. "The pax are unhappy," our steward reported. "One of the mechanics complained to them that we didn't need to turn back as quickly as we had, we should have isolated the bad engine by turning the bleeds on one-by-one. Then we could have made it home on the other three." The pilot's face reddened. "Better safe than sorry," I replied. He brooded for the rest of the night, thinking word of our divert would filter back to the squadron about prematurely aborting the mission.

The next morning, we met for breakfast and the pilot greeted us with a hearty smile. "Well, we done good after all," he said. The base's maintenance shop found that an oily rag had somehow been ingested by the air cycle machine and the fire was contained to our air conditioning pack and was only extinguished once all the bleeds had been cut off. We only had one air conditioning pack and once that was shut off, all other options were out of the question. The divert, it turned out, was our only option.

Sometimes the only option you have is to head for the nearest runway and land.

These "no other option" decisions turn out to be the easiest to make but sometimes the hardest to execute. A fire of any kind, loss of an engine on a two-engine aircraft, or a flight control problem that leaves you with any doubts about the aircraft's airworthiness are examples of when the right answer is to quickly turn your air vehicle into a ground vehicle so someone else can sort it out after making a safe landing.


A cabin fire training exercise.

AIRCARE INTERNATIONAL

Equal Time Point

"Our Equal Time Point (ETP) was ahead of us but the situation wasn't anything we had trained for . . . "

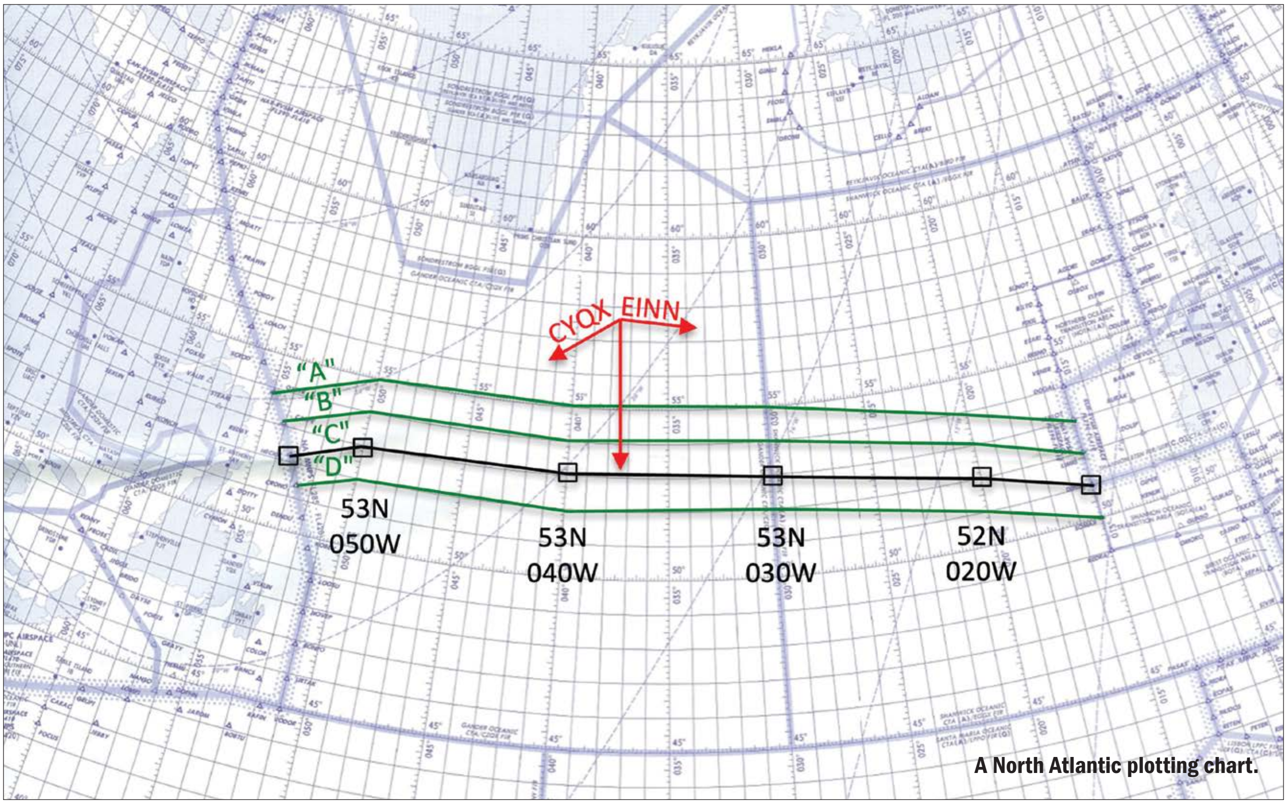
Twenty years ago, our attitudes about drift down were more, shall we say, self-centered. "We are the emergency, everyone else can get out of our way." We taught that if an engine fails, you set a specified maximum thrust on the operating engine, allow the speed to decay to a speed calculated to maximize your forward distance, and then you descended at that speed. If you were past the ETP—the position along your route that results in an equal time continuing forward as the time turning around—then you pressed on. Otherwise, you turned around.

Most of us today know these decisions are rarely this cut-and-dried, but back then, I believed the conventional wisdom. Until I was faced with reality.

We were flying a Challenger 604 from Europe to the U.S. at flight level 360 on the North Atlantic Track System (NATS), with airplanes above, below and to either side of us. Our Standard Operating Procedure required us to compute three ETPs. The one-engine- inoperative ETP considered the need to descend to an optimal altitude with one engine out and less speed. The loss of pressurization ETP assumed the need to descend. Finally, the remain-at-altitude ETP was used for medical and other emergencies to minimize the remaining time in flight. While an ETP is computed using time, the "T" in the acronym, it is more properly thought of as geographic point, the "P" in ETP. Our company procedures required that we compute all three, but if all three were grouped within 100 nm of each other, only the middle point was plotted.

That was the case on this flight, and our ETP was at 53 05.0' deg. N Lat., 37 17.3' deg. W Long. Passing the infamous 30 W Long. waypoint, we made the necessary switch to Gander Oceanic on our high-frequency radio and busied ourselves with the many checklists triggered by waypoint passages. I briefed the other pilot that our ETP was still in front of us and that if we had any problems, the plan was to turn 180 deg. back to Shannon, Ireland. We would drift down in the turn if we lost an engine, complete a rapid descent if we lost pressurization, or remain at altitude if we could. "Obviously," my fellow pilot said. "Obviously," I agreed.

Back then, we were required to take wind and temperature readings at each halfway point between waypoints and I was doing just that when an engine indication turned amber, letting us know one of our engines was vibrating excessively. The FAN VIB readout showed the left engine at 3.5 Mils, well above the 2.7 Mil limit. I pulled out the Quick Reference Handbook and read. The fan is the first set of blades in the engine compressor section, and the largest. An excessive vibration risks separation of a blade with risk to the fuselage and the rest of the engine. The procedure



A North Atlantic plotting chart.

JAMES ALBRIGHT

called for us to reduce the throttle until the vibration was within the limits. I did that, but it resulted in enough thrust loss that our Mach number decreased from our filed Mach 0.80 to Mach 0.76. The procedure also called for the engine to be shut down if there were any other abnormal engine indications. There were not.

"Back to Shannon?" my fellow pilot asked. I stared at our plotting chart, which clearly indicated the ETP was still almost a hundred nautical miles in front of us. "Give me a moment," I said. "I need to think about this."

Turning around at this altitude would take us about 25 nm left or right, almost halving the distance between us and any aircraft on the next track and increasing the risk of running into an airliner carrying hundreds of passengers (many more than the three we had onboard). But I also thought about losing the engine and wanting to minimize my distance to a runway should that happen. How much distance would be taken by the turn itself?

Looking at the plotting chart, I thought that we might end up taking longer to turn around than just pressing forward. Finally, I looked at the engines, both of which seemed to be operating fine, albeit one at a reduced thrust setting. "Let's press on and let Gander know we have to slow down," I finally said. "I'll phone a friend," using a phrase from a game show popular at the time.

I called our mechanic, who asked for a few minutes to speak with technicians at General Electric, the engine manufacturer. A few minutes later our mechanic called back. "They've been seeing more and more of this lately," he said. "They say there is a coating on the fan blades that sometimes delaminates and causes these indications. There isn't any increased risk of the engine failing. Just keep the engine at or below where you have it and bring the airplane home."

Sometimes the best decision is to delay and take time to consider your options.

In some cases, a diversion decision needs to be made quickly because fuel and altitude are robbing you of time. In other cases, the best decision might be procrastination. A mid-oceanic diversion carries with it added risks that must be considered. Will drifting down put you into the path of another airplane? Do your ETP fuel computations consider the winds at lower altitude or any abnormal fuel burns that have taken you off your planned numbers? If the decision doesn't have to be made immediately, perhaps it shouldn't be. Many in the Air Force used to say, "Flexibility is the key to air power." To that I would add, "Procrastination is the key to flexibility."

The Divert Decision

There are two, almost primal, motivations tugging at us when faced with a divert decision. As mission-oriented pilots, we want to press on to the destination. This isn't "get-home-itis," it is mission accomplishment. But we are also highly trained to think in terms of action-reaction scenarios. "In case of ____, I will do ____." Both instincts serve us well, until they don't.

In the case of a cabin fire, a structural failure or any scenario where the ability to fly the airplane is in doubt, an immediate action may be necessary and the divert decision becomes easy. But for most situations, the right answer could be to take a breath and consider your options. It's just like we used to say back in the days when bad things happened in the air almost routinely:

Question: "What's the first thing you should do in the case of an inflight emergency, and when should you do it?

Answer: "You should do nothing, and you should do that immediately." **BCA**

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Strong Outlook, with Some Hurdles

The market outlook is still rosy but . . .

BY **FRED GEORGE**

Stagflation, that ugly nightmare of the late 1970s, when the trio of persistent inflation, substantial unemployment and stagnant economic growth trapped consumers in a tailspin, is showing signs of reemerging four decades later, says Ronald Epstein, Bank of America's senior equity analyst for aerospace. He adds that it won't be the near-fatal disease it was when groovy tie-dyed shirts and plaid bell-bottoms were all the rage, but potentially it will slow and weaken demand for business aircraft, particularly at the entry level.

"Things were slowing down gradually until two weeks ago [early March 2023]," notes Epstein. Then, the collapse of Silicon Valley Bank and jitters at First Republic Bank, plus the implosion of Credit Suisse, rocked capital markets. They took a full haircut when Credit Suisse grabbed for a life preserver from the Swiss government to avoid drowning. Investors in, as well as depositors at, several U.S. regional banks shuddered.

Those events are clouding the broader economic outlook. "People are becoming more risk-averse. They're cashing out their holdings. Money market funds are reaching all-time highs," notes Epstein. In other words, investors are keeping their powder dry and not taking risks. "The lower down you go on the food chain, the less the demand." Upsets in the economy likely will hurt OEMs like Cirrus, Piper and Textron more than Bombardier, Dassault and Gulfstream.

Raising interest rates, even in quarter-point increments, risks quenching, rather than just cooling, economic growth because of systemic inflation. "I have no crystal ball, but I can tell you that inflation can kill the economy. It's the silent knife in your side," says Marc Foulkrod, CEO of Avjet Global aircraft sales and a 40-year industry veteran.

Used bizjet aircraft inventories are building and the gap is narrowing between asking and selling prices in the pre-owned market. Foulkrod cautions against speculating in the business jet market, as in betting that you'll be able to buy an aircraft for $16-million and flip it for $18-20-million. "Buy the airplane if you need the transportation," he adds.

Brant Dahlfors, co-founder of the Jet Transactions brokerage with Mark Bloomer, has another take on the current state of the pre-owned market. "Sure, it's slowed a little bit and inventories are three times what they were three years ago. But they're still below 5% of all aircraft. Prices have flattened. Asking prices have decreased 5% to 10%, putting them more in line with selling prices. A lot of buyers have been rewarded for having waited until now."

Textron is holding firm on the $999,000 asking price for the Beechcraft Bonanza G36.

TEXTRON

"There are no panic sales. A lot of people are taking advantage of the market by trading up. We've signed four new letters of intent in the last month. And OEMs remain bullish on harder [new-aircraft] prices," Dahlfors notes.

Sheila Kahyaoglu, equity analyst at Jefferies Research Services, is even more bullish on the pre-owned market than Dahlfors. Her March 19, 2023 newsletter says that while used aircraft inventories are up 53% year-over-year, only 3.5% of the fleet is on the market, significantly below the 5.7% five-year average. And prices for aircraft 7-years-old or younger are up 22%.

Moreover, she notes that business jet operations are up 15% from 2019, including a 30% increase in private flights and a 21% boost in fractional and charter operations. Top performers in the jet card, fractional and charter sector include NetJets, FlexJet and Kinston, North Carolina-based flyExclusive.

But overall activity levels are 5% lower than a year earlier, and corporate flight department activity remains almost flat. Even so, business jet operations were higher in both 2021 and 2022 than they were in 2019 before the COVID-19 pandemic virtually closed down international flights.

Barring a recession more severe than in 2008, deliveries of new business jets will remain robust, says Rolland Vincent, the veteran market analyst. The Big Five—Bombardier, Dassault, Embraer, Gulfstream and Textron Aviation—racked up a record $49 billion backlog in 2022, a 27% increase over 2021. Their book-to-bill ratios, the number of orders versus number of deliveries, average 1.3:1 to 1.6:1, and provide 2+ year backlogs, Vincent notes.

Vincent predicts 750 deliveries in 2023, up 6% from 2022. He also foresees 800 deliveries in 2024. Delivery rates in 2026 should accelerate, climbing to about 950 shipments in the second half of his ten-year forecast period.

This will reduce backlogs of some current-production aircraft. But, the arrival of new aircraft, such as the swift Gulfstream G400, roomy Falcon 6X, four-section cabin G700 and top-of-the-class Falcon 10X will help spur a new round of orders and thus sustain long-term demand.

Evolution also continues in the piston-engine segment, although Vincent and Epstein don't track that end of the market. For 2023, Piper is dropping the PA-34-220T Seneca V from its model line-up, leaving the PA-44-180 Seminole trainer as its only multi-engine aircraft. Piper dropped the PA-28R-201 Arrow in 2022, ceding the four-seat high-performance single-engine market to Cirrus and Textron Aviation. Prices for some piston-engine aircraft generally have risen 5-6% over 2022, but Cirrus hiked the SR20 price by 10%. Textron, in contrast, is holding fast on its $999,000 asking price for the Beechcraft Bonanza G36.

Single-engine turboprop sales remain strong, with Daher delivering 56 TBM 960, 16 Kodiak 100 utility aircraft and its first $3.5-million Kodiak 900, a faster, longer and more powerful variant of the Kodiak 100. Piper delivered 41 M600 aircraft in 2022, bolstering a $226,000 price hike for 2023. Sales of the M500, essentially a rebadged Meridian, remain lackluster. Epic remains focused on poaching sales from Daher with its all-composite 300+ KTAS E1000 GX, a direct competitor to the TBM 910/960. The Bend, Oregon-based company also is hiking prices by $260,000, closing the gap between the E1000 GX and TBM 910 to $90,000.

Pilatus delivered 80 PC-12 NGX aircraft in 2022 and predicts it will deliver the 2,000th PC-12 in 2023. It's celebrating by hiking prices by 5.5%, so a new PC-12 NGX will cost more than $6 million this year. Textron Aviation still is forecasting certification and first customer deliveries for the Beech Denali, a direct competitor for the PC-12 NGX, in late 2024. Ongoing development woes with Denali's GE Catalyst turboprop engine continue to delay the program. Notably, Textron has reduced 2023 prices for both the Caravan and Grand Caravan EX to stimulate sales.

Twin turboprops remain a strong suit for Textron, as the venerable Beech King Air B200 and B300 series soldier on with steady sales. Deliveries of freighter versions of the versatile Cessna CE-408 SkyCourier began in May 2022 and are expected to ramp up in 2023. The SkyCourier Freighter can tote three LD3 cargo containers in its 884-ft.^{3} cabin, making an ideal fit for launch partner Fedex, which has 50 orders and 50 options for the aircraft.

There continues to be room for growth in the single-engine turbofan segment, a niche solely owned by the Cirrus SF50 at

EMBRAER

Embraer's Phenom 300 retains its position as the best-selling light jet.

present. Stratos Aircraft of Redmond, Oregon has intentions of developing a 1,600-nm range, 41,000-ft. cruise, 400+ kt., step-up single-engine jet with better fuel efficiency than current single-engine turboprops, but chronic underfunding continues to hobble development work.

The FAR/CS 23 light-jet segment remains a strong segment for Textron as deliveries of Citation M2, CJ3+ and CJ4 Gen2 remain robust. New entrants, however, are challenging the old guard. Embraer's EMB-505 Phenom 300 retains its position as the best-selling light jet of the last decade, racking up 59 deliveries in 2022. Pilatus anticipates rolling out its 200th PC-24 this year, but industry analysts say production is capped at 40- 45 units per year because of supply chain bottlenecks.

In other news, many industry observers still are waiting for Embraer to announce a successor to the EMB-500 Phenom 100. For now, Embraer is concentrating its efforts upmarket with its Praetor 500 and 600 super-midsize jets, plus its second-generation regional jets. The industry still waits for Textron to announce a successor to the Citation XLS+, perhaps a large-fuselage variant of the CJs. Those light jets share their fuselage cross-sections with the original Cessna Fanjet 500 announced in October 1968. The average American is much larger than a half-century ago, so bigger would be better inside the cabin.

Vincent believes Honda Aircraft will announce the launch of its HondaJet 2600 in the next several months, a super-light jet with a cabin larger than the now-discontinued Learjet 75, but with 30% more range, higher usable cruising altitudes and a considerably quieter cabin environment.

Super-midsize aircraft continue to be hot sellers, as Bombardier, Embraer, Gulfstream and Textron collectively delivered 166 units. "Every OEM has its own niche," Vincent says. Top honors go to the Citation Latitude, with 42 deliveries in 2022. Its blend of runway performance, cabin comfort and $20-million price tag make it a winner. Bombardier's Challenger 350/3500 came in second, with 38 deliveries. Challenger 3500 carries on as Bombardier's only super-mid in 2023. It's an airplane essentially identical to Challenger 350, but having a plusher interior and lower cabin sound levels.

The Big Three—Bombardier, Dassault and Gulfstream—continue to control the large-cabin-class segment. Gulfstream maintains its unassailable first-place position, logging $6.6 billion in revenue with 120 deliveries. At the end of 2022, its backlog stood at $19 billion, 20% higher than at the end of 2021. Gulfstream's order book now totals nearly almost as much as Bombardier and Dassault combined for 2022.

Gulfstream's financial strength is enabling it to refresh its model line more aggressively than either Bombardier or Dassault. This is especially evident in the 4,000-mi.-class large-cabin entry point. Speed sells, and slower competitors are at a potential disadvantage. Gulfstream's 4,200-nm, Mach 0.85 GVII-G400 arrives in just over two years. The 4,000-nm Bombardier Challenger 650 and Dassault Falcon 2000LXS clearly are in its sights. The G400 will have a larger cabin than either competitor, a 50-60-kt. speed advantage on the longest missions, higher cruising altitudes, lower cabin altitudes and more advanced technologies, including fly-by-wire flight controls. It's also the only entry-level large-cabin aircraft to offer an optional forward lavatory in addition to the standard aft lav.

Brant Dahlfors of Jet Transactions offers counterpoints in defense of the Challenger 650 and Falcon 2000LXS. He notes that while Challenger 650 is the sixth iteration of the original 1980 Challenger 600, it has earned considerable operator loyalty. Similarly, the Falcon 2000LXS has been refreshed four times since it was first certified in 1995 and Dassault is tops in the industry for brand allegiance. Long order backlogs will slow migration to the G400. In addition, Bombardier likely will offer deep discounts on the Challenger 650 to spur sales, if the G400 becomes a threat.

"G400 will kill Challenger 650," opines Epstein. But "G400 also is late to the game. People are looking for solutions . . . now," counters Foulkrod. Older Challenger operators continue to trade up to the Challenger 650, says Dahlfors, because they're comfortable with its capabilities and its support requirements.

Dassault is moving away from entry-level, large-cabin models with its commodious 5,500-nm-range, Falcon 6X, due to enter service in 2023 and topline Falcon 10X flagship slated for 2025 deliveries. Falcon 6X offers the largest cabin cross-section of any current-production large-cabin aircraft outside of jetliner derivatives, exceptionally low cabin sound levels, unparalleled low-speed agility and advanced safety technologies. Long-range cruise speed is Mach 0.80. Push it up to Mach 0.85 and range drops to 5,100 nm.

The Falcon 6X competes head-to-head with Bombardier Global 5500 and Gulfstream G500. Bombardier only delivered 8 Global 5500s in 2022, preferring to step up to the Global 6500. Gulfstream, in contrast, delivered 23 G500 jets, in large part due to its blend of speed, superior fuel efficiency, high cruise altitudes, quiet cabin and the lowest cabin altitude in its class.

Gulfstream's 6,600-nm-range G600, its replacement for the G550, continues to sell against Bombardier's Global 6500. As with the G500, it offers an unmatched combination of speed, fuel efficiency and cabin comfort.

Fuel-efficiency issues continue to dog the Global 5500 and 6500, as the basic designs remain rooted in 1990s-era Global Express technology. Newer designs from Dassault, such as the Falcon 7X and 8X, and Gulfstream's G500 and G600, are far more economical to operate.

Savannah also is well-positioned with its 6,900-nm-range G650 and 7,400-nm-range G650ER models. The 500th G650/G650ER should be delivered in 2023, just as the first 8,000+ nm G800 enters service. The G800 is an enhanced version of the G650 with an improved wing, more powerful and fuel-efficient engines, and new Symmetry flight deck adapted from the G400/G500/G600 series. Foulkrod expects the G800 to have considerably more range than Gulfstream currently predicts—more than any other purpose-built business aircraft. The G800 eventually may replace the G650 in Gulfstream's product line, but for now the G650/G650ER continue to sell well, especially with their lower prices.

Bombardier reset expectations for large-cabin aircraft in 2018 when its 7,700-nm-range, four-section cabin Global 7500 entered service. It's the biggest, heaviest and roomiest purpose-built business aircraft in current production, proving quite popular with ultra-high net worth individuals seeking the ultimate air yachts. Bombardier makes no pretense about Global 7500's being designed primarily for public companies whose shareholders increasingly scrutinize the use of corporate aircraft.

The Global 7500 triggered strong responses, first from Gulfstream, then Dassault. Gulfstream's own four-section cabin jet, the G700, is due for deliveries in 2023. It features enhanced, higher bypass-ratio Rolls-Royce Pearl 700 engines [aka BR700-730B2-14 turbofans], improved wing aerodynamics and the Symmetry flight deck carried over from the G-VII G400/G500/G600 series. Gulfstream advertises a 7,500-nm maximum range, but Foulkrod believes it will be closer to 8,000 nm.

Dassault was late to this party when it announced the 7,500-nm-range, four-section cabin Falcon 10X in mid-2021, so it needed a distinctive selling advantage: this would be the biggest, purpose-built business jet yet announced. "It's a totally different creature," says Epstein, who toured the Falcon 10X cabin mock-up at NBAA last year. "It reminds me of the first time I sat in a Boeing 787."

Falcon 10X represents a radical departure for Dassault from earlier Falcon Jet designs. It's designed from the outset to cruise as fast as the best from Bombardier and Gulfstream. Its cabin is nearly 8 in. wider and 2 in. taller than any purpose-built business jet in production, plus it will have the largest window area. Dassault is crafting the first composite wing for a large-cabin business aircraft, borrowing extensively from its military aircraft designs.

Similar to its Mach 2-class Rafale, Falcon 10X will have a single thrust lever for both engines, automatic loss-of-control recovery system, and a HUD that will function as its primary flight display. Dahlfors notes that Falcons have always appealed to buyers with strong engineering interests. The Falcon 10X capitalizes on that strength to the maximum. The model is on track for late-2025 deliveries.

Vincent concedes that the Falcon 10X will cost Bombardier some Global 7500 sales. But the Gulfstream G700 "will hold its own" against Falcon 10X because of its performance advantage, fuel efficiency and brand loyalty.

Gulfstream thus retains its gold medal position, with Dassault in line to take silver and Bombardier winning the bronze. One reason for this ranking is product support. Bombardier is still late in beefing up its aftermarket business. Support stimulates sales, as demonstrated by both Dassault and Gulfstream.

Even so, Gulfstream is hedging its bets by holding to its 2022 pricing, while Bombardier and Dassault have bumped up retail prices for 2023.

The largest purpose-built business aircraft from Canada, France and the U.S., however, remain too small to meet the needs of some VIP/head-of-state air wings, air charter operators and a few ultra-high net worth individuals. These buyers are willing to spend $80-$200 million, or more, on highly modified jetliners, customized with bespoke cabins, long-range fuel tanks and elaborate communications systems. Comlux, in

DASSAULT

Dassault's Falcon 6X is scheduled to enter service this year.

Indianapolis, for instance, recently delivered its first ACJ220 to Dubai-based Five, a luxury hotel group, which will use the aircraft to fly its most elite guests between their homes and its hotel properties.

The $90-million ACJ220 airborne penthouse completed for Five has 786 ft.^{2} of floor space, accommodating 16 travelers in six seating sections, including an 8-place dining area, private stateroom with full king-size bed, en-suite bath with shower and galley worthy of a three-star Michelin restaurant. Comlux now has a second ACJ220 in the works.

Need more room? Airbus Corporate Jets offers the $115-million ACJ320neo with up to 6,000 nm of range and the slightly smaller $105-million ACJ319neo that can fly 6,750 nm, as shown in this year's Purchase Planning Handbook. The ultimate French flying palace is the ACJ350, a veritable airborne Versailles with more than 3,300 ft.^{2} of floor space and range up to 11,000 nm.

Boeing Business Jets slowly is rebuilding its biz-liner order book now that the 737 MAX is back in production after being grounded for two years due to MCAS malfunctions. Boeing Business Jets delivered a single 737-8 MAX BBJ and another 787-9 MAX BBJ in 2022. (The certification of Boeing 737-7 MAX continues to be postponed in the aftermath of the MCAS debacle.) When the BBJ enters service, it should offer a slight range advantage over the Airbus ACJ319neo due to its lower empty weight, plus it's priced $6 million less, according to our estimates.

While the business aircraft industry is propelled upward by record order backlogs, it faces tough challenges from increasingly vocal environmental activists who point to the disproportionate carbon footprint of private aircraft. While private jets account for just 0.2% of carbon emissions, they are a favorite target of activists because their carbon footprint per passenger is several times larger than for commercial airliners.

The aviation community is embracing sustainable aviation fuel (SAF) as the best near-term solution for reducing its carbon footprint. But the transition from fossil fuel to SAF is moving forward at a "glacial pace," says Vincent. SAF production tripled to 79 million gal. in 2022, according to the International Air Transport Association. But annual jet fuel consumption now exceeds 27 billion gal., according to the U.S. Energy Information Administration, so fossil fuel still accounts for 99.99% of the total.

Shortages of pilot training slots at Part 142 simulator training centers pose another challenge for business aircraft operators. OEMs have reserved all but a few seats for new-aircraft customers, plus some of their own used-aircraft customers. Many business aircraft operators are feeling the pinch.

Finally, ESG [Environmental, Social and Governance] advocates will continue to pressure public companies to recognize "stakeholder capitalism" and to promote the value of "non-financial performance." For many, this means corporate aircraft increasingly will become targets for activists, not only for their perceived excessive carbon footprint, but because they're used primarily by top management rather than rank-and-file employees. Several studies conducted by NBAA indicate that companies that use business aircraft outperform non-users, at least financially. But such statistics are discounted by activists who promote "non-financial performance" as an important goal.

For 2023, public companies that operate business aircraft thus face more potential challenges than at any time in the past. Privately owned businesses and ultra-high net worth individuals feel much less heat from critics, and they're much less susceptible to potential economic upheaval caused by a new round of stagflation. So for now, the combination of record order backlogs and a shift in marketing focus away from public corporations and toward private jet buyers is sustaining the strength of the business jet industry. **BCA**


Castle & Cooke

How to Use the Airplane Charts

PIERRE ALBOUY/AFP/GETTY IMAGES

For an aircraft to be listed in the Purchase Planning Handbook, a production-conforming article must have flown by June 1 of this year. The dimensions, weights and performance characteristics of each model listed are representative of the current-production aircraft being built or for which a type certificate application has been filed. The Basic Operating Weights are representative of actual production turboprop and turbofan aircraft delivered to retail customers, or manufacturers' estimates for aircraft that have yet to enter service. The take-off field length distances are based on Maximum Take- off Weight unless otherwise indicated in the tables.

Please note that *"all data preliminary"* in the remarks section indicates that actual aircraft weight, dimension and performance numbers may vary considerably after the model is certified and delivery of completed aircraft begins.

Manufacturer, Model and Type Designation

There are three rows at the top of each column for a specific aircraft: The manufacturer's name, abbreviated in some cases; the commercial model name; and the type certificate data sheet model designation.

BCA Equipped Price

Price estimates are first-quarter, current-year dollars for the next available delivery. Some aircraft have long lead times, thus the actual price for future- year deliveries will be higher than our published price. Also note that manufacturers may adjust prices without notification.

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

▶ **Turbine-powered aircraft—**Average price of ten of the last 12 commercial deliveries, if available. The aircraft serial numbers aren't necessarily consecutive because of variations in completion time and because some aircraft may be configured for non-commercial, special missions.

Characteristics

▶ **Seating Capacity:** Crew + Typical Executive Seating/Maximum Seating by certification—For example, 2 + 8/19 indicates that the aircraft requires two pilots, there are eight seats in the typical executive configuration and the aircraft is certified for up 19 passenger seats. A four-place single-engine aircraft is shown as 1 + 3/3, indicating that one pilot is required and there are three other seats available for passengers. We require two pilots for all FAR Part 25 transport-category certified turbofan airplanes. A single pilot is required for all FAR Part 23 normal categoryaircraft, including Level 4 turbine airplanes up to 19 occupants/19,000 lb. certified maximum takeoff weight, except where otherwise noted. Four crewmembers are specified for Ultra-Long-Range (ULR) aircraft—three pilots and one flight attendant.

Each occupant of a turbine-powered aircraft is assumed to weigh 200 lb., thus allowing for stowed luggage and carry-on items. In the case of piston-engine airplanes, we assume each occupant weighs 170 lb. There is no 30-lb. luggage allowance for piston-engine airplanes.

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

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

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

Dimensions

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

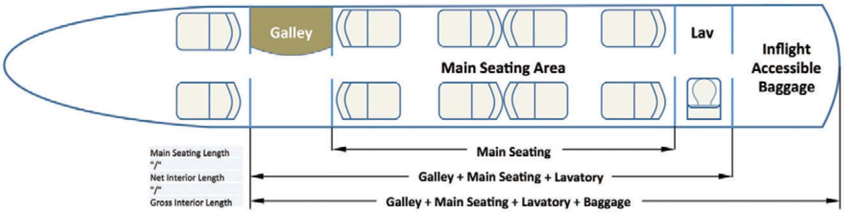
▶ **Internal Length, Height and Width** are based on a completed interior, including insulation, upholstery, carpet, carpet padding and fixtures. Note well: These dimensions are not based upon metal-to-metal or composite airframe gross interior measurements, unless noted by the airframe manufacturer. They must reflect the actual net dimensions with all soft goods installed. *BCA* reserves the right to verify interior dimensions with on-site inspections.

As shown in the Cabin Interior Dimensions illustration, for small aircraft other than "cabin-class" models, the length is measured from the forward bulkhead ahead of the rudder pedals to the back of the rearmost passenger seat in its normal, upright position.

For so-called cabin-class and larger aircraft, we provide the net length of the cabin that may be occupied by passengers. It's measured from the aft side of the forward cabin divider to an aft point defined by the rear of the cabin floor capable of supporting passenger seats, the rear wall of an aft galley or lavatory, an auxiliary pressure bulkhead or the front wall of the pressurized baggage compartment. Some aircraft have the same net and overall interior length because the manufacturer offers at least one interior configuration with the aft-most passenger seat located next to the front wall of the aft luggage compartment.

For large aircraft, we show three interior lengths: (1) Main Seating Length, the prime section of the cabin occupied by passengers not including the galley, full-width lavatory[ies] or internal, inflight accessible baggage compartment; (2) Net Interior Length, main seating length plus galley, lavatory[ies] and inflight accessible baggage compartment[s]; and (3) Gross Interior Length, the overall length of the passenger cabin, measured from the aft side of the forward cabin divider to the aft-most bulkhead of the cabin pressure vessel.

Cabin Length



The aft-most point of the gross interior length is defined by the rear side of a baggage compartment that is accessible to passengers in flight or the aft pressure bulkhead. The overall length is reduced by the length of any permanent mounted system or structure that is installed in the fuselage ahead of the aft bulkhead.

Interior height is measured at the center of the cross-section. It may be based on an aisle that is dropped several inches below the main cabin floor that supports the passenger seats. Some aircraft have dropped aisles of varying depths, resulting in less available interior height in certain sections of the cabin, such as the floor sections below the passenger seats.

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

Power

▶ **Number of engines**, if greater than one, and the abbreviated name of the manufacturer: CFMI—CFM International, Cont—Teledyne Continental, GE, GE Honda, Hon—Honeywell Aerospace, IAE—International Aero Engines, Lyc—Textron Lycoming, PW—Pratt & Whitney, PWC—Pratt & Whitney Canada, RR- Rolls-Royce, Wms Intl—Williams International

▶ **Output**—Takeoff-rated horsepower for propeller driven aircraft or pounds thrust for turbofan aircraft. If an engine is flat-rated, enabling it to produce takeoff-rated output at a higher than ISA (standard day) ambient temperature, the flat-rating limit is shown as ISA+XX°C. Highly flat-rated engines, (i.e., engines that can produce takeoff-rated thrust at a much higher than standard ambient temperature), typically provide substantially improved high-density altitude takeoff and climb, and high-altitude cruise performance.

▶ **Inspection Interval** is the longest scheduled hourly major maintenance interval for the engine, either "t" for TBO or "c" for compressor-zone inspection. OC is shown only for engines that have "on- condition" repair or replace parts maintenance.

Weights (lb.)

Weight categories are listed as appropriate to each class of aircraft.

▶ **Max Ramp**—Maximum ramp weight for taxi.

▶ **Max Takeoff**—Maximum takeoff weight as determined by structural limits.

▶ **Max Landing**—Maximum landing weight as determined by structural limits.

▶ **Zero-Fuel**—Maximum zero-fuel weight (MZFW), shown by "c," indicating the certified MZFW, or "b," a *BCA*-computed weight based on MTOW minus the weight of fuel required to fly 1.5 hr. at high-speed cruise.

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

▶ **EOW/BOW**—Empty Operating Weight is shown for piston-powered aircraft. Basic Operating Weight, which essentially is EOW plus required flight crew, is shown for turbine-powered airplanes. EOW is based on the factory standard weight, plus items specified in the *BCA* Required Equipment List, less fuel and oil. BOW, in contrast, is based on the average EOW weight of the last ten commercial deliveries, plus 200 lb. for each required crew member. We require four 200-lb. crewmembers, three flight crew and one cabin attendant, for ultra-long range aircraft.

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

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

▶ **Max Fuel**—Usable fuel weight based on 6.0 lb. per U.S. gallon for avgas or 6.7 lb. per U.S. gallon for jet fuel. Fuel capacity includes optional, auxiliary and long-range tanks, unless otherwise noted.

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

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

Limits

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

▶ **VNE**—Never-exceed speed (red line for piston-engine airplanes)

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

▶ **VMO**—Maximum operating speed (red line for turbine-powered airplanes)

▶ **MMO**—Maximum operating Mach number (red line turbofan-powered airplanes and a few turboprop airplanes)

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

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

▶ **Vdec**—Accelerate/stop decision speed (multi-engine piston and light multi-engine turboprop airplanes)

▶ **Vmca**—Minimum control airspeed while airborne (multi-engine piston and light multi-engine turboprop airplanes)

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

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

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

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

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

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

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

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

Airport Performance

Approved Flight Manual takeoff runway performance is shown for sea-level, standard day and for 5,000-ft. elevation/25C (77F) day, density altitude. All-engine takeoff distance (TO) is shown for single- and multi-engine piston, and turboprop airplanes with an MTOW of less than 12,500 lb. Takeoff distances and speeds assume Maximum Takeoff Weight, unless otherwise noted, such as when takeoff weight is limited because of density altitude.

▶ **Accelerate/Stop distance (A/S)** is shown for small multi-engine piston and small turboprop airplanes. Takeoff field length (TOFL), the greater of the one-engine inoperative (OEI) takeoff distance or the accelerate/stop distance, is shown for FAR Part 23 Commuter Category/Level 4 and FAR Part 25 aircraft. If the accelerate/stop and accelerate/stop distances are equal, the TOFL is the balanced field length.

▶ **Landing Distance (LD)** is shown for FAR Part 23 Commuter Category/Level 4 and FAR Part 25 Transport Category aircraft. The landing weight is EOW plus 3 passengers or BOW plus 4 passengers, as applicable. Fuel reserves on landing are based on 100-nm NBAA IFR reserves for Part 23 aircraft and 200-nm NBAA IFR reserves for FAR 25 aircraft. We assume that 80,000+ lb. ULR aircraft will have eight passengers on board.

▶ **V2 and VREF** speeds are useful for reference when comparing the TOFL and LD numbers because they provide an indication of potential minimum-length runway performance when low RCR (runway condition report) or runway gradient is a factor.

BCA lists two additional numbers for large turboprop- and turbofan-powered aircraft. First, we published the Mission Weight, which is the lower of: (1) the actual takeoff weight with four passengers (eight passengers for ULR aircraft) and full fuel when departing from a 5,000-ft./25C airport, or (2) the maximum allowable takeoff weight when departing with the same passenger load and at the same density altitude.

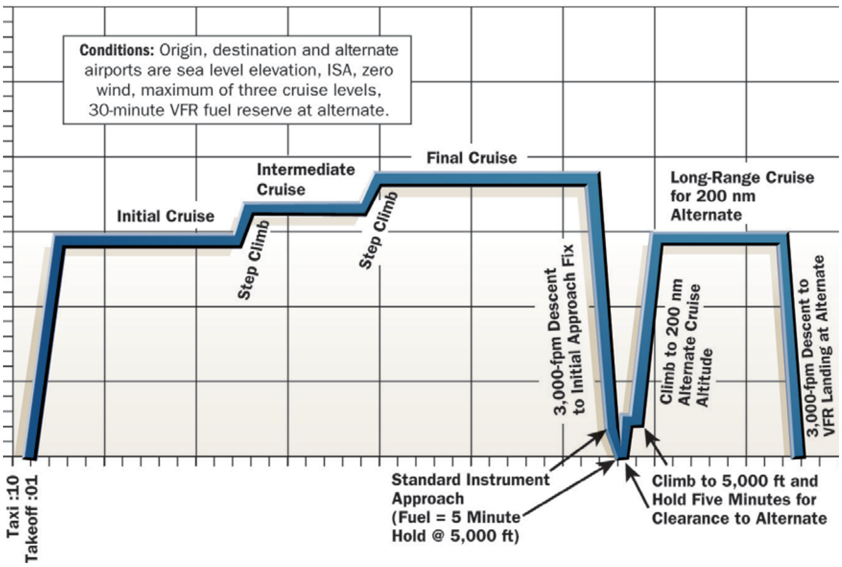
For two-engine aircraft, the mission weight when departing from a 5,000-ft., ISA+20C airport may be less than the MTOW because of FAR Part 25 second-segment, one-engine-inoperative, climb performance requirements. Aircraft with highly flat-rated engines are less likely to have a Mission Weight that is performance-limited when departing from hot-and-high airports.

We publish the NBAA IFR range for the 5,000-ft. elevation, ISA+20C departure, assuming a transition into standard-day, ISA flight conditions after takeoff. For purposes of computing NBAA IFR range, the aircraft is flown at the long-range cruise speed shown in the "Cruise" block or at the same speed as shown in the "Range" block. Missions assume four passengers and full tanks, unless otherwise noted. Thus, some aircraft, not weight-limited when departing such hot-and-high airports, actually have longer ranges than when departing sea-level facilities because they start their climbs 5,000 ft. higher on their way up to initial cruise altitude.

Climb

The all-engine time-to-climb provides an indication of overall climb performance, especially if the aircraft has an all-engine service ceiling well above our sample top-of-climb altitudes. We provide the all-engine time-to-climb to one of three specific altitudes, based on type of aircraft departing at MTOW from a sea-level, standard-day airport: (1) FL 100 (10,000 ft.) for normally aspirated, single- and multi-engine piston aircraft, plus pressurized single-engine piston aircraft and unpressurized turboprop aircraft; (2) FL 250 for pressurized single- and multi-engine turboprop aircraft; or (3) FL 370 for turbofan-powered aircraft. The data is published as time-to-climb in minutes/climb altitude. For example, if a non-pressurized twin-engine piston aircraft can depart from a sea-level airport at MTOW and climb to 10,000 ft. in 8 min., the time to climb is expressed as 8/FL 100.

NBAA IFR RANGE PROFILE



We also publish the initial all-engine climb feet-per-nautical mile gradient, plus initial engine-out climb rate and gradient, for single- and multi-engine piston and turboprops with MTOWs of 12,500 lb. or less.

The one-engine-inoperative (OEI) climb rate for multi-engine aircraft at MTOW is derived from the Airplane Flight Manual (AFM). OEI climb rate and gradient is based on landing gear retracted and wing flaps in the takeoff configuration used to compute the published takeoff distance. The climb gradient for such aircraft is obtained by dividing the product of the climb rate (fpm) in the Airplane Flight Manual times 60 by the Vy or Vyse climb speed, as appropriate.

The OEI climb gradients we show for FAR Part 23 Level 4 and FAR Part 25 Transport Category aircraft are the second-segment net climb performance numbers published in the AFMs. Please note: the AFM net second-segment climb performance numbers are adjusted downward by 0.8% to compensate for variations in pilot technique and ambient conditions.

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

Ceilings (ft.)

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

▶ **All-Engine Service Ceiling**—Maximum altitude at which at least a 100-fpm rate of climb can be attained, assuming the aircraft departed a sea-level, standard-day airport at MTOW and climbed directly to altitude.

▶ **OEI (Engine-Out) Service Ceiling**—Maximum altitude at which a 50-fpm rate of climb can be attained, assuming the aircraft departed a sea-level, standard-day airport at MTOW and climbed directly to altitude.

▶ **Sea-Level Cabin (SLC) Altitude**—Maximum cruise altitude at which a 14.7 psia, sea-level cabin altitude can be maintained in a pressurized airplane. Note: Some aircraft equipped with digital pressurization systems have altitude-proportionate cabin pressurization systems that limit the sea-level cabin altitude to relatively low cruise altitudes.

Cruise

Cruise performance is computed using EOW with four occupants or BOW with four passengers and one-half fuel load. Ultra-long-range aircraft carry eight passengers for purposes of computing cruise performance. Assume 170 lb. for each occupant of a piston-engine airplane and 200 lb. for each occupant of a turbine-powered aircraft.

▶ **Long Range**—True airspeed (TAS), fuel flow in lb./hour, (FL) flight-level cruise altitude and specific range for long-range cruise by the manufacturer.

▶ **Recommended (Piston-Engine Airplanes)** True Air Speed (TAS), fuel flow in lb./hour, (FL) flight-level cruise altitude and specific range for normal cruise performance specified by the manufacturer.

▶ **High Speed**—True Air Speed (TAS), fuel flow in lb./hour, (FL) flight-level cruise altitude and specific range for shorter-range, high-speed performance specified by the manufacturer.

Speed, fuel flow, specific range and altitude in each category are based on one mid-weight cruise point and these data reflect standard-day conditions. They are not an average for the overall mission and they are not representative of the above standard-day temperatures at cruise altitudes commonly encountered in everyday operations.

BCA imposes a 12,000-ft. maximum cabin altitude requirement on CAR3/ FAR Part 23 normally aspirated aircraft. Non-pressurized, turbine-powered or turbocharged piston-engine airplanes are limited to FL 250, providing they are fitted with supplemental oxygen systems having sufficient capacity for all occupants for the duration of the mission. Pressurized CAR3/ FAR Part 23 aircraft are limited to a maximum cruise altitude at which cabin altitude can be maintained at 10,000 ft. or below. For FAR Part 23 Category C and FAR Part 25 aircraft, the maximum cabin altitude for computing cruise performance is 8,000 ft.

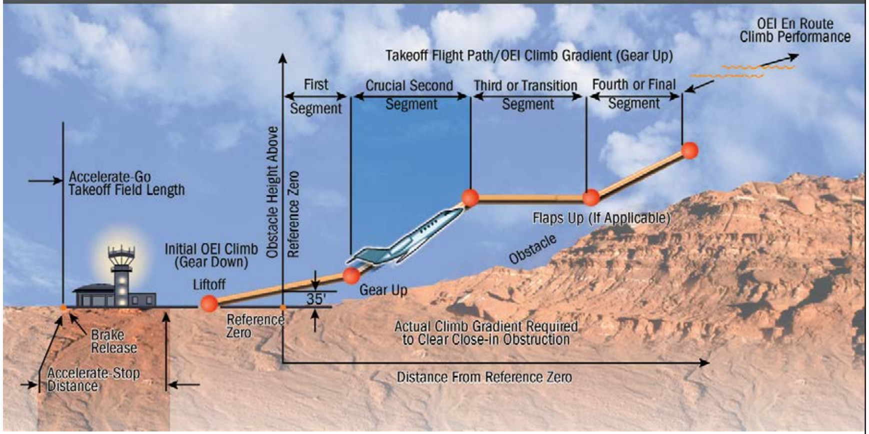
To conserve space, we use Flight Levels (FL) for all cruise altitudes, which is appropriate considering that we assume standard-day ambient temperature and pressure conditions. Cruise performance is subject to *BCA*'s verification.

Range

BCA shows various paper missions for each aircraft that illustrate range-versus-payload tradeoffs, runway and cruise performance, plus fuel efficiency. Similar to the cruise profile calculations, limits the maximum altitude to 12,000 ft. for normally aspirated, non-pressurized CAR3/FAR Part 23 aircraft, 25,000 ft. for non-pressurized turbocharged or turbine airplanes with supplemental oxygen, 10,000-ft. cabin altitude for pressurized CAR 3/FAR Part 23 airplanes and 8,000-ft. cabin altitude for FAR Part 23 Category C or FAR Part 25 aircraft.

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

▶ **Tanks-Full Range (Single-Engine Piston Airplanes)**—Based on one 170-lb. pilot, FAR Part 25 and Part 23 Commuter Category OEI Climb Performance



full fuel less 45-min. IFR fuel reserves.

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

▶ **Ferry (CAR 3/FAR Part 23 Category A and B)—**Based on one 170-lb. pilot, maximum fuel less 45-min. IFR fuel reserves.

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

NBAA IFR range format cruise profiles, having a 200-mi. alternate, are used for FAR Part 25 Transport Category turbine-powered aircraft. In the case of FAR Part 23 turboprops, including those certified in the Categories B and C, and FAR Part 23 turbofan aircraft, only a 100-mi. alternate is needed. The difference in alternate requirements should be kept in mind when comparing range performance of various classes of aircraft.

▶ **Available Fuel With Max Payload (Multi-engine Turbine Airplanes)—**Based on aircraft loaded to Maximum Zero-Fuel Weight with maximum available fuel up to Maximum Ramp Weight, less NBAA IFR fuel reserves at destination.

▶ **Available Payload With Max Fuel (Multi-engine Turbine Airplanes)—**Based on BOW plus full fuel and maximum available payload up to Maximum Ramp Weight. Range based on NBAA IFR reserves at destination.

▶ **Full/Max Fuel With Four Passengers (Multi-engine Turbine Airplanes)—**Based on BOW plus four 200-lb. passengers and the lesser of full fuel or maximum available fuel up to Maximum Ramp Weight. Ultra-long-range aircraft must have eight passengers on board.

▶ **Ferry (Multi-engine Turbine Airplanes)—**Based on BOW, required crew and full fuel, arriving at destination with NBAA IFR fuel reserves.

We allow 2,000-ft.-increment step climbs above the initial cruise altitude to improve specific range performance. The altitude shown in the range section is the highest cruise altitude for the trip—not the initial cruise or mid-mission altitude.

The range profiles are in nautical miles, and the average speed is computed by dividing that distance by the total flight time or weight-off-wheels time en route. The Fuel Used or Trip Fuel includes the fuel consumed for start, taxi, takeoff, cruise, descent and landing approach, but not after-landing taxi or reserves.

The Specific Range is obtained by dividing the distance flown by the total fuel burn. The Altitude is the highest cruise altitude achieved on the specific mission profile shown.

Missions

Various paper missions are computed to illustrate the runway requirements, speeds, fuel burns and specific range, plus cruise altitudes. The mission ranges are chosen to be representative for the aircraft category. All fixed-distance missions are flown with four passengers on board, except for ultra-long-range airplanes which have eight passengers on board. The pilot is counted as a passenger on board piston-engine airplanes. If an airplane cannot complete a specific fixed-distance mission with the appropriate payload, *BCA* shows a reduction of payload in the remarks section or marks the fields NP (Not Possible) at our option.

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

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

▶ **200 nm—**(Piston-engine airplanes)

▶ **500 nm—**(Piston-engine airplanes)

▶ **300 nm—**(Turbine-engine airplanes, except ultra-long-range)

▶ **600 nm—**(Turbine-engine airplanes, except ultra-long-range)

▶ **1,000 nm—**(All turbine-engine airplanes)

▶ **3,000 nm—**(Ultra-long-range turbine-engine airplanes)

▶ **6,000 nm—**(Ultra-long-range turbine-engine airplanes)

Remarks

In this section, *BCA* generally includes the base price, if it is available or applicable; the certification basis and year; and any notes about estimations, limitations or qualifications regarding specifications, performance or price. All prices are in 2023 dollars, FOB at a U.S. delivery point, unless otherwise noted. The certification basis includes the regulation under which the airplane was originally type certified, the year in which it was originally certified and, if applicable, subsequent years during which the airplane was re-certified.

General

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

SINGLE-ENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Cirrus Design	Textron Aviation	Cirrus Design	Textron Aviation
Model			SR20	Cessna Skylane CE-182T	SR22	Beechcraft Bonanza G36 G36
BCA Equipped Price			$579,000	$603,000	$772,900	$999,000
Character-istics		Seating	1+3/4	1+3/3	1+3/4	1+4/5
		Wing Loading	21.7	17.8	23.5	20.2
		Power Loading	14.65	13.48	11.61	12.68
		Noise (dBA)	83.4	77.7	83.7	TBD
External Dimensions (ft.)		Length	26.0	29.0	26.0	27.5
		Height	8.9	9.3	8.9	8.6
		Span	38.3	36.0	38.3	33.5
Internal Dimensions (ft.)		Length	8.0	7.2	8.0	12.6
		Height	4.1	4.0	4.1	4.2
		Width	4.1	3.5	4.1	3.5
Power		Engine	Lyc IO-390-C3B6	Lyc IO-540-AB1A5	Cont IO-550-N	Cont IO-550-B
		Output (hp)	215	230	310	300
		Inspection Interval	2,000t	2,000t	2,000t	1,900t
Weights (lb.)		Max Ramp	3,160	3,110	3,610	3,860
		Max Takeoff	3,150	3,100	3,600	3,805
		Max Landing	3,150	2,950	3,600	3,805
		Zero Fuel	3,043b	2,986b	3,400c	3,665b
		EOW	2,122	2,000	2,272	2,605
		Max Payload	921	986	1,128	1,060
		Useful Load	1,038	1,110	1,338	1,255
		Max Baggage	130	200	130	670
		Max Fuel	336	522	552	444
		Available Payload w/Max Fuel	702	588	786	811
		Available Fuel w/Max Payload	117	124	210	195
Limits		V_{NE}	201	175	205	203
		V_{NO}	164	140	176	165
		V_A	133	110	140	139
Airport Perfor-mance		TO (SL elev./ISA temp.)	2,530	1,514	1,756	1,913
		TO (5,000-ft. elev.@25C)	4,305	2,708	3,016	TBD
		V_{SO}	62	49	64	59
		V_X	81	65	88	84
		V_Y	88	80	108	100
Climb		Time to Climb (min.)/Altitude	20/FL 100	15/FL 100	11/FL 100	TBD/FL 100
		Initial Gradient (ft./nm)	540	694	775	TBD
Ceiling (ft.)		Service	17,500	18,100	17,500	18,500
Cruise	Long Range	TAS	135	125	160	160
		Fuel Flow	53	61	68	71
		Altitude	FL 080	FL 100	FL 080	80
		Specific Range	2.547	2.049	2.353	2.254
	Recommended	TAS	145	135	171	167
		Fuel Flow	61	69	92	86
		Altitude	FL 080	FL 100	FL 080	80
		Specific Range	2.377	1.957	1.859	1.942
	High Speed	TAS	152	144	180	174
		Fuel Flow	71	76	107	93
		Altitude	FL 080	FL 060	FL 080	FL 080
		Specific Range	2.141	1.895	1.682	1.865
Ranges	Seats Full	Nautical Miles	672	723	1,118	217
		Average Speed	135	130	162	153
		Fuel Used	275	379	492	115
		Specific Range/Altitude	2.444/FL 080	1.908/FL 120	2.272/FL 080	1.887/FL 040
	Tanks Full	Nautical Miles	672	912	1,118	860
		Average Speed	135	131	162	159
		Fuel Used	275	471	492	403
		Specific Range/Altitude	2.444/FL 080	1.936/FL 120	2.272/FL 080	2.134/FL 080
Missions (4 occupants)	200 nm	Runway	1,685	1,249	1,303	1,665
		Block Time	1+26	1+37	1+09	1+11
		Fuel Used	112	123	127	130
		Specific Range/Altitude	1.786/FL 080	1.626/FL 120	1.575/FL 080	1.538/FL 060
	500 nm	Runway	1,685	1,402	1,519	1,858
		Block Time	3+30	3+52	2+49	2+54
		Fuel Used	245	269	305	304
		Specific Range/Altitude	2.041/FL 080	1.859/120	1.639/FL 080	1.645/FL 060
		Suggested Base Price	$579,000	$603,000	$772,900	$999,000
Remarks		Certification Basis	FAR 23, 2000 Includes Garmin Perspective+ avionics.	FAR 23, 1996/2001 A23-6 Garmin G1000 NXi with GFC 700 autopilot.	FAR 23, 2000 includes Garmin Perspective+ avionics.	CAR 3, 1956/69/83/2005 A/C system standard; Garmin G1000 NXi.

SINGLE-ENGINE PISTONS TURBOCHARGED

Manufacturer			Textron Aviation	Textron Aviation	Cirrus Design
Model			Turbo Skylane CE-T182T	Turbo Stationair HD CE-T206H	SR22T
BCA Equipped Price			$653,000	$835,000	$887,900
Characteristics		Seating	1+3/3	1+5/5	1+3/4
		Wing Loading	17.8	21.8	23.5
		Power Loading	13.19	12.22	11.43
		Noise (dBA)	75.4	82.6	80.3
External Dimensions (ft.)		Length	29.0	28.3	26.0
		Height	9.3	9.3	8.9
		Span	36.0	36.0	38.3
Internal Dimensions (ft.)		Length	7.2	9.3	8.0
		Height	4.0	4.1	4.1
		Width	3.5	3.7	4.1
Power		Engine	Lyc TIO-540-AK1A	Lyc TIO-540-AJ1A	Cont TSIO-550-K
		Output (hp)	235	310	315
		Inspection Interval	2,000t	2,000t	2,000t
Weights (lb.)		Max Ramp	3,112	3,806	3,610
		Max Takeoff	3,100	3,789	3,600
		Max Landing	2,950	3,600	3,600
		Zero Fuel	2,953b	3,615b	3,400c
		EOW	2,114	2,365	2,354
		Max Payload	839	1,250	1,046
		Useful Load	998	1,441	1,256
		Max Baggage	200	180	130
		Max Fuel	522	522	552
		Available Payload w/Max Fuel	476	919	704
		Available Fuel w/Max Payload	159	191	210
Limits		V_{NE}	175	182	205
		V_{NO}	140	149	176
		V_A	110	125	140
Airport Performance		TO (SL elev./ISA Temp.)	1,385	1,970	1,517
		TO (5,000-ft. elev.@25C)	1,928	2,845	2,268
		V_{SO}	50	59	64
		V_X	64	70	88
		V_Y	84	88	103
Climb		Time to Climb (min.)/Altitude	10/FL 100	12/FL 100	7/FL 100
		Initial Gradient (ft./nm)	743	724	782
Ceilings (ft.)		Certificated	20,000	26,000	25,000
		Service	20,000	26,000	25,000
Cruise	Long Range	TAS	132	137	171
		Fuel Flow	62	85	76
		Altitude	FL 200	FL 240	FL 250
		Specific Range	2.129	1.612	2.250
	Recommended	TAS	152	155	201
		Fuel Flow	77	99	98
		Altitude	FL 200	FL 240	FL 250
		Specific Range	1.974	1.574	2.051
	High Speed	TAS	165	164	213
		Fuel Flow	98	116	110
		Altitude	FL 200	FL 200	FL 250
		Specific Range	1.684	1.410	1.936
Ranges	Seats Full	Nautical Miles	520	465	1,021
		Average Speed	134	137	171
		Fuel Used	291	358	486
		Specific Range/Altitude	1.787/FL 200	1.299/FL 200	2.101/FL 250
	Tanks Full	Nautical Miles	915	608	1,021
		Average Speed	134	138	171
		Fuel Used	476	430	486
		Specific Range/Altitude	1.922/FL 200	1.414/FL 240	2.101/FL 250
Missions (4 occupants)	200 nm	Runway	1,385	1,420	1,405
		Block Time	1+24	1+23	1+08
		Fuel Used	144	163	197
		Specific Range/Altitude	1.389/FL 120	1.227/FL 150	1.015/FL 100
	500 nm	Runway	1,385	1,626	1,699
		Block Time	3+14	3+22	2+28
		Fuel Used	319	386	360
		Specific Range/Altitude	1.567/FL 200	1.295/FL 240	1.389/FL 180
Remarks		Suggested Base Price	$653,000	$835,000	$887,900
		Certification Basis	FAR 23, 2006 Garmin G1000 NXi with GFC700 autopilot standard.	FAR 23, 1998 Garmin G1000 NXi with GFC700 autopilot standard.	FAR 23, 2010 Includes Garmin Perspective+ avionics.

SINGLE-ENGINE PISTONS PRESSURIZED

Manufacturer			Piper Aircraft
Model			M350 PA-46-350P
BCA Equipped Price			$1,695,200
Characteristics		Seating	1+4/5
		Wing Loading	24.8
		Power Loading	12.40
		Noise (dBA)	81.0
External Dimensions (ft.)		Length	28.9
		Height	11.3
		Span	43.0
Internal Dimensions (ft.)		Length	12.4
		Height	3.9
		Width	4.2
Power		Engine	Lyc TIO-540-AE2A
		Output (hp)	350
		Inspection Interval	2,000t
Weights (lb.)		Max Ramp	4,358
		Max Takeoff	4,340
		Max Landing	4,123
		Zero Fuel	4,123c
		EOW	3,146
		Max Payload	977
		Useful Load	1,212
		Max Baggage	200
		Max Fuel	720
		Available Payload w/Max Fuel	492
		Available Fuel w/Max Payload	235
Limits		V_{NE}	198
		V_{NO}	168
		V_A	133
		PSI	5.5
Airport Performance		TO (SL elev./ISA temp.)	2,090
		TO (5,000-ft. elev.@25C)	2,977
		V_{SO}	58
		V_X	81
		V_Y	110
Climb		Time to Climb (min.)/Altitude	8/FL 100
		Initial Gradient (ft./nm)	703
Ceilings (ft.)		Certificated	25,000
		Service	25,000
		Sea-Level Cabin	12,300
Cruise	Long Range	TAS	156
		Fuel Flow	66
		Altitude	FL 250
		Specific Range	2.364
	Recommended	TAS	203
		Fuel Flow	108
		Altitude	FL 250
		Specific Range	1.880
	High Speed	TAS	213
		Fuel Flow	120
		Altitude	FL 250
		Specific Range	1.775
Ranges	Seats Full	Nautical Miles	535
		Average Speed	138
		Fuel Used	312
		Specific Range/Altitude	1.715/FL 120
	Tanks Full	Nautical Miles	1,343
		Average Speed	159
		Fuel Used	670
		Specific Range/Altitude	2.004/FL 250
Missions (4 occupants)	200 nm	Runway	2,090
		Block Time	1+06
		Fuel Used	167
		Specific Range/Altitude	1.198/FL 200
	500 nm	Runway	2,090
		Block Time	2+31
		Fuel Used	350
		Specific Range/Altitude	1.429/FL 250
Remarks		Suggested Base Price	$1,382,189
		Certification Basis	FAR 23, 1983/88 Garmin G1000 NXi with GFC 700 autopilot; pressurized and A/C.

MULTIENGINE PISTONS NORMALLY ASPIRATED

Manufacturer			Vulcanair SpA	Vulcanair SpA	Textron Aviation
Model			P.68C	Victor P.68R	Beech Baron G58 G58
BCA **Equipped Price**			$1,250,000*	$1,500,000*	$1,599,000
Character-istics		Seating	1+5/6	1+5/6	1+4/5
		Wing Loading	22.9	22.7	27.6
		Power Loading	11.49	11.37	9.17
		Noise (dBA)	74.7	78.8	77.6
External Dimensions (ft.)		Length	31.3	31.3	29.8
		Height	11.2	11.2	9.8
		Span	39.4	39.4	37.8
Internal Dimensions (ft.)		Length	10.6	10.6	12.6
		Height	3.9	3.9	4.2
		Width	3.8	3.8	3.5
Power		Engines	2 Lyc IO-360-A1B6	2 Lyc IO-360-A1B6	2 Cont IO-550-C
		Output (hp each)	200	200	300
		Inspection Interval	2,000t	2,000t	1,900t
Weights (lb.)		Max Ramp	4,630	4,548	5,524
		Max Takeoff	4,594	4,548	5,500
		Max Landing	4,365	4,321	5,400
		Zero Fuel	4,167c	4,374b	5,210b
		EOW	3,153	3,197	3,965
		Max Payload	1,014	1,177	1,245
		Useful Load	1,477	1,351	1,559
		Max Fuel	1,063	1,063	1,164
		Available Payload w/Max Fuel	415	289	395
		Available Fuel w/Max Payload	463	174	314
Limits		VNE	194	197	223
		VNO	154	157	195
		VA	132	127	156
Airport Performance		TO (SL elev./ISA Temp.)	1,312	1,260	2,345
		TO (5,000-ft. elev.@25C)	4,000	4,000	4,144
		A/S (SL elev./ISA)	2,150	1,410	3,009
		A/S (5,000-ft. elev.@25C)	2,950	2,370	4,335
		VMCA	60	60	84
		VDEC	70	70	85
		VXSE	82	82	100
		VYSE	88	88	101
Climb		Time to Climb (min.)/Altitude	12/FL 100	12/FL 100	10/FL 100
		Initial Engine-Out Rate (fpm)	217	217	390
		Initial All-Engine Gradient (ft./nm)	1,100	920	988
		Initial Engine-Out Gradient (ft./nm)	147	147	232
Ceilings (ft.)		Certificated	—	—	—
		All-Engine Service	18,000	20,000	20,688
		Engine-Out Service	5,000	5,650	7,284
Cruise	**Long Range**	TAS	144	144	185
		Fuel Flow	94	94	144
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.532	1.532	1.285
	Recommended	TAS	155	155	192
		Fuel Flow	108	108	174
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.435	1.435	1.103
	High Speed	TAS	162	162	200
		Fuel Flow	116	116	193
		Altitude	FL 080	FL 080	FL 080
		Specific Range	1.397	1.397	1.035
Ranges	**Max Payload**	Nautical Miles	300	300	250
		Average Speed	140	140	174
		Trip Fuel	315	315	231
		Specific Range/Altitude	0.952/FL 080	0.952/FL 080	1.082/FL 040
	Ferry	Nautical Miles	1,000	1,000	1,480
		Average Speed	145	145	180
		Trip Fuel	975	975	1,081
		Specific Range/Altitude	1.026/FL 080	1.026/FL 080	1.369/FL 120
Missions (4 occu-pants)	**200 nm**	Runway	1,450	1,450	2,861
		Block Time	1+28	1+28	1+02
		Fuel Used	140	140	226
		Specific Range/Altitude	1.429/FL 080	1.429/FL 080	0.885/FL 060
	500 nm	Runway	1,500	1,500	2,940
		Block Time	3+25	3+25	2+31
		Fuel Used	375	375	531
		Specific Range/Altitude	1.333/FL 080	1.333/FL 080	0.942/FL 060
		Suggested Base Price	$1,176,115	$1,205,000	$1,599,000
Remarks		Certification Basis	FAR 23, 1976/80 Garmin G1000 NXi with GFC700 autopilot. **BCA* estimated price.	EASA 23, 2009 Garmin G1000 NXi with GFC700 autopilot. **BCA* estimated price.	CAR 3 1957/69/ 83/2005 A/C system standard; Garmin G1000 NXi; Max payload mission flown with six occupants.

MULTIENGINE PISTONS TURBOCHARGED

Manufacturer			Vulcanair SpA
Model			P.68C TC
BCA **Equipped Price**			$1,550,000*
Character-istics		Seating	1+5/5
		Wing Loading	20.7
		Power Loading	10.94
		Noise (dBA)	74.7
External Dimensions (ft.)		Length	31.3
		Height	11.2
		Span	39.4
Internal Dimensions (ft.)		Length	10.6
		Height	3.9
		Width	3.8
Power		Engines	2 Lyc TIO-360-C1A6D
		Output (hp each)	210
		Inspection Interval	2,000t
Weights (lb.)		Max Ramp	4,630
		Max Takeoff	4,594
		Max Landing	4,365
		Zero Fuel	4,140b
		EOW	3,197
		Max Payload	943
		Useful Load	1,433
		Max Fuel	1,062
		Available Payload w/Max Fuel	371
		Available Fuel w/Max Payload	490
Limits		VNE	194
		VNO	154
		VA	132
Airport Perfor-mance		TO (SL elev./ISA temp.)	1,260
		TO (5,000-ft. elev.@25C)	2,200
		A/S (SL elev./ISA)	1,800
		A/S (5,000-ft. elev.@25C)	2,400
		VMCA	66
		VDEC	NA
		VXSE	78
		VYSE	88
Climb		Time to Climb (min.)/Altitude	10/FL 100
		Initial Engine-Out Rate (fpm)	240
		Initial All-Engine Gradient (ft./nm)	1,400
		Initial Engine-Out Gradient (ft./nm)	NA
Ceilings (ft.)		Certificated	20,000
		All-Engine Service	20,000
		Engine-Out Service	10,000
Cruise	**Long Range**	TAS	144
		Fuel Flow	104
		Altitude	FL 080
		Specific Range	1.385
	Recommended	TAS	155
		Fuel Flow	125
		Altitude	FL 080
		Specific Range	1.240
	High Speed	TAS	162
		Fuel Flow	150
		Altitude	FL 080
		Specific Range	1.080
Range	**Ferry**	Nautical Miles	1,100
		Average Speed	145
		Trip Fuel	960
		Specific Range/Altitude	1.146/FL 080
Missions (4 occupants)	**200 nm**	Runway	NA
		Block Time	1+28
		Fuel Used	260
		Specific Range/Altitude	0.769/FL 080
	500 nm	Runway	NA
		Block Time	3+25
		Fuel Used	485
		Specific Range/Altitude	1.031/FL 080
		Suggested Base Price	$1,315,000
Remarks		Certification Basis	FAR 23, 1982 Garmin G1000 NXi. *BCA* estimated data. **BCA* estimated price.

SINGLE-ENGINE TURBOPROPS

Manufacturer			Textron Aviation	Textron Aviation	Piper Aircraft	Daher	Daher	Piper Aircraft
Model			**Cessna Caravan CE-208**	**Grand Caravan EX CE-208B**	**M500 PA-46-500TP**	**Kodiak 100 Kodiak 100 Series III**	**Kodiak 200 Kodiak 900**	**M600 PA-46-600TP**
BCA Equipped Price			$2,320,000	$2,610,000	$2,650,000	$2,953,653	$3,487,389	$3,750,000
Characteristics		Seating	1+9/13*	1+9/13*	1+4/5	1+6/9	1+6/9	1+4/5
		Wing Loading	28.6	31.5	27.8	30.2	33.3	28.7
		Power Loading	11.85	10.16	10.18	9.67	8.89	10.00
		Noise (dBA)	79.0	84.1	76.8	84.4	79.5	76.8
External Dimensions (ft.)		Length	37.6	41.6	29.6	33.8	37.7	29.6
		Height	14.9	15.5	11.3	14.7	16.1	11.3
		Span	52.1	52.1	43.0	45.0	45.0	43.2
Internal Dimensions (ft.)		Length	12.7	16.7	12.3	15.8	18.1	12.3
		Height	4.5	4.5	3.9	4.8	4.8	3.9
		Width	5.3	5.3	4.1	4.5	4.5	4.1
Power		Engine	P&WC PT6A-114A	P&WC PT6A-140	P&WC PT6A-42A	P&WC PT6A-34	P&WC PT6A-140A	P&WC PT6A-42A
		Output (shp)/Flat Rating	675/ISA+31C	867/ISA+24C	500/ISA+60C	750/ISA+7C	900/ISA+22C	600/ISA+45C
		Inspection Interval	3,600t	4,000t	3,600t	4,000t	4,000t	3,600t
Weights (lb.)		Max Ramp	8,035	8,842	5,134	7,305	8,100	6,050
		Max Takeoff	8,000	8,807	5,092	7,255	8,000	6,000
		Max Landing	7,800	8,500	4,850	7,255	7,800	5,800
		Zero Fuel	7,432b	8,152b	4,850c	7,071c	7,410c	4,850c
		BOW	4,930	5,510	3,634	4,417	4,840	3,850
		Max Payload	2,502	2,642	1,216	2,654	2,570	1,000
		Useful Load	3,105	3,332	1,500	2,888	3,260	2,200
		Max Fuel	2,224	2,246	1,160	2,144	2,144	1,742
		Available Payload w/Max Fuel	881	1,086	340	744	1,116	458
		Available Fuel w/Max Payload	604	691	284	234	690	1,200
Limits		V_{MO}	175	175	188	180	190	250
		V_A	150	148	127	143	155	151
		PSI	—-	—	5.6	—	—	5.6
Airport Performance		TO (SL elev./ISA temp.)	2,055	2,160	2,438	1,468	1,504	2,635
		TO (5,000-ft. elev.@25C)	2,973	3,661	3,691	2,396	2,515	3,998
		V_{SO}	61	61	69	60	65	62
		V_X	90	86	95	73	79	95
		V_Y	107	108	125	101	111	122
Climb		Time to Climb (min.)/Altitude	9/FL 100	9/FL 100	19/FL 250	10/FL 100	7/FL 100	21/FL 250
		Initial Gradient (ft./nm)	771	816	753	778	932	785
Ceilings (ft.)		Certificated	25,000	25,000	30,000	25,000	25,000	30,000
		Service	25,000	25,000	30,000	25,000	25,000	30,000
		Sea-Level Cabin	—-	—-	12,600	—	—	12,600
Cruise	Long Range	TAS	157	156	179	164	185	184
		Fuel Flow	281	328	135	251	324	155
		Altitude	FL 100	FL 100	FL 280	FL 120	FL 120	FL 280
		Specific Range	0.559	0.476	1.326	0.653	0.571	1.187
	High Speed	TAS	186	185	258	175	210	274
		Fuel Flow	379	437	242	335	409	324
		Altitude	FL 100	FL 100	FL 280	FL 120	FL 120	FL 280
		Specific Range	0.491	0.423	1.066	0.522	0.513	0.846
NBAA IFR Ranges (100-nm alternate)	Full Fuel (w/available payload)	Nautical Miles	965	807	834	1,005	925	1,406
		Average Speed	156	156	171	175	210	179
		Trip Fuel	1,799	1,761	748	1,941	1,903	1,324
		Specific Range/Altitude	0.536/FL 100	0.458/FL 100	1.115/FL 280	0.518/FL 120	0.486/FL 120	1.062/FL 280
	Ferry	Nautical Miles	970	816	834	1,299	1,345	1,406
		Average Speed	156	156	171	141	177	179
		Trip Fuel	1,800	1,772	748	1,941	1,903	1,324
		Specific Range/Altitude	0.539/FL 100	0.460/FL 100	1.115/FL 280	0.669/FL 200	0.707/FL 200	1.062/FL 280
Missions (4 passengers)	300 nm	Runway	1,468	1,428	1,550	1,468	1,504	1,593
		Flight Time	1+40	1+41	1+22	1+50	1+30	1+21
		Fuel Used	648	750	379	591	651	429
		Specific Range/Altitude	0.463/FL 100	0.400/FL 100	0.792/FL 280	0.508/FL 120	0.461/FL 120	0.699/FL 280
	600 nm	Runway	1,675	1,792	1,625	1,468	1,504	1,687
		Flight Time	3+17	3+19	2+32	3+32	2+55	2+31
		Fuel Used	1,260	1,462	660	1,165	1,235	735
		Specific Range/Altitude	0.476/FL 100	0.410/FL 100	0.909/FL 280	0.515/FL 120	0.486/FL 120	0.816/FL 280
	1,000 nm	Runway	NP	NP	1,700	1,467	1,504	1,812
		Flight Time	NP	NP	4+18	5+50	4+50	4+06
		Fuel Used	NP	NP	985	1,931	2,014	1,142
		Specific Range/Altitude	NP/NP	NP/NP	1.015/FL 280	0.518/FL 120	0.497/FL 120	0.876/FL 280
		Suggested Base Price	NA	NA	$2,505,677	$2,634,407	$3,285,043	$3,536,536
Remarks		Certification Basis	FAR 23, 1984/98 Garmin G1000 NXi with GFC700 autopilot. *Export only.	FAR 23, 1986/2012 Includes cargo pod; Garmin G1000 NXi and GFC700 autopilot. *Export only.	FAR 23 A52 Garmin G1000 NXi with SVS; GFC 700 autopilot; enhanced AFCS. 1,000 nm, three occupants.	FAR 23, 2007 Normal category Includes Garmin G1000 NXi and GFC700 autopilot with coupled GA; Summit interior.	FAR 23, 2007 Normal category Includes Garmin G1000 NXi with GFC700 autopilot with coupled GA; Summit+ interior.	FAR 23, 2016 A62 Garmin G3000 with SVS and enhanced AFCS; HALO emergency autoland.

SINGLE-ENGINE TURBOPROPS

Manufacturer			Epic Aircraft	Daher	Daher	Pilatus Aircraft	Textron Aviation
Model			**E1000 GX** **E1000**	**TBM 910** **TBM 700 N**	**TBM 960** **TBM 700 N**	**PC-12 NGX** **PC-12/47E**	***Beechcraft Denali*** ***BE-220***
BCA Equipped Price			$4,450,000	$4,546,289	$4,997,960	$6,028,000	$6,450,000
Characteristics		Seating	1+5/6	1+5/6	1+5/6	1+8/9	1+7/9
		Wing Loading	38.6	38.2	39.4	37.6	NA
		Power Loading	6.67	8.70	8.96	8.71	NA
		Noise (dBA)	77.3	76.4	77.1	77.0	NA
External Dimensions (ft.)		Length	35.8	35.2	35.2	47.3	48.8
		Height	12.5	14.3	14.3	14.0	15.2
		Span	43.0	42.1	42.1	53.3	54.3
Internal Dimensions (ft.)		Length	13.9	15.0	15.0	16.9	16.8
		Height	4.5	4.1	4.1	4.8	4.8
		Width	4.5	4.0	4.0	5.0	5.3
Power		Engine	P&WC PT6A-67A	P&WC PT6A-66D	P&WC PT6E-66XT	P&WC PT6E-67XP	GE Aviation Catalyst
		Output (shp)/Flat Rating	1,200/ISA+35C	850/ISA+37C	850/ISA+37C	1,200/ISA+35C	1,300/NA
		Inspection Interval	3,500t	3,500t	5,000t	5,000t	4,000t
Weights (lb.)		Max Ramp	8,050	7,430	7,650	10,495	NA
		Max Takeoff	8,000	7,394	7,615	10,450	NA
		Max Landing	7,600	7,024	7,110	9,921	NA
		Zero Fuel	7,498b	6,032c	6,252c	9,039c	NA
		BOW	5,330	4,929	5,006	6,803	NA
		Max Payload	2,168	1,103	1,246	2,236	NA
		Useful Load	2,720	2,501	2,644	3,692	NA
		Max Fuel	1,770	1,955	1,955	2,704	NA
		Available Payload w/Max Fuel	950	546	689	988	1,100
		Available Fuel w/Max Payload	553	1,398	1,398	1,456	NA
Limits		V_{MO}	270	266	266	240	NA
		V_A	170	160	160	166	NA
		PSI	6.6	6.2	6.2	5.8	7.6
Airport Performance		TO (SL elev./ISA temp.)	2,254	2,380	2,535	2,485	NA
		TO (5,000-ft. elev.@25C)	3,193	3,475	3,680	4,080	NA
		V_{SO}	68	65	65	67	NA
		V_X	116	100	100	120	NA
		V_Y	150	124	124	130	NA
Climb		Time to Climb (min.)/Altitude	12/FL 250	13/FL 250	13/FL 250	19/FL 250	NA/NA
		Initial Gradient (ft./nm)	1,400	1,000	1,000	877	NA
Ceilings (ft.)		Certificated	34,000	31,000	31,000	30,000	31,000
		Service	34,000	31,000	31,000	30,000	31,000
		Sea-Level Cabin	15,000	14,390	14,390	13,100	18,700
Cruise	Long Range	TAS	238	252	252	225	NA
		Fuel Flow	234	241	241	269	NA
		Altitude	FL 340	FL 310	FL 310	FL 300	NA
		Specific Range	1.017	1.046	1.046	0.836	NA
	High Speed	TAS	322	330	330	290	285
		Fuel Flow	335	412	412	463	NA
		Altitude	FL 340	FL 260	FL 260	FL 240	NA
		Specific Range	0.961	0.801	0.801	0.626	NA
NBAA IFR Ranges (100-nm alternate)	Full Fuel (w/available payload)	Nautical Miles	1,232	1,514	1,514	1,548	1,600
		Average Speed	310	252	252	270	NA
		Trip Fuel	1,374	1,599	1,599	2,235	NA
		Specific Range/Altitude	0.897/FL 340	0.947/FL 310	0.947/FL 310	0.693/FL 300	NA/NA
	Ferry	Nautical Miles	1,243	1,594	1,594	1,571	NA
		Average Speed	312	252	252	275	NA
		Trip Fuel	1,374	1,598	1,598	2,224	NA
		Specific Range/Altitude	0.905/FL 340	0.997/FL 310	0.997/FL 310	0.706/FL 300	NA/NA
Missions (4 passengers)	300 nm	Runway	1,260	1,765	1,765	1,677	NA
		Flight Time	1+13	1+00	1+00	1+08	NA
		Fuel Used	426	440	440	534	NA
		Specific Range/Altitude	0.704/FL 340	0.682/FL 280	0.682/FL 280	0.562/FL 240	NA/NA
	600 nm	Runway	1,260	2,005	2,005	1,866	NA
		Flight Time	2+09	1+55	1+55	2+12	NA
		Fuel Used	738	830	830	977	NA
		Specific Range/Altitude	0.813/FL 340	0.723/FL 280	0.723/FL 280	0.614/FL 260	NA/NA
	1,000 nm	Runway	1,457	2,380	2,380	2,109	NA
		Flight Time	3+25	3+10	3+10	3+40	NA
		Fuel Used	1,165	1,320	1,320	1,525	NA
		Specific Range/Altitude	0.858/FL 340	0.758/FL 290	0.758/FL 290	0.656/FL 280	NA/NA
		Suggested Base Price	NA	$4,317,488	$4,784,785	$4,800,000	$6,450,000
Remarks		Certification Basis	FAR 23, 2019/21 Garmin G1000 NXi; all performance at MTOW.	FAR 23, 1990/2006/07/14 Pilot door standard; five-blade propeller; Garmin G1000 NXi; elec.-heated seats; five-year system warranty.	FAR 23, 1990/2006/07/14 Pilot door standard, five-blade propeller; HomeSafe; E-throttle; Garmin G3000; Prestige cabin; five-year system warranty.	FAR 23, 1996/2005/08/19 Typically equipped with executive interior, autothrottle.	FAR/EASA 23 pending Typically equipped with executive interior, autothrottle. 2024 dollars.

MULTIENGINE TURBOPROPS ≤12,500-LB. MTOW

Manufacturer			**Vulcanair SpA**	**Viking Air**	**Piaggio Aero Industries SpA**	**Textron Aviation**
Model			**Viator AP68TP-600**	**400 Series DHC-6-400**	**Avanti Evo P.180 Avanti II**	**Beechcraft King Air 260 B200GT**
***BCA* Equipped Price**			$3,500,000*	$7,250,000*	$7,695,000	$7,780,000
Characteristics		Seating	1+7/10	1+19/19	1+7/9	1+8/10
		Wing Loading	33.0	29.8	70.3	40.3
		Power Loading	10.08	10.08	7.12	7.35
		Noise (dBA)	71.7	85.6	74.0	81.2
External Dimensions (ft.)		Length	37.0	51.8	47.3	43.8
		Height	11.9	19.5	13.0	14.8
		Span	39.4	65.0	47.1	57.9
Internal Dimensions (ft.)		**Length:** OA/Net	11.9/17.2	18.4/24.5	17.5/17.5	16.7/16.7
		Height	4.1	4.9	5.8	4.8
		Width: Max/Floor	3.7/3.7	5.4/4.4	6.1/3.5	4.5/4.1
Power		Engines	2 RR 250 B17F	2 P&WC PT6A-34	2 P&WC PT6A-66B	2 P&WC PT6A-52
		Output (shp each)/Flat Rating	328/ISA+25C	620/ISA+27C	850/ISA+28C	850/ISA+37C
		Inspection Interval	3,500t	4,000t	3,600t	3,600t
Weights (lb.)		Max Ramp	6,669	12,560	12,150	12,590
		Max Takeoff	6,613	12,500	12,100	12,500
		Max Landing	6,283	12,300	11,500	12,500
		Zero Fuel	5,621c	11,582b	10,200c	11,000c
		BOW	3,850	7,650	8,350	8,830
		Max Payload	1,771	3,932	1,850	2,170
		Useful Load	2,819	4,910	3,800	3,760
		Max Fuel	1,487	3,129	2,802	3,645
		Available Payload w/Max Fuel	1,332	1,781	998	115
		Available Fuel w/Max Payload	1,048	978	1,950	1,590
Limits		V_{MO}	200	170	260	259
		V_A	141	136	202	181
		PSI	—	—	9.0	6.5
Airport Performance		TO (SL elev./ISA temp.)	2,034	1,490	3,196	2,111
		TO (5,000-ft. elev.@25C)	2,950	2,031	4,700	3,099
		A/S (SL elev./ISA temp.)	2,034	2,220	5,750	3,687
		A/S (5,000-ft. elev.@25C)	2,953	2,447	7,400	4,859
		V_{MCA}	77	66	100	86
		V_{DEC}	85	NA	106	94
		V_{XSE}	90	NA	132	115
		V_{YSE}	105	82	140	121
Climb		Time to Climb (min.)/Altitude	7/FL 100	7/FL 100	10/FL 250	13/FL 250
		Initial Engine-Out Rate (fpm)	270	340	670	682
		Initial All-Engine Gradient (ft./nm)	1,500	1,033	1,067	1,170
		Initial Engine-Out Gradient (ft./nm)	180	243	287	364
Ceilings (ft.)		Certificated	25,000	25,000	41,000	35,000
		All-Engine Service	25,000	26,700	41,000	35,000
		Engine-Out Service	8,050	11,600	22,500	26,000
		Sea-Level Cabin	—	—	24,000	2,700*
Cruise	**Long Range**	TAS	169	146	304	256
		Fuel Flow	261	460	438	430
		Altitude	FL 100	FL 100	FL 390	FL 350
		Specific Range	0.648	0.317	0.694	0.595
	High Speed	TAS	214	182	378	310
		Fuel Flow	375	652	783	750
		Altitude	FL 100	FL 100	FL 310	FL 260
		Specific Range	0.571	0.279	0.483	0.413
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	543	887	774	321
		Average Speed	180	146	297	267
		Trip Fuel	781	2,797	1,315	870
		Specific Range/Altitude	0.695/FL 100	0.317/FL 100	0.589/FL 390	0.369/FL 330
	Max Fuel (w/available payload)	Nautical Miles	837	887	1,366	1,403
		Average Speed	179	146	300	291
		Trip Fuel	1,220	2,797	2,165	2,941
		Specific Range/Altitude	0.686/FL 100	0.317/FL 100	0.631/FL 390	0.477/FL 330
	Full Fuel (w/4 passsengers)	Nautical Miles	837	887	1,376	1,038
		Average Speed	179	146	300	288
		Trip Fuel	1,220	2,797	2,165	2,225
		Specific Range/Altitude	0.686/FL 100	0.317/FL 100	0.636/FL 390	0.467/FL 330
	Ferry	Nautical Miles	837	963	1,389	1,420
		Average Speed	179	143	304	293
		Trip Fuel	1,220	2,927	2,165	2,942
		Specific Range/Altitude	0.686/FL 100	0.329/FL 100	0.642/FL 390	0.483/FL 330
Missions (4 passengers)	**300 nm**	Runway	1,247	892	2,350	3,504
		Flight Time	1+35	1+44	0+53	1+03
		Fuel Used	419	1,092	725	869
		Specific Range/Altitude	0.716/FL 100	0.275/FL 100	0.414/FL 310	0.345/FL 250
	600 nm	Runway	1,558	1,096	2,550	3,587
		Flight Time	3+18	3+22	1+45	2+03
		Fuel Used	866	2,107	1,220	1,494
		Specific Range/Altitude	0.693/FL 100	0.285/FL 100	0.492/FL 350	0.402/FL 290
	1,000 nm	Runway	NP	NP	2,700	3,677
		Flight Time	NP	NP	3+05	3+28
		Fuel Used	NP	NP	1,672	2,147
		Specific Range/Altitude	NP/NP	NP/NP	0.598/FL 390	0.466/FL 330
		Suggested Base Price	$3,332,000	NA	NA	NA
Remarks		Certification Basis	FAR 23, 1986 Garmin G1000 NXi; S-TEC Genesys 2100 autopilot. *BCA*-computed performance data. **BCA* estimated price.	EASA/FAR 23, 2010 A57 **BCA* estimated price.	FAR 23, 2015; EASA 23, 2014 Collins Pro Line 21; TCAS I; Iridium satcom; RVSM approved; optional 390-lb. capacity internal tank; enlarged door.	FAR 23, 1973/80/2008/11 Collins Pro Line Fusion standard; Wi-Fi optional; STC SA02131SE; autothrottles standard. *Optional press'n. sched.

MULTIENGINE TURBOPROPS >12,500-LB. MTOW

Manufacturer			Textron Aviation	Textron Aviation	Textron Aviation	Textron Aviation
Model			**SkyCourier (Freighter) CE-408**	**SkyCourier (Passenger) CE-408**	**Beechcraft King Air 360 B300**	**Beechcraft King Air 360ER B300ER**
BCA Equipped Price			$7,195,000	$7,745,000	$9,255,000	$9,760,000
Character-istics		Seating	1+1/11	1+19/19	1+9/11	1+9/11
		Wing Loading	43.0	43.0	48.4	53.2
		Power Loading	8.56	8.56	7.14	7.86
		Noise (dBA)	84.6	84.6	72.9	81.5
External Dimensions (ft.)		Length	55.1	55.1	46.7	46.7
		Height	20.7	20.7	14.3	14.3
		Span	72.3	72.3	57.9	57.9
Internal Dimensions (ft.)		**Length:** OA/Net	23.3/23.3	23.3/19.5	19.5/19.5	19.5/19.5
		Height	5.9	5.9	4.8	4.8
		Width: Max/Floor	6.4/5.8	6.2/5.8	4.5/4.1	4.5/4.1
Power		Engines	2 P&WC PT6A-65SC	2 P&WC PT6A-65SC	2 P&WC PT6A-60A	2 P&WC PT6A-60A
		Output (shp each)/Flat Rating	1,110/ISA+35C	1,110/ISA+35C	1,050/ISA+10C	1,050/ISA+10C
		Inspection Interval	6,000t	6,000t	3,600t	3,600t
Weights (lb.)		Max Ramp	19,070	19,070	15,100	16,600
		Max Takeoff	19,000	19,000	15,000	16,500
		Max Landing	18,600	18,600	15,000	15,675
		Zero Fuel	17,200c	17,575c	12,500c	13,000c
		BOW	11,200	12,725	9,955	10,215
		Max Payload	6,000	4,850	2,545	2,785
		Useful Load	7,870	6,345	5,145	6,385
		Max Fuel	4,826	4,926	3,611	5,192
		Available Payload w/Max Fuel	3,044	1,419	1,534	1,193
		Available Fuel w/Max Payload	1,870	1,495	2,600	3,600
Limits		MMO	0.40	0.40	0.58	0.58
		Trans. Alt. FL/VMO	120/210	120/210	210/263	240/245
		VA	NA	NA	184	182
		PSI	—	—	6.8	6.8
Airport Perfor-mance		TO (SL elev./ISA temp.)	2,740*	3,660*	3,300	4,057
		TOFL (5,000-ft. elev.@25C)	4,305*	4,850*	5,376	7,675
		Mission Weight	19,000	19,000	14,196	16,100
		NBAA IFR Range	797	792	1,549	2,257
		V2	98	98	109	111
		VREF	96	96	100	104
		Landing Distance	2,366	2,378	2,390	2,728
Climb		Time to Climb (min.)/Altitude	37/FL 250	37/FL 250	15/FL 250	18/FL 250
		*FAR 25 Initial Engine-Out Rate (fpm)	350	350	622	337
		FAR 25 Initial Engine-Out Gradient (ft./nm)	NA	NA	304	182
Ceilings (ft.)		Certificated	25,000	25,000	35,000	35,000
		All-Engine Service	25,000	25,000	35,000	35,000
		Engine-Out Service	13,900	13,900	21,500	17,100
		Sea-Level Cabin	—	—	2,700†	2,700
Cruise	**Long Range**	TAS	160	160	235	238
		Fuel Flow	630	630	362	402
		Altitude	FL 120	FL 120	FL 330	FL 330
		Specific Range	0.254	0.254	0.649	0.592
	High Speed	TAS	210	210	312	303
		Fuel Flow	1,020	1,020	773	764
		Altitude	FL 120	FL 120	FL 240	FL 240
		Specific Range	0.206	0.206	0.404	0.397
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	100	85	896	1,316
		Average Speed	189	182	273	261
		Trip Fuel	609	533	1,891	2,880
		Specific Range/Altitude	0.164/FL 120	0.159/FL 120	0.474/FL 350	0.457/FL 350
	Max Fuel (w/available payload)	Nautical Miles	783	783	1,485	2,223
		Average Speed	205	205	280	269
		Trip Fuel	3,915	3,915	2,944	4,528
		Specific Range/Altitude	0.200/FL 120	0.200/FL 120	0.504/FL 350	0.491/FL 350
	Full Fuel (w/4 passengers)	Nautical Miles	792	787	1,533	2,271
		Average Speed	208	206	285	271
		Trip Fuel	3,946	3,925	2,951	4,533
		Specific Range/Altitude	0.201/FL 120	0.201/FL 120	0.519/FL 350	0.501/FL 350
	Ferry	Nautical Miles	795	790	1,560	2,338
		Average Speed	207	207	289	276
		Trip Fuel	3,956	3,936	2,958	4,543
		Specific Range/Altitude	0.201/FL 120	0.201/FL 120	0.527/FL 350	0.515/FL 350
Missions (4 passengers)	**300 nm**	Runway	1,631	2,737	2,586	2,795
		Flight Time	1+28	1+29	1+02	1+05
		Fuel Used	1,545	1,538	881	919
		Specific Range/Altitude	0.194/FL 120	0.195/FL 120	0.341/FL 250	0.326/FL 250
	600 nm	Runway	1,902	3,141	2,702	2,927
		Flight Time	2+54	2+55	2+02	2+07
		Fuel Used	3,007	3,005	1,470	1,529
		Specific Range/Altitude	0.200/FL 120	0.200/FL 120	0.408/FL 290	0.392/FL 290
	1,000 nm	Runway	NP	NP	2,827	3,048
		Flight Time	NP	NP	3+27	3+35
		Fuel Used	NP	NP	2,102	2,195
		Specific Range/Altitude	NP/NP	NP/NP	0.476/FL 330	0.456/FL 330
		Suggested Base Price	$8,140,000**	$8,770,000**	NA	NA
Remarks		Certification Basis	FAR 23, 2022 A64 Normal category (Level 1) Garmin G1000 NXi; 800-lb. payload for *BCA* missions. *AE TOD 50-ft. obstacle. **2025 dollars.	FAR 23, 2022 A64 Normal category (Level 4) Garmin G1000 NXi. *OEI TOFL 35-ft. obstacle. **2025 dollars.	FAR 23, 1989 Commuter category Collins Pro Line Fusion MultiScan Radar and iTAWS; Wi-Fi optional; RVSM app'd.; also available as 350HW with 16,500-lb. MTOW, 15,675-lb. MLW; autothrottles standard.	FAR 23, 1989/2007 Commuter category Collins Pro Line Fusion MultiScan Radar and iTAWS; Wi-Fi optional; RVSM approved; autothrottles standard.

JETS <10,000-LB. MTOW

Manufacturer			**Cirrus Design**
Model			**Vision G2+ SF-50**
BCA Equipped Price			$3,250,000
Characteristics		Seating	1+4/6
		Wing Loading	30.7
		Power Loading	3.25
		Noise (EPNdB): Lateral/Flyover/Approach	79.6/70.9/80.3
External Dimensions (ft.)		Length	30.7
		Height	10.9
		Span	38.7
Internal Dimensions (ft.)		**Length:** OA/Net	11.5/9.8
		Height/Dropped Aisle Depth	4.1/NA
		Width: Max/Floor	5.1/3.1
Baggage		**Internal:** Cu. ft./lb.	24/NA
		External: Cu. ft./lb.	30/NA
Power		Engine(s)	1 Wms Intl FJ33-5A
		Output (lb. each)/Flat Rating	1,846/ISA+10C
		Inspection Interval/Manu. Service Plan Interval	4,000t/—
Weights (lb.)		Max Ramp	6,040
		Max Takeoff	6,000
		Max Landing	5,550
		Zero Fuel	4,900c
		BOW	3,860
		Max Payload	1,040
		Useful Load	2,180
		Max Fuel	2,000
		Available Payload w/Max Fuel	180
		Available Fuel w/Max Payload	1,140
Limits		MMO	0.530
		Trans. Alt. FL/VMO	FL 183/250
		PSI	7.1
Airport Performance		TOFL (SL elev./ISA temp.)	1,920
		TOFL (5,000-ft. elev.@25C)	3,045
		Mission Weight	6,000
		NBAA IFR Range	1,098
		V2	91
		VREF	87
		Landing Distance	1,628
Climb		Time to Climb/Altitude	23/310
		FAR 25 Engine-Out Rate (fpm)	NA
		FAR 25 Engine-Out Gradient (ft./nm)	NA
Ceilings (ft.)		Certificated	31,000
		All-Engine Service	31,000
		Engine-Out Service	—
		Sea-Level Cabin	NA
Cruise	**Long Range**	TAS	259
		Fuel Flow	300
		Altitude	FL 310
		Specific Range	0.863
	High Speed	TAS	305
		Fuel Flow	384
		Altitude	FL 310
		Specific Range	0.794
NBAA IFR Ranges (100-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	461
		Average Speed	233
		Trip Fuel	745
		Specific Range/Altitude	0.619/FL 310
	Max Fuel (w/available payload)	Nautical Miles	1,171
		Average Speed	233
		Trip Fuel	1,611
		Specific Range/Altitude	0.727/FL 310
	Four Passengers (w/available fuel)	Nautical Miles	622
		Average Speed	233
		Trip Fuel	941
		Specific Range/Altitude	0.661/FL 310
	Ferry	Nautical Miles	1,220
		Average Speed	233
		Trip Fuel	1,760
		Specific Range/Altitude	0.693/FL 310
Missions (4 passengers)	**300 nm**	Runway	1,867
		Flight Time	1+12
		Fuel Used	548
		Specific Range/Altitude	0.547/FL 310
	600 nm	Runway	2,036
		Flight Time	2+36
		Fuel Used	914
		Specific Range/Altitude	0.656/FL 310
	1,000 nm	Runway	2,437
		Flight Time	4+18
		Fuel Used	1,401
		Specific Range/Altitude	0.714/FL 310
Remarks		Certification Basis	FAR 23, 2016/18 Garmin Perspective Touch+ avionics; RVSM standard; Safe Return emergency autoland.

JETS <20,000-LB. MTOW

Manufacturer			**Nextant Aerospace**	**Embraer**
Model			**Nextant 400 XTi BE 400A**	**Phenom 100 EV EMB-500**
BCA Equipped Price			$4,650,000	$4,995,000
Characteristics		Seating	2+7/9/9	1+5/7/7
		Wing Loading/Power Loading	67.6/2.67	53.1/3.09
		Noise (EPNdB): Lateral/Flyover/Approach	76.9/91.5/88.8	81.6/70.8/86.1
External Dimensions (ft.)		Length	48.4	42.1
		Height	13.9	14.3
		Span	43.5	40.4
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	15.5/15.5/—	9.0/11.0/11.0
		Height/Dropped Aisle Depth	4.8/flat floor	4.9/0.3
		Width: Max/Floor	4.9/4.0	5.1/3.6
Baggage		**Internal:** Cu. ft./lb.	27/410	10/93
		External: Cu. ft./lb.	26/450	60/419
Power		Engines	2 Wms Intl FJ44-3AP	2 P&WC PW 617F1-E
		Output (lb. each)/Flat Rating	3,052/ISA+7C	1,730/ISA+8C
		Inspection Interval/Manu. Service Plan Interval	5,000t/—	3,500t/—
Weights (lb.)		Max Ramp	16,500	10,748
		Max Takeoff	16,300	10,703
		Max Landing	15,700	9,998
		Zero Fuel	13,000c	9,072c
		BOW	10,950	7,297
		Max Payload	2,050	1,775
		Useful Load	5,550	3,451
		Max Fuel	4,912	2,804
		Available Payload w/Max Fuel	638	647
		Available Fuel w/Max Payload	3,500	1,676
Limits		MMO	0.780	0.700
		Trans. Alt. FL/VMO	FL 290/320	FL 280/275
		PSI/Sea-Level Cabin	9.1/24,000	8.3/21,280
Airport Performance		TOFL (SL elev./ISA temp.)	3,821	3,190
		TOFL (5,000-ft. elev.@25C)	5,088	5,663
		Mission Weight	14,500p	10,703
		NBAA IFR Range	1,197	1,113
		V2	116	99
		VREF	105	95
		Landing Distance	2,960	2,473
Climb		Time to Climb/Altitude	16/FL 370	19/FL 370
		FAR 25 Engine-Out Rate (fpm)	305	747
		FAR 25 Engine-Out Gradient (ft./nm)	158	453
Ceilings (ft.)		Certificated	45,000	41,000
		All-Engine Service	45,000	41,000
		Engine-Out Service	27,500	24,045
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	406/740	340/543
		Altitude/Specific Range	FL 450/0.549	FL 410/0.626
	High Speed	TAS/Fuel Flow (lb./hr.)	447/968	406/955
		Altitude/Specific Range	FL 430/0.462	FL 330/0.425
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	1,024	466
		Average Speed	367	325
		Trip Fuel	2,411	1,036
		Specific Range/Altitude	0.425/FL 450	0.450/FL 410
	Max Fuel (w/available payload)	Nautical Miles	1,895	1,194
		Average Speed	384	333
		Trip Fuel	3,953	2,196
		Specific Range/Altitude	0.479/FL 450	0.544/FL 410
	Four Passengers (w/available fuel)	Nautical Miles	1,801	1,092
		Average Speed	383	333
		Trip Fuel	3,706	2,038
		Specific Range/Altitude	0.486/450	0.536/FL 410
	Ferry	Nautical Miles	1,981	1,254
		Average Speed	381	329
		Trip Fuel	3,986	2,220
		Specific Range/Altitude	0.497/FL 450	0.565/FL 410
Missions (4 passengers)	**300 nm**	Runway	3,015	2,909
		Flight Time	0+48	0+53
		Fuel Used	786	753
		Specific Range/Altitude	0.382/FL 390	0.398/FL 390
	600 nm	Runway	3,044	3,121
		Flight Time	1+30	1+45
		Fuel Used	1,323	1,236
		Specific Range/Altitude	0.454/FL 430	0.485/FL 390
	1,000 nm	Runway	3,101	3,179
		Flight Time	2+28	2+54
		Fuel Used	2,145	1,919
		Specific Range/Altitude	0.466/FL 450	0.521/FL 410
Remarks		Certification Basis	FAR 25, 1981/85 STC 02371LA STC 10959SC STC 03960AT	FAR 23, 2008

JETS <20,000-LB. MTOW

Manufacturer			**Textron Aviation**	**Honda Aircraft Co.**	**Textron Aviation**	**Embraer**	**Textron Aviation**	**Pilatus Aircraft**
Model			**Citation M2 Gen2 CE-525**	**HondaJet Elite II HA-420**	**Citation CJ3+ CE-525B**	**Phenom 300E EMB-505**	**Citation CJ4 Gen2 CE-525C**	**PC-24**
BCA Equipped Price			$6,150,000	$6,950,000	$10,415,000	$10,995,000	$11,855,000	$12,225,000
Characteristics		Seating	1+7/7/7	1+5/7/7	1+8/9/9	1+7/10/10	1+9/10/10	1+8/10/10
		Wing Loading/Power Loading	44.6/2.72	62.9/2.71	47.2/2.46	60.5/2.67	51.8/2.36	55.0/2.68
		Noise (EPNdB): Lateral/Flyover/Approach	85.9/73.2/88.5	85.5/73.1/87.4	88.7/74.0/88.6	89.2/70.6/88.9	92.8/75.6/89.5	90.4/78.2/92.0
External Dimensions (ft.)		Length	42.6	42.6	51.2	51.2	53.3	55.2
		Height	13.9	14.9	15.2	16.7	15.4	17.3
		Span	47.3	39.8	53.3	52.2	50.8	55.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	8.8/11.0/11.0	12.1/12.1/NA	12.3/15.7/15.7	14.8/17.2/17.2	12.9/17.3/17.3	17.0/17.0/23.0
		Height/Dropped Aisle Depth	4.8/0.4	4.8/NA	4.8/0.4	4.9/0.3	4.8/0.4	5.1/flat floor
		Width: Max/Floor	4.8/3.1	5.0/NA	4.8/3.1	5.1/3.6	4.8/3.3	5.6/3.8
Baggage		**Internal:** Cu. ft./lb.	—/—	NA/NA	—/—	10/77	7/40	90/1,000
		External: Cu. ft./lb.	46/725	62/750	65/1,000	74/573	71/1,000	NA/NA
Power		Engines	2 Wms Intl FJ44-1AP-21	2 GE Honda HF-120-H1A	2 Wms Intl FJ44-3A	2 P&WC PW 535E1	2 Wms Intl FJ44-4A	2 Wms Intl FJ44-4A-QPM
		Output (lb. each)/Flat Rating	1,965/ISA+7C	2,050/ISA+10C	2,820/ISA+11C	3,478/ISA+15C	3,621/ISA+11C	3,420/ISA+23C
		Inspection Interval/Manu. Service Plan Interval	3,500t/5,000	5,000t*/—	4,000t/5,000	5,000t/—	5,000t/5,000	5,000t/5,000
Weights (lb.)		Max Ramp	10,800	11,180	14,070	18,618	17,230	18,400
		Max Takeoff	10,700	11,100	13,870	18,552	17,110	18,300
		Max Landing	9,900	10,360	12,750	17,273	15,660	16,900
		Zero Fuel	8,500c	9,300c	10,675c	14,264c	12,500c	14,220c
		BOW	6,990	7,422	8,540	11,628	10,280	11,720
		Max Payload	1,510	1,878	2,135	2,636	2,220	2,500
		Useful Load	3,810	3,758	5,530	6,990	6,950	6,680
		Max Fuel	3,296	3,138	4,710	5,404	5,828	5,965
		Available Payload w/Max Fuel	514	620	820	1,586	1,122	715
		Available Fuel w/Max Payload	2,300	1,880	3,395	4,354	4,730	4,180
Limits		MMO	0.710	0.720	0.737	0.800	0.770	0.740
		Trans. Alt. FL/VMO	FL 305/263	FL 302/270	FL 293/278	FL 276/320	FL 279/305	FL 280/290
		PSI/Sea-Level Cabin	8.5/22,027	8.8/23,060	8.9/23,586	9.4/25,560	9.0/24,005	9.3/25,100
Airport Performance		TOFL (SL elev./ISA temp.)	3,210	3,699	3,180	3,209	3,410	2,930
		TOFL (5,000-ft. elev.@25C)	5,580	5,637	4,750	5,374	5,180	4,980
		Mission Weight	10,700	11,100	13,870	18,552	16,788	18,300
		NBAA IFR Range	1,204	1,380	1,918	2,033	2,109	2,000
		V2	111	117	114	111	117	106
		VREF	101	108	99	103	99	90
		Landing Distance	2,340	2,912	2,422	2,212	2,281	2,120
Climb		Time to Climb/Altitude	18/FL 370	16/FL 370	15/FL 370	14/FL 370	14/FL 370	14/FL 370
		FAR 25 Engine-Out Rate (fpm)	618	634	808	872	839	665
		FAR 25 Engine-Out Gradient (ft./nm)	334	284	425	471	430	379
Ceilings (ft.)		Certificated	41,000	43,000	45,000	45,000	45,000	45,000
		All-Engine Service	41,000	43,000	45,000	45,000	45,000	45,000
		Engine-Out Service	26,800	26,400	26,250	30,137	28,200	32,500
Cruise	Long Range	TAS/Fuel Flow (lb./hr.)	323/516	360/543	352/624	385/783	377/812	358/757
		Altitude/Specific Range	FL 410/0.626	FL 430/0.663	FL 450/0.564	FL 450/0.492	FL 450/0.464	FL 450/0.473
	High Speed	TAS/Fuel Flow (lb./hr.)	401/920	419/999	415/1,197	464/1,549	442/1,470	438/1,717
		Altitude/Specific Range	FL 350/0.436	FL 330/0.419	FL 350/0.347	FL 350/0.300	FL 370/0.301	FL 300/0.255
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	751	612	1,080	1,381	1,425	1,206
		Average Speed	358	332	366	397	407	400
		Trip Fuel	1,600	1,255	2,381	3,369	3,753	3,069
		Specific Range/Altitude	0.469/FL 410	0.488/FL 430	0.454/FL 450	0.410/FL 450	0.380/FL 450	0.393/FL 450
	Max Fuel (w/available payload)	Nautical Miles	1,357	1,523	1,814	1,932	1,913	2,013
		Average Speed	372	347	377	393	413	366
		Trip Fuel	2,675	2,601	3,846	4,450	4,904	4,920
		Specific Range/Altitude	0.507/FL 410	0.586/FL 430	0.472/FL 450	0.434/FL 450	0.390/FL 450	0.409/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	1,183	1,358	1,825	2,010	1,927	2,030
		Average Speed	370	346	276	387	416	367
		Trip Fuel	2,352	2,366	3,767	4,471	4,920	4,956
		Specific Range/Altitude	0.503/FL 410	0.574/FL 430	0.484/FL 450	0.450/FL 450	0.392/FL 450	0.410/FL 450
	Ferry	Nautical Miles	1,400	1,605	1,900	2,094	1,955	2,129
		Average Speed	378	344	383	380	420	359
		Trip Fuel	2,705	2,622	3,872	4,498	4,955	5,046
		Specific Range/Altitude	0.518/FL 410	0.612/FL 430	0.491/FL 450	0.466/FL 450	0.395/FL 450	0.422/FL 450
Missions (4 passengers)	**300 nm**	Runway	2,625	3,372	2,608	2,899	2,669	2,280
		Flight Time	0+52	0+53	0+49	0+49	0+46	0+50
		Fuel Used	804	715	969	998	1,087	978
		Specific Range/Altitude	0.373/FL 370	0.420/FL 390	0.310/FL 370	0.301/FL 390	0.276/FL 390	0.307/FL 410
	600 nm	Runway	2,692	3,413	2,609	2,868	2,715	2,320
		Flight Time	1+38	1+40	1+35	1+29	1+27	1+32
		Fuel Used	1,362	1,185	1,571	1,653	1,865	1,674
		Specific Range/Altitude	0.441/FL 390	0.506/FL 430	0.382/FL 410	0.363/FL 410	0.322/FL 410	0.358/FL 450
	1,000 nm	Runway	3,009	3,473	2,720	2,831	2,770	2,360
		Flight Time	2+42	2+43	2+36	2+24	2+23	2+29
		Fuel Used	2,018	1,872	2,315	2,533	2,747	2,659
		Specific Range/Altitude	0.496/FL 410	0.534/FL 430	0.432/FL 430	0.395/FL 450	0.364/FL 430	0.376/FL 450
Remarks		Certification Basis	FAR 23, 2013	FAR 23, 2015/19 *Mature TBO.	FAR 23, 2004/14 Commuter category Garmin G3000.	FAR 23, 2009/20 Commuter category	FAR 23, 2010 Commuter category	EASA CS 23, 2017; FAR 23, 2018 Approved for unpaved runway operations.

JETS ≥20,000-LB. MTOW

Manufacturer			**Textron Aviation**	**Embraer**	**Textron Aviation**	**Embraer**
Model			**Citation XLS+ Gen2 CE-560XL**	**Praetor 500 EMB-545**	**Citation Latitude CE-680A**	**Praetor 600 EMB-550**
BCA Equipped Price			$16,110,000	$18,995,000	$19,775,000	$21,995,000
Character-istics		Seating	2+9/12/12	2+7/9/9	2+9/9/9	2+8/12/12
		Wing Loading/Power Loading	54.6/2.47	77.7/2.87	56.8/2.61	88.7/2.85
		Noise (EPNdB): Lateral/Flyover/Approach	86.8/72.3/92.8	84.1/73.5/89.9	87.7/73.5/87.7	86.9/75.1/90.3
External Dimensions (ft.)		Length	52.5	64.6	62.3	68.1
		Height	17.2	21.1	20.9	21.2
		Span	56.3	70.5	72.3	70.5
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	14.3/18.5/18.5	17.4/20.6/24.0	15.9/21.8/21.8	21.3/24.1/27.5
		Height/Dropped Aisle Depth	5.7/0.7	6.0/flat floor	6.0/flat floor	6.0/flat floor
		Width: Max/Floor	5.5/3.9	6.8/4.7	6.4/4.1	6.8/4.7
Baggage		**Internal:** Cu. ft./lb.	10/100	40/418	27/245	45/418
		External: Cu. ft./lb.	80/700	110/880	100/1,000	110/880
Power		Engines	2 P&WC PW545C	2 Hon HTF7500E	2 P&WC PW306D1	2 Hon HTF7500E
		Output (lb. each)/Flat Rating	4,119/ISA+10C	6,540/ISA+18C	5,907/ISA+15C	7,528/ISA+18C
		Inspection Interval/Manu. Service Plan Interval	5,000t/—	OC/—	6,000t/—	OC/—
Weights (lb.)		Max Ramp	20,530	37,699	31,050	42,990
		Max Takeoff	20,330	37,567	30,800	42,857
		Max Landing	18,700	34,172	27,575	37,478
		Zero Fuel	15,360c	25,959c	21,430c	28,660
		BOW	12,990	23,038	18,656	24,658
		Max Payload	2,370	2,921	2,774	4,002
		Useful Load	7,540	14,661	12,394	18,332
		Max Fuel	6,740	13,051	11,394	16,138
		Available Payload w/Max Fuel	800	1,610	1,000	2,194
		Available Fuel w/Max Payload	5,170	11,740	9,620	14,330
Limits		MMO	0.750	0.830	0.800	0.830
		Trans. Alt. FL/VMO	FL 265/305	FL 295/320	FL 298/305	FL 295/320
		PSI/Sea-Level Cabin	9.3/25,230	9.7/27,140	9.7/26,800	9.7/27,140
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	3,600	4,222	3,580	4,717
		TOFL (5,000-ft. elev.@25C)	5,500	5,692	5,070	6,431
		Mission Weight	20,330	37,567	30,675	42,857
		NBAA IFR Range	2,019	3,412	2,700	4,040
		V2	118	119	115	128
		VREF	106	101	95	104
		Landing Distance	2,740	2,086	2,085	2,165
Climb		Time to Climb/Altitude	16/FL 370	14/FL 370	16/FL 370	13/FL 370
		FAR 25 Engine-Out Rate (fpm)	741	743	652	777
		FAR 25 Engine-Out Gradient (ft./nm)	377	375	340	364
Ceilings (ft.)		Certificated	45,000	45,000	45,000	45,000
		All-Engine Service	45,000	43,000	43,000	43,000
		Engine-Out Service	28,400	27,513	27,620	28,189
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	353/865	426/1,352	368/1,114	433/1,449
		Altitude/Specific Range	FL 450/0.408	FL 450/0.315	FL 430/0.330	FL 450/0.299
	High Speed	TAS/Fuel Flow (lb./hr.)	431/1,238	469/2,018	432/1,765	466/1,826
		Altitude/Specific Range	FL 410/0.348	FL 390/0.232	FL 390/0.245	FL 430/0.255
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	1,175	2,819	2,135	3,277
		Average Speed	353	423	394	426
		Trip Fuel	3,533	9,963	7,901	12,600
		Specific Range/Altitude	0.333/FL 430	0.283/FL 450	0.270/FL 450	0.260/FL 450
	Max Fuel (w/available payload)	Nautical Miles	1,877	3,282	2,645	3,878
		Average Speed	349	419	401	425
		Trip Fuel	5,175	11,322	9,586	14,357
		Specific Range/Altitude	0.363/FL 430	0.290/FL 450	0.276/FL 450	0.270/FL 450
	Four Passengers (w/available fuel)	Nautical Miles	1,877	3,340	2,678	4,018
		Average Speed	349	417	401	423
		Trip Fuel	5,175	11,342	9,594	14,404
		Specific Range/Altitude	0.363/FL 430	0.294/FL 450	0.279/FL 450	0.279/FL 450
	Ferry	Nautical Miles	1,982	3,416	2,731	4,102
		Average Speed	345	417	405	421
		Trip Fuel	5,275	11,357	9,628	14,436
		Specific Range/Altitude	0.376/FL 430	0.301/FL 450	0.284/FL 450	0.284/FL 450
Missions (4 passengers)	**300 nm**	Runway	2,732	2,673	2,760	2,745
		Flight Time	0+47	0+48	0+46	0+46
		Fuel Used	1,229	1,564	1,610	1,558
		Specific Range/Altitude	0.244/FL 430	0.192/FL 430	0.186/FL 390	0.193/FL 450
	600 nm	Runway	2,781	2,690	2,845	2,746
		Flight Time	1+29	1+28	1+29	1+26
		Fuel Used	2,079	2,494	2,573	2,580
		Specific Range/Altitude	0.289/FL 430	0.241/FL 450	0.233/FL 430	0.233/FL 450
	1,000 nm	Runway	3,064	2,875	2,951	2,810
		Flight Time	2+26	2+21	2+25	2+18
		Fuel Used	3,216	3,802	3,989	3,969
		Specific Range/Altitude	0.311/FL 430	0.263/FL 450	0.251/FL 430	0.252/FL 450
Remarks		Certification Basis	FAR 25, 1998/ 2004/08/22	RBAC/FAR 25, 2015/19; EASA CS 25, 2015/19 Mod: DCA 0550-000-00100-2018.	FAR 25, 2015 Garmin G5000.	RBAC/FAR/EASA CS 25, 2014/19; ANAC 2019 Mod: DCA 0550-000-00026-2016.

JETS ≥20,000-LB. MTOW

Manufacturer			Gulfstream Aerospace	Bombardier	Textron Aviation	Bombardier
Model			**Gulfstream 280 G280**	**Challenger 3500 BD-100-1A10**	**Citation Longitude CE-700**	**Challenger 650 CL-600-2B16**
***BCA* Equipped Price**			$24,500,000	$27,200,000	$29,995,000	$33,000,000
Characteristics		Seating	2+9/10/19	2+9/11/19	2+8/12/12	2+12/13/19
		Wing Loading/Power Loading	80.0/2.60	77.6/2.77	73.5/2.58	98.6/2.61
		Noise (EPNdB): Lateral/Flyover/Approach	89.5/75.2/90.5	87.6/75.3/89.6	88.4/72.9/89.9	86.2/81.2/90.3
External Dimensions (ft.)		Length	66.8	68.7	73.2	68.4
		Height	21.3	20.0	19.4	20.7
		Span	63.0	69.0	68.9	64.3
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.7/25.8/32.3	16.6/25.2/28.6	16.5/25.2/28.1	15.4/25.6/28.3
		Height/Dropped Aisle Depth	6.1/4.5	6.0/flat floor	6.0/flat floor	6.0/flat floor
		Width: Max/Floor	6.9/5.4	7.2/5.1	6.4/4.1	7.9/6.9
Baggage		**Internal:** Cu. ft./lb.	154/1,980	106/750	112/1,115	112/900
		External: Cu. ft./lb.	—/—-	—-/—-	NA/NA	—/—
Power		Engines	2 Hon HTF7250G	2 Hon HTF 7350	2 Hon HTF7700L	2 GE CF34-3B
		Output (lb. each)/Flat Rating	7,624/ISA+17C	7,323/ISA+15C	7,665/ISA+19C	9,220*/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	OC/—
Weights (lb.)		Max Ramp	39,750	40,750	39,700	48,300
		Max Takeoff	39,600	40,600	39,500	48,200
		Max Landing	32,700	34,150	33,500	38,000
		Zero Fuel	28,200c	28,200c	26,800c	32,000c
		BOW	24,200	24,800	23,600	27,150
		Max Payload	4,000	3,400	3,200	4,850
		Useful Load	15,550	15,950	16,100	21,150
		Max Fuel	14,600	14,045	14,500	19,852
		Available Payload w/Max Fuel	950	1,905	1,600	1,298
		Available Fuel w/Max Payload	11,550	12,550	12,900	16,300
Limits		MMO	0.850	0.830	0.840	0.850
		Trans. Alt. FL/VMO	FL 280/340	FL 295/320	FL 293/325	FL 222/348
		PSI/Sea-Level Cabin	9.2/25,000	8.8/23,338	9.7/26,800	8.8/23,000
Airport Performance		TOFL (SL elev./ISA temp.)	4,750	4,835	4,810	5,640
		TOFL (5,000-ft. elev.@25C)	7,320	6,809	6,810	9,025
		Mission Weight	39,600	40,600	38,725	48,200
		NBAA IFR Range	3,700	3,400	3,500	4,044
		V2	137	133	136	147
		VREF	115	111	110	117
		Landing Distance	2,365	2,303	2,595	2,368
Climb		Time to Climb/Altitude	14/FL 370	14/FL 370	13/FL 370	21/FL 370
		FAR 25 Engine-Out Rate (fpm)	680	N/A	1,330	NA
		FAR 25 Engine-Out Gradient (ft./nm)	298	N/A	456	NA
Ceilings (ft.)		Certificated	45,000	45,000	45,000	41,000
		All-Engine Service	44,100	44,000	45,000	37,200
		Engine-Out Service	28,000	27,500	28,420	20,000
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	459/1,522	442/1,473	449/1,478	424/1,828
		Altitude/Specific Range	FL 450/0.302	FL 450/0.300	FL 450/0.304	FL 410/0.232
	High Speed	TAS/Fuel Flow (lb./hr.)	482/1,877	470/1,658	478/1,937	470/2,089
		Altitude/Specific Range	FL 410/0.257	FL 450/0.283	FL 430/0.247	FL 410/0.225
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,628	2,814	3,074	3,015
		Average Speed	447	432	452	416
		Trip Fuel	9,667	10,628	11,600	14,255
		Specific Range/Altitude	0.272/FL 450	0.265/FL 450	0.265/FL 450	0.212/FL 410
	Max Fuel (w/available payload)	Nautical Miles	3,688	3,297	3,422	3,979
		Average Speed	451	434	453	418
		Trip Fuel	12,837	12,164	12,763	17,940
		Specific Range/Altitude	0.287/FL 450	0.271/FL 450	0.268/FL 450	0.222/FL 410
	Four Passengers (w/available fuel)	Nautical Miles	3,703	3,377	3,500	4,025
		Average Speed	451	434	454	419
		Trip Fuel	12,843	12,193	12,763	17,959
		Specific Range/Altitude	0.288/FL 450	0.277/FL 450	0.274/FL 450	0.224/FL 410
	Ferry	Nautical Miles	3,787	3,435	3,500	4,100
		Average Speed	451	434	454	418
		Trip Fuel	12,872	12,214	12,787	17,988
		Specific Range/Altitude	0.294/FL 450	0.281/FL 450	0.274/FL 450	0.228/FL 410
Missions (4 passengers)	**300 nm**	Runway	2,860	3,612	2,744	3,387
		Flight Time	0+47	0+48	0+44	0+48
		Fuel Used	1,405	1,573	1,516	1,573
		Specific Range/Altitude	0.214/FL 450	0.191/FL 450	0.198/FL 450	0.191/FL 410
	600 nm	Runway	2,885	3,655	2,880	3,415
		Flight Time	1+26	1+29	1+23	1+28
		Fuel Used	2,309	2,527	2,457	2,810
		Specific Range/Altitude	0.260/FL 450	0.237/FL 450	0.244/FL 450	0.214/FL 410
	1,000 nm	Runway	3,020	3,714	3,025	3,444
		Flight Time	2+18	2+23	2+16	2+20
		Fuel Used	3,539	3,822	3,746	4,502
		Specific Range/Altitude	0.283/FL 450	0.262/FL 450	0.267/FL 450	0.222/FL 410
Remarks		Certification Basis	FAR 25, 2012; EASA CS 25, 2013	FAR 25 A98; JAR 25 Chg. 15 Collins Pro Line 21 Advanced.	FAR 25, 2019 Garmin G5000.	FAR 25, 1980/83/87/95/2006/15 Collins Pro Line 21 Advanced. *9,220 max takeoff; 8,729 normal takeoff.

JETS ≥20,000-LB. MTOW

Manufacturer			Dassault	Dassault	Bombardier	Gulfstream Aerospace
Model			**Falcon 2000LXS Falcon 2000EX**	**Falcon 900LX Falcon 900EX**	**Global 5500 BD-700-1A11**	**Gulfstream 500 GVII-G500**
BCA Equipped Price			$36,000,000	$44,700,000	$47,400,000	$49,500,000
Characteristics		Seating	2+8/10/19	2+12/12/19	3+13/16/19	2+13/19/19
		Wing Loading/Power Loading	81.2/3.06	92.9/3.27	90.6/3.06	83.8/2.63
		Noise (EPNdB): Lateral/Flyover/Approach	91.7/76.4/90.5	90.3/78.2/92.1	88.9/79.7/89.4	87.7/75.3/91.0
External Dimensions (ft.)		Length	66.3	66.3	96.8	91.2
		Height	23.3	25.2	25.5	25.5
		Span	70.2	70.2	94.0	86.3
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	17.1/26.2/31.0	23.5/33.2/39.3	27.2/40.7/45.7	26.3/41.5/47.6
		Height/Dropped Aisle Depth	6.2/flat floor	6.2/flat floor	6.2/flat floor	6.2/flat floor
		Width: Max/Floor	7.7/6.3	7.7/6.3	7.9/6.5	7.6/6.1
Baggage		**Internal:** Cu. ft./lb.	131/1,600	127/2,866	195/1,000	175/2,250
		External: Cu. ft./lb.	8/92	—/—	—/—	—/—
Power		Engines	2 P&WC PW308C	3 Hon TFE731-60	2 RR BR700-710D5-21*	2 P&WC PW814GA
		Output (lb. each)/Flat Rating	7,000/ISA+15C	5,000/ISA+17C	15,125/ISA+15C	15,144/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	7,000c/—	6,000c/—	OC/—	OC/—
Weights (lb.)		Max Ramp	43,000	49,200	92,750	80,000
		Max Takeoff	42,800	49,000	92,500	79,600
		Max Landing	39,300	44,500	78,600	64,350
		Zero Fuel	29,700c	30,864c	58,000c	52,100c
		BOW	24,750	26,750	50,861	46,850
		Max Payload	4,950	4,114	7,139	5,250
		Useful Load	18,250	22,450	41,889	33,150
		Max Fuel	16,660	20,905	38,967	30,250
		Available Payload w/Max Fuel	1,590	1,545	2,922	2,900
		Available Fuel w/Max Payload	13,300	18,336	34,750	27,900
Limits		M_{MO}	0.862	0.870	0.900	0.925
		Trans. Alt. FL/V_{MO}	FL 250/370	FL 250/370	FL 308/340	FL 290/340
		PSI/Sea-Level Cabin	9.3/25,300	9.6/25,300	10.3/30,125	10.7/31,900
Airport Performance		TOFL (SL elev./ISA temp.)	4,675	5,360	5,340	5,300
		TOFL (5,000-ft. elev.@25C)	6,840	7,615	7,284	7,300
		Mission Weight	42,010	48,255	92,500	79,600
		NBAA IFR Range	4,100	4,685	6,310	5,400
		V_2	127	134	133	148
		V_{REF}	106	111	108	117
		Landing Distance	2,295	2,455	2,195	2,645
Climb		Time to Climb/Altitude	17/FL 370	19/FL 370	18/FL 370	16/FL 370
		FAR 25 Engine-Out Rate (fpm)	463	723	NA	644
		FAR 25 Engine-Out Gradient (ft./nm)	221	324	NA	261
Ceilings (ft.)		Certificated	47,000	51,000	51,000	51,000
		All-Engine Service	42,315	39,630	41,000	43,400
		Engine-Out Service	21,010	24,980	25,100	27,400
Cruise	**Long Range**	TAS/Fuel Flow (lb./hr.)	437/1,485	431/1,665	488/2,815	488/2,417
		Altitude/Specific Range	FL 450/0.294	FL 430/0.259	FL 450/0.173	FL 470/0.202
	High Speed	TAS/Fuel Flow (lb./hr.)	483/2,325	474/2,225	505/3,016	516/3,048
		Altitude/Specific Range	FL 390/0.208	FL 390/0.213	FL 410/0.167	FL 430/0.169
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	2,915	3,790	5,037	4,670
		Average Speed	427	422	477	480
		Trip Fuel	11,438	16,340	31,785	24,987
		Specific Range/Altitude	0.255/FL 450	0.232/FL 430	0.158/FL 470	0.187/FL 490
	Max Fuel (w/available payload)	Nautical Miles	3,990	4,565	5,893	5,238
		Average Speed	430	421	479	481
		Trip Fuel	14,798	18,909	36,124	27,406
		Specific Range/Altitude	0.270/FL 470	0.241/FL 430	0.163/FL 470	0.191/FL 490
	Four Passengers (w/available fuel)	Nautical Miles	4,065	4,650	6,038	5,408
		Average Speed	430	420	479	481
		Trip Fuel	14,798	18,909	36,186	27,468
		Specific Range/Altitude	0.275/FL 470	0.246/FL 430	0.167/FL 490	0.197/FL 510
	Ferry	Nautical Miles	4,155	4,740	6,095	5,476
		Average Speed	431	419	479	481
		Trip Fuel	14,798	18,909	36,209	27,491
		Specific Range/Altitude	0.281/FL 470	0.251/FL 430	0.168/FL 490	0.199/FL 510
Missions (4 passengers)	**300 nm**	Runway	2,795	2,730	2,540	3,595
		Flight Time	0+47	0+47	0+47	0+45
		Fuel Used	1,525	1,595	2,542	2,405
		Specific Range/Altitude	0.197/FL 470	0.188/FL 470	0.118/FL 430	0.125/FL 470
	600 nm	Runway	2,855	2,865	2,557	3,615
		Flight Time	1+27	1+27	1+25	1+22
		Fuel Used	2,465	2,625	4,008	3,659
		Specific Range/Altitude	0.243/FL 470	0.229/FL 470	0.150/FL 490	0.164/FL 510
	1,000 nm	Runway	2,920	2,880	2,583	3,640
		Flight Time	2+20	2+20	2+14	2+11
		Fuel Used	3,755	4,070	6,033	5,351
		Specific Range/Altitude	0.266/FL 470	0.246/FL 450	0.166/FL 490	0.187/FL 510
Remarks		Certification Basis	FAR/EASA CS 25, 2013 EASy II flight deck; FalconEye available; 2023 delivery price.	FAR 25/EASA 25, 1979/2010 EASy II flight deck; FalconEye available; 2023 delivery price.	FAR 25, 1998/2004/19; EASA 25, 2004 Global Vision flight deck; ModSums: 700T901902; 700T03185; 700T63572. *Marketed as Pearl 15.	FAR 25, 2018; EASA CS 25, 2019

JETS ≥20,000-LB. MTOW

Manufacturer			*Dassault*	Dassault	Airbus	Airbus
Model			***Falcon 6X***	**Falcon 7X**	**ACJTwoTwenty BD500-1A10**	**ACJ320neo A320-271N***
***BCA* Equipped Price**			*$53,800,000*	$54,200,000	$80,000,000*	$117,000,000**
Characteristics		Seating	*3+12/14/19*	3+12/14/19	5+8/19/135**	4+19/NA/195***
		Wing Loading/Power Loading	*99.4/2.87*	92.0/3.64	116.2/2.88	132.1/3.25
		Noise (EPNdB): Lateral/Flyover/Approach	*NA/NA/NA*	90.1/82.3/92.6	87.9/79.6/91.3	86.4/81.7/92.4
External Dimensions (ft.)		Length	*84.3*	76.7	114.8	123.3
		Height	*24.5*	26.2	38.7	38.6
		Span	*85.1*	86.0	115.1	117.4
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	*27.5/40.3/46.0*	26.2/39.1/46.5	51.6/78.1/78.1	91.0/91.0/91.0
		Height/Dropped Aisle Depth	*6.5/flat floor*	6.2/flat floor	6.9/flat floor	7.4/flat floor
		Width: Max/Floor	*8.5/7.2*	7.7/6.3	10.8/10.1	12.1/11.7
Baggage		**Internal:** Cu. ft./lb.	*155/2,645*	140/2,004	150***/NA	NA/NA
		External: Cu. ft./lb.	*—/—*	—/—	177/2,300	650/NA
Power		Engines	*2 P&WC PW812D*	3 P&WC PW307A	2 P&W PW1524G****	2 P&W PW1127G
		Output (lb. each)/Flat Rating	*13,500/ISA+20C*	6,402/ISA+17C	24,400/ISA+15C	26,800/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	*OC/—*	7,200c/—	OC/—	OC/—
Weights (lb.)		Max Ramp	*77,660*	70,200	141,000	175,045
		Max Takeoff	*77,460*	70,000	140,500	174,165
		Max Landing	*66,190*	62,400	112,500	148,592
		Zero Fuel	*45,920c*	41,000c	108,000c	141,757c
		BOW	*40,880*	36,600	87,675***	110,000****
		Max Payload	*5,040*	4,400	20,325	31,757
		Useful Load	*36,780*	33,600	53,325	65,045
		Max Fuel	*33,790*	31,940	50,578	60,812
		Available Payload w/Max Fuel	*2,990*	1,660	2,747	4,233
		Available Fuel w/Max Payload	*31,740*	29,200	33,000	33,288
Limits		MMO	*0.900*	0.900	0.820	0.820
		Trans. Alt. FL/VMO	*NA/NA*	FL 270/370	FL 275/330	FL 250/350
		PSI/Sea-Level Cabin	*10.2/29,200*	10.2/29,200	9.3/NA	9.2/NA
Airport Performance		TOFL (SL elev./ISA temp.)	*5,480*	5,710	5,478	6,333
		TOFL (5,000-ft. elev.@25C)	*7,155*	8,045	8,706	8,189
		Mission Weight	*75,270*	69,140	140,500	174,165
		NBAA IFR Range	*5,535*	5,795	5,686	6,000
		V2	*139*	133	NA	NA
		VREF	*107*	106	110	115
		Landing Distance	*2,460*	2,120	2,300	2,565
Climb		Time to Climb/Altitude	*NA/FL 370*	19/FL 370	23/FL 370	19/FL 350
		FAR 25 Engine-Out Rate (fpm)	*NA*	597	NA	NA
		FAR 25 Engine-Out Gradient (ft./nm)	*NA*	269	NA	NA
Ceilings (ft.)		Certificated	*51,000*	51,000	41,000	41,000
		All-Engine Service	*NA*	40,215	41,000	41,000
		Engine-Out Service	*NA*	25,480	24,000	23,000
Cruise	Long Range	TAS/Fuel Flow (lb./hr.)	*459/2,425*	459/2,260	432/3,507***	447/4,046****
		Altitude/Specific Range	*FL 450/0.189*	FL 430/0.203	FL 410/0.123	FL 410/0.110
	High Speed	TAS/Fuel Flow (lb./hr.)	*505/NA*	497/3,205	465/3,937***	465/4,681****
		Altitude/Specific Range	*NA/NA*	FL 390/0.155	FL 410/0.118	FL 410/0.099
NBAA IFR Ranges (FAR Part 23, 100-nm alternate; FAR Part 25, 200-nm alternate)	Max Payload (w/available fuel)	Nautical Miles	*4,850*	5,000	3,105	2,500
		Average Speed	*452*	453	422	447
		Trip Fuel	*28,574*	26,820	28,150	27,152
		Specific Range/Altitude	*0.170/FL 470*	0.186/FL 450	0.110/FL 390	0.092/FL 370
	Max Fuel (w/available payload)	Nautical Miles	*5,350*	5,670	5,684	6,000
		Average Speed	*457*	454	427	NA
		Trip Fuel	*30,624*	29,560	46,528***	55,832
		Specific Range/Altitude	*0.175/FL 490*	0.192/FL 470	0.122/FL 410	0.107/FL 410
	Four Passengers (w/available fuel)	Nautical Miles	*5,570*	5,760	5,724	6,060
		Average Speed	*459*	454	427	NA
		Trip Fuel	*30,624*	29,560	46,550	55,368
		Specific Range/Altitude	*0.182/FL 490*	0.195/FL 470	0.123/FL 410	0.109/FL 410
	Ferry	Nautical Miles	*5,640*	5,840	5,763	6,100
		Average Speed	*459*	454	427	NA
		Trip Fuel	*30,624*	29,560	46,571	55,394
		Specific Range/Altitude	*0.184/FL 490*	0.198/FL 470	0.124/FL 410	0.110/FL 410
Missions (4 passengers)	300 nm	Runway	*2,885*	2,500	3,201	3,235
		Flight Time	*0+46*	0+46	0+53	0+53
		Fuel Used	*2,385*	2,075	3,264	3,489
		Specific Range/Altitude	*0.126/FL 490*	0.145/FL 450	0.092/FL 390	0.086/FL 370
	600 nm	Runway	*2,900*	2,515	3,268	3,297
		Flight Time	*1+25*	1+25	1+36	1+34
		Fuel Used	*3,705*	3,285	5,330	5,790
		Specific Range/Altitude	*0.162/FL 490*	0.183/FL 470	0.113/FL 410	0.104/FL 410
	1,000 nm	Runway	*2,915*	2,640	3,327	3,402
		Flight Time	*2+18*	2+17	2+34	2+27
		Fuel Used	*5,520*	4,945	8,136	8,780
		Specific Range/Altitude	*0.181/FL 490*	0.202/FL 470	0.123/FL 410	0.114/FL 410
Remarks		Certification Basis	*FAR/EASA CS 25 pending EASy IV flight deck; DFCS; FalconEye; Dual HUD with FalconEye available; 2023 delivery price. Preliminary data.*	FAR/EASA 25, 2007 EASy II flight deck; DFCS; 2023 delivery price.	FAR 25, Q4 2023 **BCA* estimate. **Airliner configuration. ***ACJ estimate. ****Also available with PW1521G rated at 21,000 lbf; includes five additional center tanks and VIP cabin.	FAR 25, 1999/2016 *Also available as -251N with CFM LEAP1A-26 engines rated at 26,600 lbf; includes four additional center tanks and VIP cabin. ***BCA* estimate. ***Airliner configuration. ****ACJ estimate.

ULTRA-LONG-RANGE JETS

Manufacturer			**Bombardier**	**Gulfstream Aerospace**	**Dassault**	**Gulfstream Aerospace**	**Gulfstream Aerospace**
Model			**Global 6500 BD-700-1A10**	**G600 GVII-600**	**Falcon 8X Falcon 7X**	**G650 GVI**	**G650ER GVI**
BCA Equipped Price			$58,000,000	$59,500,000	$63,800,000	$68,500,000	$70,500,000
Characteristics		Seating	4+13/17/19	4+16/19/19	3+12/14/19	4+16/19/19	4+16/19/19
		Wing Loading/Power Loading	97.5/3.29	81.5/3.02	95.9/3.62	77.6/2.95	80.7/3.07
		Noise (EPNdB): Lateral/Flyover/Approach	88.7/82.2/89.4	88.3/78.3/91.3	88.7/80.1/90.6	89.8/77.5/88.3	89.6/78.7/88.3
External Dimensions (ft.)		Length	99.4	96.1	80.2	99.8	99.8
		Height	25.5	25.3	26.1	25.7	25.7
		Span	94.0	94.1	86.3	99.6	99.6
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	27.3/43.3/48.3	32.0/45.2/51.3	29.8/42.7/50.1	32.7/46.8/53.6	32.7/46.8/53.6
		Height/Dropped Aisle Depth	6.2/flat floor	6.2/flat floor	6.2/flat floor	6.3/flat floor	6.3/flat floor
		Width: Max/Floor	7.9/6.5	7.6/6.1	7.7/6.3	8.2/6.7	8.2/6.7
Baggage		**Internal:** Cu. ft./lb.	195/1,000	175/2,500	140/2,004	195/2,500	195/2,500
		External: Cu. ft./lb.	—/—	—/—	—-/—-	—/—	—/—
Power		Engines	2 RR BR700-710D5-21*	2 P&WC PW815GA	3 P&WC PW307D	2 RR BR700-725A1-12	2 RR BR700-725A1-12
		Output (lb. each)/Flat Rating	15,125/ISA+15C	15,680/ISA+15C	6,722/ISA+17C	16,900/ISA+15C	16,900/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	7,200c/—	10,000t/—	10,000t/—
Weights (lb.)		Max Ramp	99,750	95,000	73,200	100,000	104,000
		Max Takeoff	99,500	94,600	73,000	99,600	103,600
		Max Landing	78,600	76,800	62,400	83,500	83,500
		Zero Fuel	58,000c	57,440c	41,000c	60,500c	60,500c
		BOW	52,230	50,900	36,800	54,500	54,500
		Max Payload	5,770	6,540	4,200	6,000	6,000
		Useful Load	47,520	44,100	36,400	45,500	49,500
		Max Fuel	44,715	41,500	35,141	44,200	48,200
		Available Payload w/Max Fuel	2,805	2,600	1,259	1,300	1,300
		Available Fuel w/Max Payload	41,750	37,560	32,200	39,500	43,500
Limits		MMO	0.900	0.925	0.900	0.925	0.925
		Trans. Alt. FL/VMO	FL 308/340	FL 290/340	FL 270/370	FL 290/340	FL 290/340
		PSI/Sea-Level Cabin	10.3/30,125	10.7/31,900	10.2/30,300	10.7/31,900	10.7/31,900
Airport Performance		TOFL (SL elev./ISA temp.)	6,145	5,700	5,880	5,858	6,299
		TOFL (5,000-ft. elev.@25C)	8,509	8,493	8,540	8,771	11,131
		Mission Weight	99,500	94,600	72,591	99,600	103,600
		NBAA IFR Range	6,990	6,630	6,415	6,890	7,437
		V2	138	142	138	146	148
		VREF	109	109	107	115	115
		Landing Distance	2,231	2,365	2,245	2,445	2,445
Climb		Time to Climb/Altitude	21/FL 370	18/FL 370	20/FL 370	19/FL 370	21/FL 370
		FAR 25 Engine-Out Rate (fpm)	NA	403	774	503	435
		FAR 25 Engine-Out Gradient (ft./nm)	NA	170	339	207	176
Ceiling (ft.)		Certificated	51,000	51,000	51,000	51,000	51,000
		All-Engine Service	41,000	41,900	40,075	41,300	40,600
		Engine-Out Service	22,000	24,200	26,645	24,900	23,700
Cruise	**Long Range**	TAS	488	488	459	488	488
		Fuel Flow	2,986	2,809	2,254	2,865	2,930
		Altitude	FL 430	FL 450	FL 430	FL 450	FL 450
		Specific Range	0.163	0.174	0.204	0.170	0.167
	High Speed	TAS	505	516	497	516	516
		Fuel Flow	3,094	3,590	3,172	3,679	3,730
		Altitude	FL 410	FL 410	FL 390	FL 410	FL 410
		Specific Range	0.163	0.144	0.157	0.140	0.138
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	5,954	5,665	5,555	5,912	6,459
		Average Speed	478	481	452	481	481
		Trip Fuel	38,783	34,478	29,507	36,285	40,285
		Specific Range/Altitude	0.154/FL 470	0.164/FL 470	0.188/FL 470	0.163/FL 490	0.160/FL 490
	Max Fuel (w/available payload)	Nautical Miles	6,547	6,544	6,325	6,959	7,507
		Average Speed	479	482	453	482	482
		Trip Fuel	41,835	38,518	32,558	41,129	45,129
		Specific Range/Altitude	0.156/FL 470	0.170/FL 490	0.194/FL 470	0.169/FL 510	0.166/FL 510
	Eight Passengers (w/available fuel)	Nautical Miles	6,636	6,630	6,235	6,890	7,437
		Average Speed	480	481	453	482	482
		Trip Fuel	41,870	38,543	32,204	40,820	44,820
		Specific Range/Altitude	0.158/FL 470	0.172/FL 490	0.194/FL 470	0.169/FL 510	0.166/FL 510
	Ferry	Nautical Miles	6,754	6,767	6,475	7,083	7,636
		Average Speed	480	483	454	482	482
		Trip Fuel	41,916	38,584	32,653	41,168	45,168
		Specific Range/Altitude	0.161/FL 490	0.175/FL 490	0.198/FL 470	0.172/FL 510	0.169/FL 510
Missions (8 passengers)	**1,000 nm**	Runway	2,718	3,655	2,715	3,300	3,300
		Flight Time	2+14	2+10	2+12	2+10	2+10
		Fuel Used	6,219	5,872	5,440	5,942	5,942
		Specific Range/Altitude	0.161/FL 490	0.170/FL 510	0.184/FL 450	0.168/FL 510	0.168/FL 510
	3,000 nm	Runway	3,487	3,870	3,730	3,590	3,590
		Flight Time	6+21	6+17	6+19	6+17	6+17
		Fuel Used	17,490	16,102	15,945	16,280	16,280
		Specific Range/Altitude	0.172/FL 490	0.186/FL 490	0.188/FL 450	0.184/FL 510	0.184/FL 510
	6,000 nm	Runway	5,482	5,115	5,785	5,240	5,240
		Flight Time	12+32	12+26	12+45	12+28	12+28
		Fuel Used	37,302	34,243	32,200	34,622	34,622
		Specific Range/Altitude	0.161/FL 490	0.175/FL 490	0.186/FL 470	0.173/FL 510	0.173/FL 510
Remarks		Certification Basis	FAR 25, 1998/2003/19; EASA CS 25, 1998/2019 BEVS and Global Vision flight deck standard; ModSums: 700T901901; 700T03185; 700T63572. *Marketed as Pearl 15.	FAR 25, 2019; EASA CS 25, 2020	FAR/EASA 25, 2016 EASy IV flight deck; DFCS; FalconEye; dual HUD with FalconEye available. 2023 delivery price.	FAR, EASA CS 25, 2012	FAR 25, 2014; EASA CS 25, 2018; ASC 014

ULTRA-LONG-RANGE JETS

Manufacturer			*Gulfstream Aerospace*	Bombardier	*Gulfstream Aerospace*	*Bombardier*
Model			***G800*** ***GVIII-G800***	**Global 7500** **BD-700-2A12**	***G700*** ***GVIII-G700***	***Global 8000*** ***BD-700-2A12***
BCA Equipped Price			*$72,500,000*	$78,000,000	*$79,900,000*	*$81,000,000*
Character-istics		Seating	*4+16/19/19*	4+17/19/19	*4+16/19/19*	*4+17/19/19*
		Wing Loading/Power Loading	*82.2/2.89*	91.6/3.04	*83.8/2.95*	*91.6/3.04*
		Noise (EPNdB): Lateral/Flyover/Approach	*NA/NA/NA*	91.6/80.3/88.8	*NA/NA/NA*	*91.6/80.3/88.8*
External Dimensions (ft.)		Length	*99.8*	111.0	*109.9*	*111.0*
		Height	*25.5*	27.0	*25.4*	*27.0*
		Span	*103.0*	104.0	*103.0*	*104.0*
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	*32.7/46.8/53.6*	36.0/54.4/60.6	*40.8/56.9/63.7*	*36.0/54.4/60.6*
		Height/Dropped Aisle Depth	*6.3/flat floor*	6.2/flat floor	*6.3/flat floor*	*6.2/flat floor*
		Width: Max/Floor	*8.2/6.7*	8.0/6.8	*8.2/6.7*	*8.0/6.8*
Baggage		**Internal:** Cu. ft./lb.	*195/2,500*	195/2,500	*195/2,500*	*195/2,500*
		External: Cu. ft./lb.	*—/—*	—/—	*—/—*	*—/—*
Power		Engines	*2 RR* *BR700-730B2-14**	2 GE Passport 20-19BB1A	*2 RR* *BR700-730B2-14**	*2 GE* *Passport 20-19BB1A*
		Output (lb. each)/Flat Rating	*18,250/NA*	18,920/ISA+15C	*18,250/NA*	*18,920/ISA+15C*
		Inspection Interval/Manu. Service Plan Interval	*NA/—*	OC/—	*NA/—*	*OC/—*
Weights (lb.)		Max Ramp	*106,000*	115,100	*108,000*	*115,100*
		Max Takeoff	*105,600*	114,850	*107,600*	*114,850*
		Max Landing	*83,500*	87,600	*83,500*	*87,600*
		Zero Fuel	*60,500c*	67,500c	*62,750c*	*67,500c*
		BOW	*54,300*	61,700	*56,365*	*60,900*
		Max Payload	*6,200*	5,800	*6,385*	*6,600*
		Useful Load	*51,700*	53,400	*51,635*	*54,200*
		Max Fuel	*49,400*	51,510	*49,400*	*51,925*
		Available Payload w/Max Fuel	*2,300*	1,890	*2,235*	*2,275*
		Available Fuel w/Max Payload	*45,500*	47,600	*45,250*	*47,600*
Limits		MMO	*0.925*	0.925	*0.925*	*0.940*
		Trans. Alt. FL/VMO	*FL 290/340*	FL 350/320	*FL 290/340*	*FL 350/320*
		PSI/Sea-Level Cabin	*10.7/31,900*	10.3/30,125	*10.7/31,900*	*10.7/31,900*
Airport Performance		TOFL (SL elev./ISA temp.)	*6,000*	5,760	*6,250*	*5,760*
		TOFL (5,000-ft. elev.@25C)	*9,872*	8,679	*9,977*	*8,679*
		Mission Weight	*105,600*	114,850	*107,600*	*114,850*
		NBAA IFR Range	*8,025*	7,800	*7,510*	*7,800*
		V2	*NA*	137	*NA*	*137*
		VREF	*115*	108	*1,178*	*108*
		Landing Distance	*2,500*	2,240	*2,570*	*2,216*
Climb		Time to Climb/Altitude	*17/FL 370*	20/FL 370	*20/FL 370*	*20/FL 370*
		FAR 25 Engine-Out Rate (fpm)	*NA*	NA	*NA*	*NA*
		FAR 25 Engine-Out Gradient (ft./nm)	*NA*	NA	*NA*	*NA*
Ceiling (ft.)		Certificated	*51,000*	51,000	*51,000*	*51,000*
		All-Engine Service	*NA*	43,000	*NA*	*43,000*
		Engine-Out Service	*NA*	26,600	*NA*	*26,600*
Cruise	**Long Range**	TAS	*488*	488	*488*	*488*
		Fuel Flow	*2,800*	2,983	*2,992*	*2,924*
		Altitude	*FL 450*	FL 450	*FL 450*	*FL 450*
		Specific Range	*0.174*	0.164	*0.163*	*0.167*
	High Speed	TAS	*516*	516	*516*	*516**
		Fuel Flow	*3,438*	3,207	*3,698*	*3,099*
		Altitude	*FL 430*	FL 450	*FL 450*	*FL 450*
		Specific Range	*0.150*	0.161	*0.140*	*0.167*
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	*7,050*	6,930	*6,560*	*7,031*
		Average Speed	*482*	482	*482*	*481*
		Trip Fuel	*42,522*	44,501	*42,030*	*44,510*
		Specific Range/Altitude	*0.166/FL 490*	0.156/FL 510	*0.156/FL 490*	*0.158/FL 510*
	Max Fuel (w/available payload)	Nautical Miles	*7,952*	7,700	*7,450*	*7,949*
		Average Speed	*483*	482	*483*	*482*
		Trip Fuel	*46,526*	48,512	*46,301*	*48,921*
		Specific Range/Altitude	*0.171/FL 510*	0.159/FL 510	*0.161/FL 510*	*0.162/FL 510*
	Eight Passengers (w/available fuel)	Nautical Miles	*8,025*	7,770	*7,510*	*8,006*
		Average Speed	*483*	483	*483*	*482*
		Trip Fuel	*46,544*	48,526	*46,319*	*48,940*
		Specific Range/Altitude	*0.172/FL 510*	0.160/FL 510	*0.162/FL 510*	*0.164/FL 510*
	Ferry	Nautical Miles	*8,190*	7,903	*7,660*	*8,143*
		Average Speed	*483*	483	*483*	*482*
		Trip Fuel	*46,587*	48,570	*46,364*	*48,986*
		Specific Range/Altitude	*0.176/FL 510*	0.163/FL 510	*0.165/FL 510*	*0.166/FL 510*
Missions (8 passengers)	**1,000 nm**	Runway	*3,500*	3,375	*3,100*	*3,364*
		Flight Time	*2+10*	2+11	*2+10*	*2+11*
		Fuel Used	*5,621*	6,191	*5,993*	*6,089*
		Specific Range/Altitude	*0.178/FL 510*	0.162/FL 510	*0.167/FL 510*	*0.164/FL 510*
	3,000 nm	Runway	*3,660*	3,510	*3,400*	*3,495*
		Flight Time	*6+17*	6+18	*6+17*	*6+18*
		Fuel Used	*15,396*	17,002	*16,564*	*16,713*
		Specific Range/Altitude	*0.195/FL 510*	0.176/FL 510	*0.181/FL 510*	*0.180/FL 510*
	6,000 nm	Runway	*4,490*	4,573	*4,940*	*4,430*
		Flight Time	*12+27*	12+28	*12+27*	*12+28*
		Fuel Used	*32,758*	35,795	*35,372*	*34,886*
		Specific Range/Altitude	*0.183/FL 510*	0.168/FL 510	*0.170/FL 510*	*0.172/FL 510*
Remarks		Certification Basis	*FAR 25 pending;* *EASA CS 25 pending* **Marketed as Pearl 700.*	FAR 25, 2018; EASA CS 25, 2019	*FAR 25 pending;* *EASA CS 25 pending* **Marketed as Pearl 700*	*FAR 25, 2018;* *EASA CS 25, 2019* **Mach 0.920 alternate high-speed cruise but reduced range.* *All data preliminary.*

ULTRA-LONG-RANGE JETS

Manufacturer			Boeing	Airbus	Boeing	Boeing
Model			**BBJ MAX7** **737-7**	**ACJ319neo** **A319-153N***	**BBJ MAX8** **737-8**	**BBJ MAX9** **737-9**
BCA Equipped Price			$101,500,000	$107,500,000**	$110,500,000	$188,500,000
Characteristics		Seating	4+19/NA/172	4+19/NA/165	4+19/NA/189	4+19/75/220
		Wing Loading/Power Loading	132.0/3.35	130.8/3.22	135.1/3.25	145.2/3.49
		Noise (EPNdB): Lateral/Flyover/Approach	NA/NA/NA	86.1/80.7/91.8	88.5/82.6/94.2	NA/NA/NA
External Dimensions (ft.)		Length	116.7	111.0	129.7	138.2
		Height	40.3	38.6	40.3	40.3
		Span	117.8	117.4	117.8	117.8
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	85.7/85.7/85.7	79.0/79.0/79.0	98.5/98.5/98.5	107.2/107.2/107.2
		Height/Dropped Aisle Depth	7.1/flat floor	7.4/flat floor	7.1/flat floor	7.1/flat floor
		Width: Max/Floor	11.6/10.7	12.1/11.7	11.6/10.7	11.6/10.7
Baggage		**Internal:** Cu. ft./lb.	NA/NA	NA/NA	NA/NA	NA/NA
		External: Cu. ft./lb.	274/NA	128/NA	593/NA	775/NA
Power		Engines	2 CFMI LEAP-1B27	2 P&W PW1127G	2 CFMI LEAP-1B28	2 CFMI LEAP-1B28
		Output (lb. each)/Flat Rating	26,400/ISA+15C	26,800/ISA+15C	27,900/ISA+15C	27,900/ISA+15C
		Inspection Interval/Manu. Service Plan Interval	OC/—	OC/—	OC/—	OC/—
Weights (lb.)		Max Ramp	177,500	173,283	181,700	195,200
		Max Takeoff	177,000	172,401	181,200	194,700
		Max Landing	145,600	140,875	152,800	163,900
		Zero Fuel	138,700c	116,845c	145,400c	156,500c
		BOW	101,550	104,000**	105,200	111,750
		Max Payload	37,150	12,845	40,200	44,750
		Useful Load	75,950	69,283	76,500	83,450
		Max Fuel	67,690	66,209	69,553	73,097
		Available Payload w/Max Fuel	8,260	3,074	6,947	10,353
		Available Fuel w/Max Payload	38,800	56,438	36,300	38,700
Limits		MMO	0.820	0.820	0.820	0.820
		Trans. Alt. FL/VMO	FL 260/340	FL 250/350	FL 260/340	FL 260/340
		PSI/Sea-Level Cabin	9.0/24,000	9.2/NA	9.0/24,000	9.0/24,000
Airport Performance		TOFL (SL elev./ISA temp.)	6,820	6,217	6,600	8,380
		TOFL (5,000-ft. elev.@25C)	NA	8,189	NA	NA
		Mission Weight	NA	172,401	NA	NA
		NBAA IFR Range	6,810	6,750	6,680	6,355
		V2	NA	NA	NA	NA
		VREF	118	119	120	122
		Landing Distance	2,360	2,740	2,335	2,520
Climb		Time to Climb/Altitude	23/FL 360	19/FL 350	25/FL 360	25/FL 340
		FAR 25 Engine-Out Rate (fpm)	NA	NA	NA	NA
		FAR 25 Engine-Out Gradient (ft./nm)	NA	NA	NA	NA
Ceiling (ft.)		Certificated	41,000	41,000	41,000	41,000
		All-Engine Service	41,000	41,000	41,000	41,000
		Engine-Out Service	NA	24,000	NA	NA
Cruise	**Long Range**	TAS	456	447	456	456
		Fuel Flow	NA	4,004**	NA	NA
		Altitude	FL 410	FL 410	FL 410	FL 410
		Specific Range	NA	0.112	NA	NA
	High Speed	TAS	471	465	471	471
		Fuel Flow	NA	4,637**	NA	NA
		Altitude	FL 410	FL 410	FL 410	FL 410
		Specific Range	NA	0.100	NA	NA
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	3,060	5,250	2,655	2,615
		Average Speed	439	447	439	439
		Trip Fuel	33,177	51,295	30,419	32,397
		Specific Range/Altitude	0.092/FL 370	0.102/FL 410	0.087/FL 370	0.081/FL 350
	Max Fuel (w/available payload)	Nautical Miles	6,525	6,750	6,465	6,255
		Average Speed	448	442	450	450
		Trip Fuel	63,026	61,436	64,874	68,030
		Specific Range/Altitude	0.104/FL 410	0.110/FL 410	0.100/FL 410	0.092/FL 410
	Eight Passengers (w/available fuel)	Nautical Miles	6,810	6,750	6,680	6,600
		Average Speed	448	442	450	450
		Trip Fuel	63,214	61,436	64,981	68,195
		Specific Range/Altitude	0.108/FL 410	0.110/FL 410	0.103/FL 410	0.097/FL 410
	Ferry	Nautical Miles	6,885	6,870	6,755	6,660
		Average Speed	448	NA	450	450
		Trip Fuel	63,250	60,994	65,022	68,212
		Specific Range/Altitude	0.109/FL 410	0.113/FL 410	0.104/FL 410	0.098/FL 410
Missions (8 passengers)	**1,000 nm**	Runway	3,640	3,543	3,345	3,630
		Flight Time	2+26	2+26	2+25	2+25
		Fuel Used	8,909	8,591	9,255	9,793
		Specific Range/Altitude	0.112/FL 410	0.116/FL 410	0.108/FL 410	0.102/FL 410
	3,000 nm	Runway	3,940	4,114	4,055	4,505
		Flight Time	6+51	6+54	6+49	6+48
		Fuel Used	25,596	25,148	26,782	28,430
		Specific Range/Altitude	0.117/FL 410	0.119/FL 410	0.112/FL 410	0.106/FL 410
	6,000 nm	Runway	5,480	5,308	5,720	6,545
		Flight Time	13+26	13+38	13+23	13+23
		Fuel Used	54,502	53,086	57,265	61,004
		Specific Range/Altitude	0.110/FL 410	0.113/FL 410	0.105/FL 410	0.098/FL 410
Remarks		Certification Basis	FAR 25, 2023 A137, A141 VIP cabin; includes seven auxiliary fuel tanks.	FAR 25 1999/2018 *Also available as -271N with CFM LEAP1A-26 engines with 26,600 lbf; includes five additional center tanks plus VIP cabin. ***BCA* estimate.	FAR 25, 2017 A137, A141 VIP cabin; includes seven auxiliary fuel tanks.	FAR 25, 2018 A137, A141 VIP cabin; includes eight auxiliary fuel tanks.

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France Puts Environmental Pressure on Business Aviation

As climate concerns grow, at the heart of the controversy is whether business aviation is about actual business or leisure

BY **THIERRY DUBOIS**

French society has long been particularly sensitive to ensuring a fair distribution of wealth. Regardless of the government's composition, taxes remain higher in the country than in many others. More recently, French citizens have shown a growing concern for the impact of global warming. Combine those two touchy themes, and business aviation finds itself among the accused.

Since national-level measures can be the starting point for Europe-wide regulations, the business aviation industry should watch the ongoing debates and lawmaking process in France closely. Additional taxes and use restrictions in the country might be the harbinger of a more stringent framework and disincentives for business aviation throughout the entire European Union (EU).

The paradox, of course, is that France is home of two of the most important business aircraft manufacturers. Daher is mostly known for its TBM turboprop singles. Dassault Aviation has long been a strong player, with its Falcon business jets at the high end of the market.

Among the very first business jets were French designs. The four-seat Morane-Saulnier MS.760 Paris—part of Daher's legacy—flew in 1954. The Dassault Falcon 20 (nee Mystere 20) flew in 1963.

Dassault uses France's image for luxury products, as well as the identity of a recognized nation in aircraft engineering, to promote its upscale Falcons. It is therefore probably with at least some disbelief that CEO Eric Trappier has been watching recent developments.

Over the last 12 months, two business airports—Le Bourget and Chambery—have been the targets of sit-in demonstrations by Extinction Rebellion's activists. At Lyon-Bron airport, they symbolically attacked business aircraft that were part of a general aviation trade show.

The center-right government disapproves of such actions but has been taking unprecedented measures to curb what is being increasingly perceived by some as unjustified use of a CO_2-intensive mode of transportation.

At the NBAA business aviation show in October 2022, Trappier said recent moves to regulate business aviation in France were politically motivated and did nothing to address overall issues of environmental sustainability.

Part of the "flight-shaming" issue in France is tied to the use of the term "private jet" with corporate aircraft, rather than "business jet," he said. "There is a kind of turmoil in France in particular where they are called private jets—they are not called business jets. A business jet supports economic development and supports companies to extend their capabilities to commerce and industry. It makes a difference."

The different wordings reflect the lack of a consistent definition. In his proposed bill banning business jets, opposition Green Party Deputy Julien Bayou suggests the category should be defined as including on-demand flights for 60 passengers or less. Time constraints prevented the bill—which had little chance of passing–from being officially presented in April at the National Assembly. But it prompted further discussion and French Transport Minister Clement Beaune announced an unspecified additional contribution for business aviation.

Last summer, Beaune sparked a debate inside the government. He had called for restrictions on the use of private jets. Quoted by French newspaper *Le Parisien*, he said: "There can't be a means of individual travel for comfort at a time when the president's campaign [to reduce carbon footprints] requires everyone to make an effort." Not everyone in the government is seeing business aviation as negatively as Beaune, but the budget for 2023 nevertheless includes a new fiscal measure targeting the sector.

Fuel Tax Implications

The fuel tax known as TICPE (a French acronym for domestic tax on the consumption of energy products) was doubled for non-commercial flights.

The TICPE for non-commercial flights now stands at an amount identical to that for individual cars. "Business aviation is a tool for business development, the issue is rather to regulate some usages," a representative at the Transport Ministry says. "At the national level, the government is working on other measures so that business aviation contributes to the ecological and energy transition in a fairer and more proportionate way."

It has yet to be seen whether France will try to extend the reach of the tax increase. In the meantime, it impacts only a small proportion of business aviation activity.

While the French government describes business aviation as a tool for business development, it intends to regulate usage.

A. PECCHI/DASSAULT AVIATION

"That is just a spectacular measure without a strong basis," says Charles Aguettant, vice president of the European Business Aviation Association's French chapter, EBAA France.

Most business flights take place under an air operator's certificate (AOC), or as part of an association for developing commercial interests (GIE, which usually regroups small companies), he explains. Together, AOC and GIE flights account for 90% of the activity in business aviation, according to Aguettant. That means that the rest, for which the tax has been doubled, account for just 10%.

"With its minimal impact, the measure can be called greenwashing," says Aguettant. "How better is it than banning motorcycles on weekends?"

A regulation should not make a difference between two kinds of users, transport-focused environmental NGO Transport & Environment (T&E) points out. Users of directly owned aircraft are not on an equal footing with those those flying on an aircraft operated by a third-party but actually owned via a tax-optimization scheme, Matteo Mirolo, T&E' s sustainable aviation policy manager, emphasizes. "The distinction does not make sense from an environmental viewpoint," he says.

Extending the tax increase to commercially operated flights would be tricky because of international agreements on fuel taxation. It would not be impossible, however, both inside the EU or within bilateral aviation agreements.

At the European Union political level, the French stance is being closely followed. "It is difficult to understand where the French government stands," says a spokesman at EBAA's headquarters in Brussels. "At EU transport ministers meetings, which happen twice a year, France is one of the strongest proponents of additional incremental measures. What is not clear is whether they want to go toward more subsidies to incentivize green solutions, or bans and regulations."

What is clear is that the focus on sustainability is very important to French society and politicians, he adds.

In commercial aviation, French law now prohibits regular domestic flights on routes where a rail alternative of under 2.5 hr. is available. According to figures from T&E, the three routes affected by the French flight ban (Paris-Orly to Bordeaux, Nantes and Lyon) represent just 0.3% of emissions from flights departing from mainland France, or 3% of domestic emissions.

Sword of Damocles

"The French short-flight ban is a good and symbolic start—as it shows that we must cut aviation emissions by reducing demand—but it will have little impact on reducing emissions," a T&E representative says.

While the 2.5-hr. rule does not affect business aviation, the sheer existence of the regulation is a Sword of Damocles. Extending it to other types of aviation operations would be relatively straightforward. That threat is all the more serious, as half of all business flights in France in 2019 were shorter than 500 km (270 nm), analysis by T&E shows.

At the heart of the controversy is whether business aviation is about actual business or leisure. "About 80% of our activity is for business purposes," Aguettant says. "In the remaining 20%, you can find state flights and organ transfer, which means leisure flights account for a tiny portion."

But so-called business aviation is really a leisure-driven sector, Brussels-based T&E contends, citing air traffic statistics from Eurocontrol. In Europe, private jet departures are up by 50% in July compared to January, T&E asserts. The

NGO surveyed 10 "holiday airports" in Europe, such as Nice Cote d'Azur and Cannes Mandelieu, and found they represent one-third of all business aircraft flights in July.

"Let's debunk the myth of the businessperson making an essential trip for a meeting in a remote town and saving jobs in a factory," says Mirolo. "In fact, only 35% of those flights take place for business reasons."

In France, business aviation accounts for 10% of flight movements. T&E's study highlighted France as one of the most active countries in Europe for business aviation, along with the UK.

T&E supports the French government's approach. "In sustainable aviation fuels (SAF), for instance, French mandates have given an impulse to the in-discussion European ReFuelEU regulation," says Mirolo. "Acting fast at a European level is an oxymoron. Those governments feeling like being on the frontline must devise national measures. Their application could then be widened."

Typically, if additional taxes apply to business aviation in France, they could eventually spread across the EU. Taxes may be useful to reduce the cost gap between fossil fuels and SAF, as well as funding research and technology, Mirolo stresses.

He has some advice for business aircraft manufacturers, such as Dassault and Daher. "We tell the business aviation industry, make yourself useful and be part of a solution," he says. "That falls under the concept of a society where everyone plays its part."

"We are not against aircraft but rather against the energy they use," he goes on. "From 2030, business aircraft using fossil fuels should be banned on routes under 1,000 km. That would be a strong political signal."

Pressure for greater use of SAF could come from business aviation users. They could be the starting point for requiring 100% SAF to be used in engines, up from the current limit of 50%, Mirolo suggests.

Moreover, business aircraft may benefit from breakthrough technologies first. Thanks to their relatively light weight and more modest needs in terms of range, they could more easily use electric and hydrogen power. "When you know the current limits of electric and hydrogen power, business aircraft appear perfectly suited for those technologies to start with," Mirolo says. "A 500-800 km range would be fine for most business aircraft flights."

That is at least a point of agreement between T&E and EBAA France. Business aircraft have the right size to test new technologies, Aguettant agrees.

Daher, in partnership with Airbus, and Safran under the EcoPulse demonstration program, has started flying a modified TBM 900 single-engine turboprop aimed at testing a hybrid-electric, distributed-propulsion system. **BCA**

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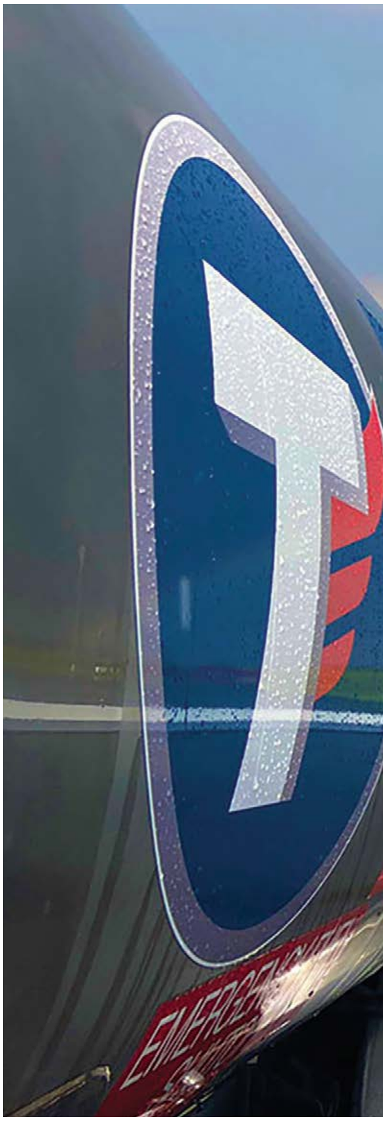
“Making Aviation Better!”

SAF In Europe: Progressing, but Slowly

New refineries and increasing deliveries hold promise, but obstacles to book-and-claim are slowing uptake

BY **ANGUS BATEY**



Supply of SAF is so constrained that fuel distributor Titan has opted to offer customers an offset program, which is investing in wind-power generation in South Dakota.

Everyone involved even tangentially with aerospace knows the figures by heart. Commercial aviation produces just more than 2% of all human-made CO2 emissions—although analysis covering non-CO2 emissions, such as nitrous oxide that causes global warming, puts the figure at nearer to 4%. Moreover, this proportion will rise as other industrial sectors able to decarbonize faster make more rapid progress in the short term—not to mention that the industry has made a global commitment to reach net-zero operations by 2050. As research and development funding is poured into a future generation of zero-emissions aircraft, significant steps are being taken to reduce the carbon footprint of current fleets by developing and adopting sustainable aviation fuels (SAF).

> "There are a lot of business aviation customers would like to fly with SAF, but price-wise, and [in terms of] the reliability of supply, **it's still just not there.**"

In the SAF narrative, many headline figures will be familiar to aerospace insiders. A like-for-like, drop-in replacement for standard Jet A1, SAF is presently certified to fly at blends of up to 50:50 with standard fossil-based fuel. Demonstrations by airframers, engine manufacturers, fuel refiners and airlines have shown that today's aircraft engines can be flown safely on 100% SAF. Additional projects and programs are planned to help build the knowledge base and gain regulator confidence before SAF-only flights move from the experimental and developmental to the operational and the everyday.

The industry is relying on SAF as the crucial bridge that will allow it to reach that net-zero goal by 2050. But many challenges remain. This part of the story, too, is told in published figures, but these may not be quite so familiar.

According to estimates published in December by the International Air Transport Association (IATA), production of SAF in 2022 was at least 200% higher than in 2021. If the more optimistic estimates turn out to be accurate, that figure could have been as high as 350%. This is clearly great news, since the same IATA news release noted that airlines believe that SAF will account for 65% of the life-cycle emissions reductions needed to achieve their 2050 goals.

As impressive as these production increases are, the actual figures present a more sobering picture. In 2021, IATA says 100 million liters (26.4 million gal.) of SAF were produced globally. The association's provisional figures suggest that may have increased to as much as 450 million liters in 2022. But if airlines are to receive enough SAF to reach their 2050 targets, the global annual production capability will need to reach 450 billion liters, meaning that production will need to increase 100-fold in a little over 25 years.

To enable that huge ramp-up in production, fuel providers will need to build new plants—and that will only happen if they have certainty that aircraft operators will buy SAF. Low production volumes and the cost of developing and proving new production technology has so far meant that SAF is still significantly more expensive than fossil fuel-based products.

Given this cost differential and supply limitations, many insiders had expected SAF uptake to be stronger among business aviation operators than commercial airlines. But last July, Farnborough Airport, the UK's busiest business aviation airport, subsidized the cost of SAF for a short period ahead of the Farnborough Airshow, and sold out of its supply of the fuel—proving, in airport CEO Simon Geere's view, that the

TITAN AVIATION FUELS

price differential is still a barrier to wider adoption among the airport's bizav clientele.

"Europe is still lagging behind compared to the U.S.," when it comes to SAF adoption, says Daniel Coetzer, CEO of Titan Europe, distributor for Titan Aviation Fuels' European operation. "They have a better structure in place; they can develop it better and quicker. In Europe, SAF is still very difficult to find; supply is still very unreliable at business aviation airports, unless you want to buy a big stock and keep it—but even then, you're lucky to find it."

Coetzer was hired to run Titan's European division in 2022, and quickly found that the prevailing narrative in business aviation around SAF was not being reflected by the reality he was seeing at airports. Rather than the continent's limited SAF supplies finding their way into business jet operations, the vast majority of production was being snapped up by low-cost airlines. Though these carriers would be far more vulnerable to price-sensitive customers choosing an alternative airline to save a few Euros on the cost of their trip, low-cost carriers are in a much better position to cut an attractive deal with the fuel refiners: far better for a SAF producer to be able to sell a plant's entire output with certainty to one airline in a single transaction than to have to work hard over a long period to find multiple customers at different bizav airfields who might take small, irregular shipments of SAF as and when their customers require it.

"What most of the suppliers are doing is that they limit the stock that's available to try to sell it in bulk to one operator," Coetzer says. And while there has been more SAF coming onto the marketplace, to whom and where it is being sold has not changed. "There are a lot of business aviation customers would like to fly with SAF," he adds, "but price-wise, and [in terms of] the reliability of supply, it's still just not there."

Book-and-Claim

The business aviation sector has identified an accounting practice called "book-and-claim" as a means of resolving short-term distribution issues while enabling customers to gain the benefits of SAF adoption. At the same time, the theory goes, book-and-claim can help prove to producers that


AIRBP

In March, AirBP made its first sale of SAF co-produced alongside fossil feedstocks at its Castellon refinery in Spain. The fuel was bought by Chilean airline LATAM Cargo and was used on a flight from Zaragoza, Spain, to North America.

demand for SAF exists, making investment in greater production capacity more attractive and feasible.

Book-and-claim allows a customer wishing to use SAF to pay the additional charges at the point where their aircraft takes on fuel and claim the appropriate amount of carbon credits from the flight, even if SAF is not available at the departure location. Somewhere else in the network, where SAF is available, the corresponding amount is pumped into an aircraft whose operator has not paid or asked for SAF. The overall amount of life-cycle emissions of the entire system is reduced, and the entity paying for the fuel receives the offset benefit.

In the U.S., book-and-claim appears to be working well, especially given that, to date, SAF availability is higher in certain regions—notably California—than in others. In Europe, however, book-and-claim is proving more problematic to implement.

The U.S. is a single federal entity, whereas the European Union is a patchwork of different nations, with different tax regimes and often differing local rules governing carbon credits. Additionally, the EU's Emissions Trading Scheme (ETS) does not recognize any published standard as ensuring sufficient transparency about claimed emissions reductions from different fuel sources, so carbon credits earned from a book-and-claim transaction cannot be used by entities to meet their obligations under the ETS.

In written answers to questions from BCA, Andreea Moyes, global aviation sustainability director at AirBP, said that the company is "set up for book-and-claim sales in France, Germany, Spain, Switzerland, UK and the U.S.," but did not provide any further details. A senior staffer at one international FBO chain has previously told BCA that, while book-and-claim is in place in the U.S., implementing a similar solution for Europe is a work in progress, and that any such solution would "not just [be] a cut-and-paste of what we have in the U.S. market."

In July 2022, the European Parliament voted to amend the text of its ReFuelEU Aviation initiative, which, when implemented, will include some language allowing for the use of book-and-claim procedures, particularly at "minor or logistically constrained airports." These appear to be time-limited to 10 years from the adoption. After that period, "all Union airports covered by this regulation should be supplied with uniform minimum shares of sustainable aviation fuels," the proposed regulation says. This puts a tighter time frame on fuel providers as to when they will have to be able to supply SAF to every airport in the EU.

"Given the current supply points and levels of demand, delivering SAF to some locations is relatively expensive, and long supply chains also create avoidable carbon emissions," AirBP's Moyes says. "The purchase of SAF through a book-and-claim solution is an alternative, which is particularly relevant to the general aviation market where volumes are smaller and are purchased over a wide number of locations."

In the longer term, the company is working to increase its SAF production capacity through measures such as co-producing SAF at traditional sites alongside fossil-derived fuels. Moyes notes that its Castellon refinery in Spain made its first sale of co-produced SAF in March, while in 2022 the company's plant at Lingen, Germany, co-produced SAF from waste and residues. Five biofuel projects the company is working on are expected to help the company raise its biofuels production to 100,000 bbl. (about 160 million liters) per day by 2030. **BCA**

Ready for Takeoff?

Industry, government and regulators are raising their game as Paris prepares to operate a commercial eVTOL service during next year's Summer Olympic Games

Volocopter's 2X demonstrator—being flown by a remote pilot—touches down outside the testbed vertiport at the Pontoise AAM Sandbox in September 2022.

ANGUS BATEY/AVIATION WEEK PHOTOS

BY **ANGUS BATEY**

Ambition is being tempered with pragmatism as a consortium of businesses, national and regional state agencies, and regulatory authorities progress toward their goal of operating a commercial eVTOL (electric vertical-takeoff-and-landing) air taxi service in Paris during the 2024 Summer Olympics. The effort is attracting headlines and driving public awareness of the emerging AAM (advanced air mobility) sector in Europe, but its partners are aware that successful implementation of the project will just be the first step on a much longer journey to see the promise of AAM transition from an enticing concept to a socially beneficial reality. It might be an exaggeration to suggest that this new industry's hopes depend on a successful Paris debut, but perhaps not a huge one.

The broad brushstrokes of the Paris plan are now clear. A network of five operating locations will host Volocopter's VoloCity multi-rotor eVTOL aircraft, which will be flown by a pilot on board and, for the purposes of the Olympics campaign, will be able to carry one passenger. The nodes of the network will connect existing airports and heliports on the outskirts of the city with a new, bespoke vertiport in the center. The project partners hope to operate up to 10 VoloCity aircraft during the games, with each aircraft capable of performing two or three flights per hour.

Compared to the scope that companies in the sector hope will be the eventual shape of commercial AAM operations, the program is modest, but the work required to deliver even this limited service is extensive. The challenges facing the project's participants include:

- Airspace regulations and air traffic control issues
- Power requirements and charging equipment availability
- The footprint of vertiports and land availability
- Noise concerns and public acceptance considerations
- Safety of operations in the event of an equipment failure on board or other emergencies in congested urban airspace.

Work to answer these questions—indeed, in some cases to figure out what those questions are—has been taking place at Pontoise Aerodrome, approximately 40 km (25 mi.) northwest of Paris, where local and regional authorities have established an AAM Sandbox to help businesses develop the technology. BCA was present during several flight trials and media/public-engagement events held there in 2022 and has had the chance to observe how preparations for the Olympics service are progressing.

Measuring Acoustics

In March 2022, the Pontoise Sandbox hosted a series of flights to measure the acoustic signature of Volocopter's 2X prototype. The aircraft is still the only eVTOL platform that has regulatory approval to fly in France, and while it is smaller than the VoloCity that will fly during the Olympics, its noise emissions are expected to be similar enough for the data to be useful. Collection and measurement equipment—some 25 microphones and vibration sensors, placed on airport buildings, on the ground and on pylons—was deployed at the airfield by the RATP, the mass transit agency for the Paris region, which is charged

The 2X demonstrator hovers above the Pontoise vertiport, while a Socata TB20, operated by ENAC, the French national civil aviation school, lands on the runway behind a full-size model of the VoloCity.

with measuring the noise impacts of other forms of urban transport and so is highly experienced in collecting, analyzing and understanding such data sets.

"We want to know exactly what the acoustic impacts are of different operations of the eVTOL, and measure the noise at different distances," says Joran Le Nabat, an acoustic engineer with RATP. "These measurements will help us make models afterwards. There are different types of modelization [model-building]: modelization at the scale of the territory, modelization at the scale of the neighborhood, modelization at the scale of the vehicle.

For each, the modelization and the type of software is completely different, because it's more complex to understand at shorter distances," he continues. "Right now, there's no software to explain and identify the [noise] impact at the micro scale."

The 2022 acoustic-signature flight campaign, Le Nabat says, will allow RATP to model the macro noise impacts, and enable the creation of territory-scale maps showing what sonic impact the 2X would have during a flight over the proposed routes in Paris. Once the VoloCity is certified to fly at the Sandbox—hopefully by the summer of 2023—further measurements can be taken that will validate the models created from the 2X flights and confirm the predictions for noise impacts of flights over the city. Even then, however, the job will not be complete.

"It's very important to quantify and to know exactly what are the best criteria in acoustics to define the [acoustic signature] of the eVTOL and to quantify the real perception," Le Nabat says. "What's the best speed, the best altitude, to decrease the impact? If RATP says, 'OK, we will make vertiports in the Seine, close to Gare d'Austerlitz or Gare de Lyon [two of the main railroad stations in Paris], we have to know how to decrease these impacts of acoustics and vibration. We also want to predict exactly how the public will perceive the differences. It's not just, 'You have [a reading of] 65 dBA

The Pontoise Sandbox vertiport, with a model of the VoloCity, emerges from the morning mist.

close to your apartment—that's OK, because they standards say it's OK.' We need to know exactly how they will perceive [different noise levels] during different operations."

Setting Up Ops

In November, the Sandbox opened a testbed vertiport to demonstrate, validate, rehearse and refine pre-boarding processes for passengers and ground operations for aircraft. The facility, a collaboration between French airport operator Groupe ADP and British-based vertiport developer Skyports, includes biometric systems, ticket gates and a coffee lounge/waiting area.


ANGUS BATEY/AVIATION WEEK PHOTOS

The design of the FATO (final approach and takeoff area), which is part of the vertiport development program, is equally important. This aspect of the work is already looking well beyond the Olympics project.

"We want to accommodate all types of aircraft," says Edward Russell, Skyports' development manager for the EMEA region. "The aim of the vertiport is to be completely agnostic to all the mainstream carriers. The main critical part to the stand, or the FATO, is how wide the rotors are going to be. That, however, will ultimately be constrained by where you are. If you find yourself, say, in central London, space will be restricted, so we'll have to accommodate and make a commercial decision on that."

Skyports is not formally part of the Paris project itself, but it is indirectly involved both via the Sandbox and because Groupe ADP is one of its major shareholders. The proposed Olympics flight map links Charles de Gaulle and Le Bourget airports, and the heliport at Issy-Les-Moulineaux, inside the city, with the suburban facility at Saint-Cyr—sites already operated by Groupe ADP. The fifth proposed site is new: a vertiport to be built on a pontoon moored on the Seine near the Austerlitz rail station in the center of the city. That project is being led by RATP, but experience and data from the vertiport at the Pontoise Sandbox will inform its design, construction and operation.

"We work very closely [with Groupe ADP] on the testbed and on other aspects of vertiport operations, whether that's vertiport designs or the digital enabling systems for the passenger journey," Damian Kysely, head of infrastructure for the EMEA region at Skyports, tells BCA. "That includes scheduling and management systems that allow us to allocate resources to turn around the aircraft; situational awareness to understand what's happening at and around the vertiport; weather; noise data; all that we need to understand what's happening and how to operate it."

RATP's innovation division, RATP Dev, has established a limited driverless ground transportation shuttle service that connects various locations around the Bois de Vincennes park in Paris. The company is considering implementing a similar service to connect the Austerlitz rail station with Gare du Lyon, on the opposite bank of the river Seine. Le Nabat says the company sees eVTOL as another means for the company to connect transport hubs that presently lack a direct link, with urban vertiports a necessary part of its vision for future urban transport connectivity.

"There's no transport between Gare d'Austerlitz and Gare de Lyon, so that's why we're making [a driverless mobility link]," he says. "The vertiport is [part of] the same thing. We want to have multiple services, so that when you arrive at Gare d'Austerlitz, for example, you can take the Metro, the railway, the eVTOL, and it's a multimodal service."

Plans for the Austerlitz pontoon vertiport, and for the deployment of other vertiport infrastructure across the five Paris sites, remain aspirations, with Groupe ADP publicly stating that "administrative procedures are underway" to establish the five sites. In the meantime, work is ongoing to ensure that the Volocopter aircraft will be able to access the floating vertiport as easily as it can the established airfield locations.

"It's very easy and quick for us to drop a simulated pontoon into the simulator and be flying approaches to do that first cut of, does it hang together? Is it going to be straightforward enough?" says Paul Stone, Volocopter's chief test pilot. "Approaching from over the water onto the pontoon actually is pretty straightforward."

Although not contracted to deliver the floating Austerlitz vertiport, Skyports is well-placed to assess the practicalities the proposed solution may be able to take advantage of, as well as the challenges developers may have to address. The company has acquired the former Falcon Heliport in London, which it is continuing to operate as a conventional heliport while investigating technologies and processes that will be applicable to riverside vertiports.

"Usage of existing waterways like the Seine makes sense," Kysely says. "It can be an expensive solution because you're building above water, but there is existing precedent. In many cities, including Paris and London, that's the only viable solution in the very center, given the unavailability of land."

One challenge vertiport developers need to solve—ensuring sufficient power supply is available to recharge the aircraft—may not be a difficult issue for the Olympics operations, given the characteristics of the VoloCity, which does not have to be plugged in directly. The aircraft's battery packs are removable, so charging can take place on shore, with the recharged units brought to the aircraft as needed.

"I don't have intimate knowledge of the exact designs RATP is working on [for the Austerlitz vertiport]," Kysely says, "but with battery swap you don't need high voltage or high power. It's slow charging, like charging a car battery, effectively."

ANGUS BATEY/AVIATION WEEK PHOTOS

Paul Stone flies the Volocopter 2X close to an array of acoustic sensors during the noise-test campaign at Pontoise in March 2022.

He points out that for projects involving other eVTOL platforms with longer flight duration times, certain city-center locations may not require any charging infrastructure at all.

"For aircraft like Joby or others, their range is well over 200 km, so they may not even want to charge in certain locations where they're doing quick-turnaround flights," Kysely says. "For single-pad locations, you can't loiter around for an hour—you need to get in and out, because you're blocking the availability of the vertiport."

Instead, he suggests, the challenges facing operators of river-based vertiports come from other directions.

"When we've looked at other river sites—not specifically the one in Paris—what's often an issue is river traffic—moving targets [such as barges], moving obstacles around it, tides which mean you can't really have a floating structure if there's high tide movement in the river," he says. "The most complex challenge is the environmental impact assessment, which relates to all parts of the operation—from noise, potential pollution in case of accidents, what the battery is going to do if it falls into the water. Those are key concerns—and then cost, ultimately: it's not cheap."

During another Sandbox event, held in September 2022 under the auspices of the European Union-sponsored CORUS-XUAM program, the 2X and a Pipistrel Velis Electro electrically powered light aircraft demonstrated deconfliction and cooperation in a scenario where a diversion on final approach was required. One element of eVTOL operations that the Olympics consortium is having to carefully look at is the scenario in which the Volocopter needs to hold its position while airborne if an airspace issue prevents access to the landing site. The aircraft has limited power reserves, and priorities may need to be changed should air traffic controllers need to revise plans in response to emergency situations.

Flight Corridors

The limits of onboard power are just one way in which eVTOLs differ from traditional helicopters. Yet the Olympics project will utilize existing helicopter flight corridors, and, in four of the five operating locations, existing helicopter ground infrastructure as well. As a first step to introduce the new technology to the operating environment, this makes perfect sense: as Skyports' Kysely says, the project team needs to learn to walk before it can start to think about running.

Yet there are also risks to taking this "pragmatic" path. Having eVTOL platforms limited to operating solely within traditional rotorcraft locations and flight corridors "is exactly what you want to avoid," says Jorn Jaeger, Volocopter's head of airspace and vertiports. "We've started [in helicopter airspace] because it is giving confidence to the authorities that we can manage it. But definitely we want to get away from it."

"That's the essential part of the puzzle," says Kysely. "For Paris, we at Skyports believe it's the right thing, but it's why we're focused on what happens after 2024. It's the hardest task. If we are stuck with only operating between existing aerodromes, [eVTOL will become] a replacement for helicopters. If we manage to prove the assumptions of eVTOL it will be a better replacement, because it will be quieter, non-polluting and cheaper, but it will still be confined to the operations of existing aircraft. If those assumptions are proven, I believe it will be easier for us to then start expanding the envelope and the network to use cases that really make sense."

While the Sandbox vertiport is providing experience the Olympics flight campaign will be built on, it is what happens after Paris 2024 that will determine the success—or future—of the whole AAM/eVTOL concept.

"The connectivity between Paris airports is great, but probably doesn't cover the best use cases for eVTOLs," Kysely says. "I'm sure there's demand between certain locations like Versailles, and Issy-Les-Moulineaux. But the driver of demand will probably be city center or other locations to airports, through airport shuttles rather than driving just between airports. So that's what we're focused on. Naturally, that's a lot harder, because—as with the Austerlitz potential vertiport—you're operating in a non-aviation environment and you have to go through the entire planning phases. It's a long process, but it's similar in every other w market we're in. It's about finding the perfect site and then starting with one or two, proving the model, and then once the social license is established, it will get easier for us as the non-airport vertiport developer to focus on progress." **BCA**

The AAM Pilot Challenge

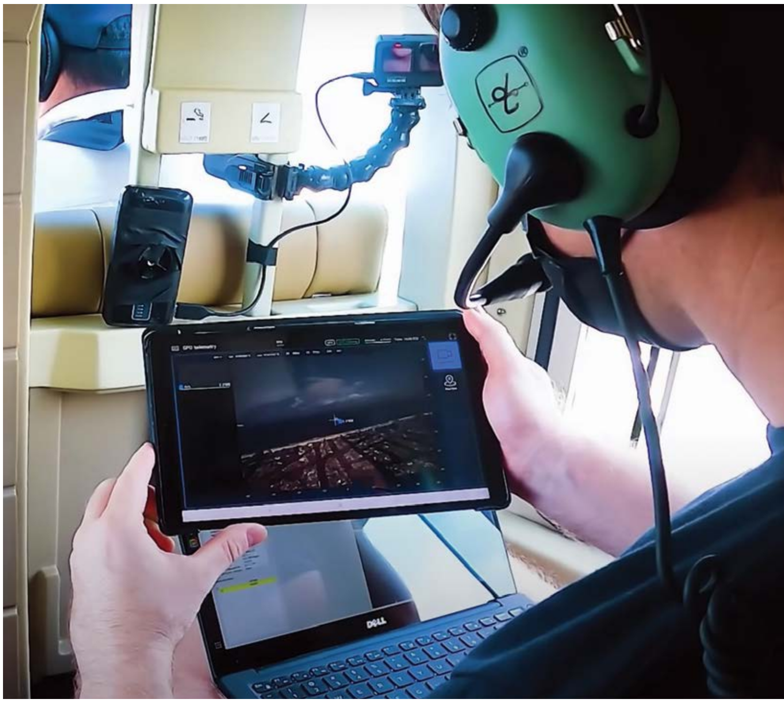
Electric and eVTOL platforms pose complex questions for OEMs, operators, regulators and training organizations as the technologies and services develop

BY **ANGUS BATEY**

The burgeoning eVTOL (electric vertical-take-off-and-landing) sector is promising to turn the long-standing dream of flying taxis into a reality. Yet while a plethora of aircraft manufacturers inch closer to achieving certification for their vehicles, several urgent operational questions remain to be answered. Of these, one of the most pressing is: who will fly them?

Many of the hundreds of eVTOL OEMs envisage a future in which the aircraft will fly autonomously. But until the technology and its many variants proves itself to regulators (not to mention the public), the aircraft will require a pilot on board.

Business models outlined by putative eVTOL operators call for high utilization rates, with many operators looking at scenarios where the aircraft would operate as on-demand shuttles—initially, between hub airports and downtown areas of the cities they serve. The pilot would be expected to carry out numerous takeoffs and landings in congested and perhaps aerodynamically challenging airspace, with very little time spent in cruise mode.


DAEDALEAN

An Embraer engineer uses one of Daedalean's pilot-aid systems during an evaluation flight in 2022.

This suggests that the job of flying eVTOLs will share many characteristics with that of piloting traditional helicopters. But the aircraft will be easier to operate than today's rotorcraft, with usually just one-stick control: a concept referred to as simplified vertical operation (SVO). A helicopter pilot may be overqualified for SVO operations, while airliner pilots will lack experience in low-altitude flight over urban areas.

Pilots are and will be an essential part of the short- and medium-term eVTOL/AAM picture. But who will they be, how will operators identify and recruit them, who will train them, to what standards, and will those requirements prove so expensive that early AAM operations will be available only to the super-rich?

Implication for Pilots

The AAM pilot will receive an unprecedented level of assistance from the platform while in the air. One company that has devoted itself to this part of the eVTOL/AAM technology marketplace is the Switzerland-based Daedalean. Initially established to develop an autopiloting solution for autonomous eVTOL platforms—it has worked with AAM developers including Volocopter and Embraer's Eve—the company is now developing a series of tools that can act as aids to pilots of today's aircraft.

"Currently, all single-pilot operations have a massive single point of failure—namely, the single pilot," says company founder Luuk van Dijk. "Garmin is already playing into this with its Autoland. But if you want to go further than that and make everything as safe as a dual-pilot operation, then maybe it would be good if you had a device that could do all the things that a co-pilot could do."

Daedalean is focusing on analyzing and understanding the tasks both pilot and co-pilot carry out during flights, and the data sets they have assembled are being used to inform a range of products that can be deployed on conventional aircraft as optional add-ons. Installing such systems on conventional aircraft will help build the safety case for their use on AAM platforms as well.

"Once we've added a co-pilot to single-pilot flights—including Part 23 privately owned aircraft and business jets—then we can gather the evidence that in cases where the pilot is incapacitated, or whenever something happened, the automatic co-pilot had his or her back," van Dijk says. "Then you can maybe get to the point where you can take out the second pilot [in dual-crewed aircraft] and replace it with our system, and have the same or a higher level of safety."

With the aircraft itself carrying out a significant chunk of the traditional pilot's tasks, and given the inherent differences of electric versus internal-combustion propulsion, the nature of the onboard pilot's role will be different.

"I'm used to flying private jets, which are state-of-the-art technology and make the situational awareness for the pilots much, much easier; and I'm also used to flying an old Cessna 210, in which, every time you fly, you're constantly juggling the mixture going into the engine, you're looking at the temperatures of all of the cylinders. It's a full-time job just looking after that engine," says Adam Twidell, a former Royal Air Force pilot who leads Flexjet's future of flight program, and chairs the European Business Aviation Association's AAM working group.

"Now, if you're flying an electric aircraft the checklist is remarkably simple," he continues. "There are three switches to use before you take off. A motor is so much simpler and more reliable than a combustion engine."

The implications for both operational flying and for pilot training are profound, Twidell argues.

"When you're learning to drive a manual car, so much of your capacity is about the gears, the clutch, the hill starts," he says. "When you move into an electric car, you go and you stop and you get that within minutes: now all of your capacity is on how you interact with the road, with other drivers, with the environment you're in. And you become a much better driver very quickly because of the automation the vehicle's giving you.

"I think it will be exactly the same with electric aircraft—either conventional takeoff or eVTOLs," he adds. "We're going to have really good pilots because the aircraft itself will be doing the job for the pilot. [And] pilots going through [electric-aircraft pilot training] courses will have a much easier time learning to fly than they would've done if they were using a conventional aircraft."

Training and Recruiting

In theory, the new career field of eVTOL pilot ought to be open to an encouragingly wide range of people. But, while different, training courses will not necessarily be shorter or less expensive; and the huge anticipated demand will be challenging for extant training providers to meet.

"How will they learn? Differently to legacy pilot training, I imagine," David Lord, a former Royal Navy helicopter pilot and now the manager of regulatory affairs for training provider FlightSafety International, told the British Business and General Aviation Association's annual conference in London on March 2. "This is going to be reflected throughout the aviation industry. We have not seen this scale of demand ever before."

But some significant questions must be addressed by regulators before companies like FlightSafety can begin to design courses.

"From a trainer's perspective, it's going to be bloody difficult to assess pilot competence in the single-seat cockpit," he said. "I had to do that when I was instructing people on the [Boeing] Apache. It's hard work. You don't always get it right. Single-pilot human-factor issues may also be masked, [and perhaps] compounded, by simplified vertical operation. The artificial intelligence on board may mask pilot incompetence."

For business aviation operators like Flexjet, little will change in terms of pilot recruitment strategy when eVTOL aircraft are added to the company's fleet. Twidell says the company will still be seeking "very overqualified pilots" and is not considering recruiting ab initio eVTOL operators.

Wideroe Zero signed a partnership memorandum of understanding with Embraer's Eve division in 2021 to develop operational models for eVTOLs in Scandinavia.

WIDEROE ZERO

He believes that the job will appeal to experienced aviators who will be keen to pioneer a new kind of flying.

For other types of operators, the selection challenge will be different. Norwegian airline Wideroe intends to operate eVTOLs and nine-seat electric/hybrid regional aircraft on short routes in and around the country. To staff up its operation, the company will have to offer a competitive financial package, despite the low fares it will need to attract passengers. There are ways of squaring that financial circle, argues Andreas Kollbye Aks, CEO of the Wideroe Zero, which the company calls its "air mobility incubator" division.


ANGUS BATEY/BCA

Volocopter test pilot Paul Stone discussing the cockpit of the company's X2 demonstrator during acoustic signature testing at Pontoise Aerodrome, France, in 2022. The control inputs are made through the single stick.

"We expect to fly to many remote destinations where there is likely very limited staff on the ground," he says. "It may make a lot of sense to have a pilot on board who can also perhaps charge the vehicle, help the passengers in and out, and be that one person on-site who can do the service. Perhaps if you can reduce the number of staff involved in a total operation, this one guy that operates the eVTOL can actually make a good salary because he's doing multiple jobs."

Demand for pilots should be manageable for initial operations, Aks says, but in the longer term, recruitment, training and retention will become significant issues for operators to manage.

"[Wideroe is] talking about an EIS [entry into service] in 2027," Aks says. "We're still expecting that to be a very limited operation, and I think we will be fine with whatever number of pilots we can get hold of within the country and within our existing structures. I would love to see 50 eVTOLs flying around Norway in the 2020s, but I'm also okay with seeing five. If this becomes a huge success, and the numbers of eVTOLs on multiple MOUs and LOIs [memoranda of understanding, letters of intent] around the world materializes, then yes, there will be a huge need—but I expect that the volume will come in 2030 and onwards, more than in the 2020s." **BCA**

Sustainable Innovation

An interior specialist innovates while making cabins more sustainable

BY **JAMES POZZI**

As business jet cabin requirements from operators have become increasingly sophisticated and bespoke, interiors specialists have had to become more innovative.

Among the specialists doubling down on new concepts is Austria-based luxury cabin materials specialist F/List. The family-run company opened as a carpentry shop more than 70 years ago and since has gained business aviation customers including OEMs Bombardier, Embraer, Gulfstream and Pilatus, as well as agreements with MRO providers and completion centers. Its work extends to commercial airline customers, which use its stone veneers to accentuate cabin seats and tables.

CEO Katharina List-Nagl, granddaughter of the company's founder, has targeted partnering with startups, architects and designers to refine product developments. Through its in-house future lab incubator F/Lab, set up in 2020, the company looks to accelerate innovation in products it designs, manufactures and for some items, maintains.


F/LIST

F/List Shapeshifter concepts use bio-based materials with pneumatic functions allowing flexibility even for wood-based veneers.

Over the past year, F/List introduced new materials, created in-house, designed to be customizable and sustainable. These materials including aenigma, linfinium and whisper leather, a sustainable alternative to real leather made from corn starch. F/List says this material is installed on an unnamed private customer's aircraft. Melanie Prince, head of innovation at F/List, says newly developed materials such as this usually undergo flammability, adherence, robustness and fluid-resistance tests. In the case of the whisper leather, it underwent a Blue Angel environmental label test in Germany for volatile organic compounds, which typically lasts for 30 days to determine if there are any toxic emissions, but after just seven days the whisper leather produced zero emissions.

Among the recent products born out of the F/Lab is the F/L Shapeshifter, a series of concepts that use bio-based materials with pneumatic functions and actuators to allow flexibility even in wood-based veneers. One moveable component, the F/L Shapeshifter Credenza, is a sideboard cabinet designed as a space-saving unit for small interiors that can be used to stow audio-visual equipment, loose cabin items and soft furnishings such as blankets. "When we think of credenzas in an aircraft, we immediately think of doors and trying to make them as wide as the aisle way and this isn't convenient in general," says Prince. "We decided that with morphing components, we would be able to do something very special by bending it around the edge so the wood veneer will bend around the corner and there will no longer be a need for a door or a gap."

As part of its wider sustainability efforts, the company's Thomasberg facility is powered by solar and renewable energy, combined with smart-energy recovery. Its headquarters also features machinery and systems with heat recovery, a cooling system that uses water from the adjacent river, 100% LED lighting, and charging of on-site electric golf carts, e-scooters and e-bikes using the Okovolt electricity filling station.

Creating new products in a sustainable fashion is also a primary objective. One way to do this is by recycling materials for future products, such as incorporating previously used leather skins on chairs and tables in aircraft interiors.

Prince demonstrated a material surface coated in dust from F/List's stone production. "They create the stone floor, polish it, cut it and then we take the dust back and bring it back into the product," she says. "This gives a natural surface that is very robust and hard to scratch," adding that such products are customizable and can be made from any texture and surface including mother-of-pearl finishes and patterns.

One example of this is taking a pre-existing skin and replicating a stingray leather, made from the upper portion of a stingray, with non-animal bases before adding customization to it. F/List's sustainability goals also extend to mother-of-pearl pieces recycled from clothing. "We take broken buttons and grind them down and then we bring that back into the material and are able to modify the patterns, textures, height, colors and composition," Prince says. Other initiatives include developing alternatives to granite, used in countertops and flooring on aircraft, which are designed to be slightly lighter than the material it imitates.

F/List aims for the perfect mix of customizable and sustainable by experimenting with mixing linseed oil with recycled Portuguese cork for aircraft flooring and bedrooms. Due to concerns over the softness of the cork, its R&D teams mixed the cork with apricot pips and bound them together with linseed oil. "In terms of density, this mix was very interesting," Prince says. "This is lighter, acoustically it's very favorable and fairly robust, and it's all very natural and non-toxic."

F/List employs more than 900 people across its global network, with branches in Dubai; Sorocaba (Brazil); Montreal, the U.S. and Europe. It plans to grow capacity at its Savannah, Georgia location with a 9,600 ft.^{2} facility scheduled to be operational by the end of 2023. It will incorporate veneer production, an on-site design showroom and after-sales services. **BCA**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The Enduring Appeal of the Falcon 900

NIGEL PREVETT/AVIATION WEEK

The long-range, large-cabin trijet remains popular nearly four decades since it was introduced

BY **BILL CAREY**

First delivered in 1986, the Dassault Falcon 900 trijet has evolved and improved through seven iterations, although its customer appeal over nearly four decades has remained constant, sales executives say.

"The Falcon 900 aircraft are loved by many owners and operators and will continue to be a standout in the market for many years to come," assures David Foster, vice president of aircraft sales with QS Partners, which tracks all Dassault Falcon types. "The bottom line is Falcon markets are still very active and quality aircraft continue to be difficult to locate. Limited inventory along with strong lift demand has allowed values to remain at historic highs."

The Dassault trijet entered the market as competition for the Canadair (later Bombardier) Challenger 601 and Gulfstream III and IV twinjets. The late David North, who served as a test pilot for *Aviation Week & Space Technology* and later became its editor-in-chief, remarked on Dassault's confidence in the Falcon 900 in 1985 when the manufacturer allowed him to fly the first prototype of the trijet after it had accumulated just 110 hr. of flight testing.

"Dassault-Breguet's Falcon 900, a larger version of the three-engine Falcon 50, combines increased cabin size with a long-range capability and offers operators a corporate aircraft with excellent short-field performance, handling characteristics and environmental acceptance," North wrote in the March 4, 1985, issue of the magazine.

A Falcon 900B with aftermarket Aviation Partners winglets from the legacy fleet introduced in the late 1980s.

"A frequent criticism by corporate operators about the Falcon 50 is that the smaller Falcon trijet is a long-range aircraft that does not have space to hold six or more passengers comfortably for the 10-hr. flights of which it is capable," North elaborated. "The Falcon 900—its ancestry quite apparent in the smaller Falcon 50—has a cabin size that more than matches the range and endurance of the standard 12-passenger aircraft."

The aerospace industry itself has evolved since North's pilot report. Dassault stopped using the name Breguet in 1990. The Sperry Corp. electronic flight instrument system he described would evolve into a Honeywell product; so too would the Garrett TFE731-5A engines, via AlliedSignal, which merged with Honeywell in 1999 and retained its name.

Falcon 900 Iterations

The Falcon 900A offered good performance, a spacious cabin and long-distance range of 3,800 nm when it entered the market. The 900B version in 1991 introduced higher-thrust (4,750-lb.) TFE731-5BR engines with increased range to 4,000 nm. The 900EX followed in 1995 with 5,000-lb.-thrust TFE731-60 engines, range of 4,500 nm, and Honeywell Primus 2000 avionics. The 900C with Primus 2000 avionics and a higher gross weight replaced the B version in 1999.

Dassault overhauled the flight deck and introduced the Falcon 900EX EASy derivative in 2003, fitted with Honeywell's Primus Epic integrated avionics system. In 2005, the manufacturer offered a shorter-range (4,100 nm) version


Business Aviation

of the C model—the 900DX—that incorporated the same engines and cockpit of the 900EX EASy, with a redesigned fuel system.

The current Falcon 900LX, certified in 2010, came equipped with the EASy II flight deck and blended winglets from Aviation Partners, which reduce drag and improve climb performance. With the LX designation, the manufacturer incorporated the winglets at the factory in France under a Dassault modification.

In 2016, Dassault obtained FAA and European Union Aviation Safety Agency certification of its FalconEye head-up display system on the Falcon 2000 and 900, followed the next year by the 8X. FalconEye is a combined vision system; it presents database-sourced synthetic vision system imagery at the top of the combiner glass and infrared enhanced vision at the bottom, divided by a horizontal split line that pilots can adjust up or down.

Dassault Aviation announced in September 2022 that it had received FAA supplemental type certification approval for installation of the Universal Avionics' InSight flight deck upgrade of the Falcon 900B, making it compatible with current data link systems. Earlier this year, the manufacturer named Universal Avionics as a North American repair facility for the FalconEye enhanced flight-vision system, which is available on the Falcon 900LX, 2000 and 8X models.

The factory-new list price of a Falcon 900 in 1986 was $13.95 million, according to the Aircraft Bluebook. The sticker price of a Falcon 900LX in 2022 was $44 million.

Performance characteristics that impressed North when he flew a prototype Falcon 900 endure in the current-production model. "The -900 has a really good approach speed, a good low Vref (landing reference) speed," observes Mark Verdesco, Dassault Falcon Jet director of pre-owned aircraft sales.

"You have that three-engine safety," Verdesco adds. "With the inboard and outboard leading-edge devices on the wings and the third engine, you've got tremendous short-field performance and high-and-hot capabilities. That's why it's a great airplane for those short runways or for the Aspens or St. Moritz or any of those high-end resorts."

As of March, there were 190 legacy Falcon 900B/Cs in service or in the possession of non-operators, according to the Aviation Week Fleet Discovery Database. The bulk of the legacy fleet—144 aircraft—is based in North America. There were 347 Falcon 900EX, EX EASy, DX and LX models in service.

There were 11 legacy Falcon 900Bs listed for sale in March, Foster says, and seven Falcon 900EXs for sale. Asking prices for the latter model, introduced in 1995, ranged from $5 million to $11 million.

"The value of each aircraft depends on several factors to include the age, history, hours, equipment, engine programs, configuration, cosmetic condition, and where the aircraft is in the maintenance life cycle," Foster advises. "It is important to be able to show a client where an aircraft stands today, but also advise them on what expenses they can expect in the future. The major inspections for legacy aircraft can be expensive, exceeding $1 million in some cases. Ensuring clients understand all sides of the acquisition and operation of the aircraft is critical."

Foster reports five Falcon 900EX Easy models listed for sale, from the fleet produced from 2003 to 2011. Asking prices ranged from $15 million to $20 million. In the previous year there were 17 confirmed retail transactions, Foster says, indicating a strong market.

Current-Production 900LX

The Aviation Week Fleet Discovery Database counted 86 in-service Falcon LXs, the current-production model dating to 2010. The LX model competes for sales with the twin-engine Gulfstream G500; there were no LXs listed for sale as of March. Foster reported three confirmed retail 900LX transactions in the previous 12 months.

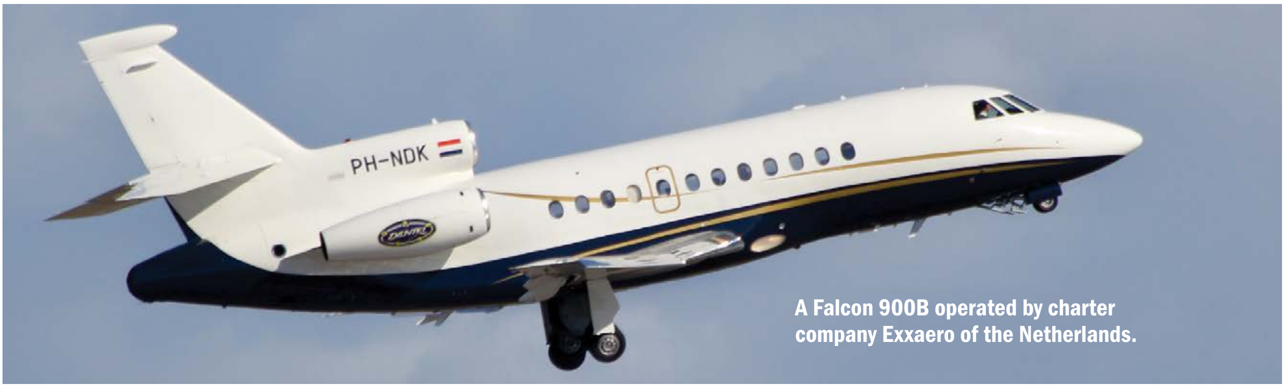

DASSAULT FALCON JET

The Honeywell-based EASy II flight deck of the current-production Falcon 900LX.

The 900LX is powered by a triad of Honeywell TFE731-60 turbofans, each producing 5,000 lb. of thrust. It can fly to a range of 4,750 nm at Mach 0.80 with six passengers and two crew. At max takeoff weight (49,000 lb.), it requires 5,360 ft. of runway in ISA sea-level conditions.

"With the new high-Mach blended winglets, the 900LX has increased the range to 4,750 mi. [with] a decreased fuel burn, making the aircraft one of the most efficient aircraft in its class," Foster says. "Other notable improvements on the Falcon 900LX are the state-of-the-art EASy II flight deck, the fighter-derived technology for the airframe and aerodynamics, and the Falcon 900LX trijet configuration of Honeywell TFE731-60 engines. All of the above allow the Falcon 900LX to stand out as one of the premium aircraft in its class."

NIGEL PREVETT/AVIATION WEEK



A Falcon 900B operated by charter company Exxaero of the Netherlands.

UNIVERSAL AVIONICS

In 2022, Dassault obtained FAA supplemental type certificate approval allowing installation of the Universal Avionics InSight flight deck upgrade of the Falcon 900B.

Standup and Walkaround Cabin

The Falcon 900LX cabin is 6 ft., 2 in. in height, 7 ft., 8 in. wide and 33 ft., 2 in. long, with three passenger zones. "[This is] a true stand-up, walkaround cabin with three zones of comfort," says Foster. "The cabin has the most modern entertainment and connectivity capabilities and is church quiet. The aircraft typically seats 12 to 14 passengers in one of the finest interiors in the industry."

Dassault finishes the jet at its completions center at Clinton National Airport in Little Rock, Arkansas. The standard configuration is a 12-passenger layout comprised of four-place club seating forward, a four-place dining group opposite a credenza at mid-cabin; and a three-place divan across from one or two executive seats aft. An aft lavatory is standard; a forward crew lavatory near the galley is optional. Passengers have access to their luggage in flight.

BCA's 2022 Operations Planning Guide estimates Falcon 900LX direct costs of $7,339 for a 1,000-nm mission, based on a nationwide average Jet-A fuel cost of $6.94 per gal. at the time of publication. Direct costs include mission fuel consumed, maintenance labor, parts and reserve costs apportioned to the actual flight time for the mission length.

The Falcon 900 has a 12-, 24- and 36-month inspection schedule to ensure the aircraft's condition regardless of its utilization rate. At every 1,600 flight hours, a B maintenance inspection ensures system functional capabilities. A C check inspection, the most comprehensive, must be performed every 3,750 flight cycles or in six years, whichever comes first.

In April, the FAA issued airworthiness directives (AD) 2023-04-10 and 2023-04-16 applying to the Dassault Mystere-Falcon 900 and Falcon 900EX, respectively. The ADs supersede earlier directives to revise existing maintenance or inspection programs to incorporate new or more restrictive airworthiness limitations. **BCA**

BCA *welcomes comment and insight from aircraft dealers and brokers for its monthly 20/Twenty pre-owned aircraft market feature. The focus aircraft for May 2023 is the Embraer Praetor 500/600 and for June 2023, the Piaggio Avanti. To participate, contact bill.carey@aviationweek.com.*

DASSAULT FALCON JET

The cabin of the current-production Falcon 900LX accommodates a bed configuration.

Time to Refocus and Get Back to Basics

For safe operations, all hands need to be on deck

BY **ROBERT SUMWALT**

Recently, I co-moderated the plenary session of the FAA's Safety Summit with FAA Acting Administrator, Billy Nolen. In case you've been living on Mars for the past few months, there have been several recent, highly publicized safety-related events affecting the U.S. commercial aviation system. The FAA issued a Safety Alert for Operators on March 22, stating that "the potential severity of these events is concerning."

In December, a United Airlines Boeing 777 flight plunged to within 800 ft. of the Pacific Ocean after departing Maui. The aircraft climbed to 2,200 ft. after takeoff and then began descending toward the water at more than 8,000 fpm. That same day, 36 people were injured in turbulence on a Hawaiian Airlines flight from Phoenix to Honolulu. Eleven of those injuries were serious. Later that month, a ramp agent died when she was ingested into an engine of an Embraer 170 at Montgomery, Alabama.

In early March, a Bombardier Challenger 300 was involved in an inflight upset. A 55-year-old old passenger died following a series of extreme pitch oscillations and severe G-forces. The Part 91 flight departed Keene, New Hampshire and was en route to Leesburg, Virginia when the upset occurred. Details have yet to emerge on the cause of the upset, but what is troubling is what happened before the aircraft even left the ground. The first departure attempt ended in a rejected takeoff (RTO), when one of the pilots noticed a disagreement between the captain's and first officer's airspeed indicators. This wasn't a disagreement of just a few knots: According to NTSB's preliminary report, at the time of the RTO, the captain's primary flight display (PFD) indicated 104 kt., while the FO's PFD displayed only 2 kt. A question yet to be answered is why this disagreement was not called out and the RTO initiated before reaching 104 kt.

The airplane was taxied clear of the runway and onto a taxiway. The left engine was shut down, and air stairs were lowered. The second-in-command deplaned, walked to the front of the airplane and discovered that the right pitot probe cover was still in place. He removed the cover, noticed no damage, and returned to the cockpit. The left engine was restarted and off they went for another takeoff. On takeoff roll, the second-in-command realized there were no V-speeds displayed on the PFD. He called out V1 and rotate at 116 kt., based on his memory of previous takeoffs. To be clear, these events may have had nothing to do with the cause of the upset, but it does call into question the crew's attention to detail before things really turned sour.


ROBERT SUMWALT

An airplane holding short of a runway, seen from the cockpit.

What has received the most attention over the past few months is the slew of highly publicized runway incursions, including two in which pilots took off without ATC clearance. During the first two-and-a-half months of this year, there have been at least six of the most severe categories of runway incursions, compared to a 20-year average of around two-and-a-half per year.

An easy explanation—one that I've heard several times over the past few weeks—is that the aviation industry is coming out of the pandemic and the workforce is a bit rusty. I don't buy it. The pilot workforce has been in a massive hiring mode for over a year now. Which pilot needs a year to wipe the rust off? Besides, what data do we have that shows that these events are related to "rusty" pilots and controllers?

A common thread woven throughout several of these events appears to be a lack of attention to detail. As in taking off without clearance. Crossing runways without clearance. Failing to remove a pitot cover. It's time to get refocused and get back to basics—basics like avoiding distractions during critical phases of taxi and flight. Basics such as the crew carefully monitoring and cross-checking each other while taxiing. Basics like ensuring that everyone on the flight deck understands and agrees on taxi instructions and ATC clearances, and basics like ensuring those instructions are followed. The FAA's Safety Alert for Operators indicated that these recent

Depiction of American Airlines Boeing 777 cleared route versus the actual taxi route.

Source: NTSB

events "demonstrate the need for continued vigilance and attention to mitigation of safety events." Within the past few days, the Air Line Pilots Association International issued a safety alert to "maintain and increase vigilance, actively prevent complacency, and continually report hazards."

Of the six or so runway incursions since January, only two of them—those at Austin, Texas and Sarasota, Florida—involved air traffic controllers trying to "push tin" too closely. In each instance, an air traffic controller issued takeoff clearance while another aircraft was on a close final to the runway. The five remaining runway incursions were pilot-related.

There are two pilots on the flight deck for a reason. Having two sets of eyes and ears is one of the most effective safety measures in the cockpit. When I first arrived at a business aviation flight department years ago, it wasn't unusual to have one pilot starting the engines and calling ATC for taxi instructions while the other pilot was still in the back briefing passengers. Similarity, during my airline career, there were times when I was talking to the ground crew on the interphone while the first officer was calling for taxi. Doing these things may save scant seconds of time, but they also circumvent the critically important redundancy of having two pilots listening to, understanding, and agreeing on the taxi instructions.

In mid-January, an American Airlines Boeing 777 bound for London Heathrow Airport entered Runway 4L at John F. Kennedy International Airport and proceeded across the runway on Taxiway Juliet without ATC authorization. As the 777 entered the runway, a Delta Air Lines Boeing 737, having received ATC clearance for takeoff, was accelerating through 80 kt. on Runway 4L. The two aircraft were approximately 2,700 ft. apart at this point. The Delta crew initiated a rejected takeoff at around 100 kt. and stopped the aircraft approximately 500 ft. from where the triple-seven had crossed on Juliet. Because the 777 had continued across while Delta was decelerating, the closest the two aircraft came to each other was about 1,400 ft., according to NTSB.

Some runway incursions are the result of an aircraft failing to stop and blundering onto a runway without clearance. This wasn't one of them. American was instructed to taxi to Runway 4L via taxiway Bravo. At some point during taxi, the crew was cleared to cross runway 31L at Taxiway Kilo. However, upon reaching the Taxiway Bravo/Taxiway Kilo intersection, the aircraft made a left turn, followed by a quick 90-deg. right turn onto Taxiway Juliet and continued across Runway 4L without ATC clearance.

One factor in runway incursions is pilots not having a clear understanding of taxi instructions or having an erroneous preconceived mindset of what the plan will be. In the JFK case, the most typical departure runway for heavy jets is Runway 31L. It's plausible that with that mindset, the captain erroneously proceeded as if 31L was the designated departure runway.

It's understandable that the erroneous mindset of one person could lead to this error, but there were two other pilots on the flight deck that evening—the first officer and an international relief officer. Where was the redundancy and cross-check from those pilots?

There are also procedures designed to enhance crew vigilance during taxi. American Airlines' procedure specifies that the crew should review the planned departure runway, as well as the planned taxi route, including hot spots and runway crossings. Several years ago, I was part of a group that revised the FAA's advisory circular on flight crew procedures during taxi operations. Although the version that we created has since been updated by FAA Advisory Circular AC 120-74B, both versions specify an important best practice: "Brief the expected taxi route to include any hold-short lines and runways to cross, hot spots, and any other potential conflicts. Once taxi instructions are received, the pre-taxi route should be reviewed and monitored. It is essential that any changes to the taxi route be understood by all crewmembers."

The first accident I investigated with the NTSB was the wrong-runway departure of Comair Flight 5191. As readers may recall, the crew taxied to and attempted to take off on a runway that was too short. The airplane overran the runway, crashed into trees, and burst into flames. Forty-nine lives were lost in the pre-dawn hours that August day. NTSB noted that the crew failed to conduct a thorough taxi briefing, as required by Comair standard operating procedures. We determined that had a complete taxi briefing been done, the crew would have had greater awareness that a shorter runway—the one that they unsuccessfully attempted to depart on —intersected their intended taxi route to the correct runway.

Although a pre-taxi briefing can help prevent runway incursions, there is also a potential downside—such a briefing could set an expectation bias for the anticipated taxi route. AC (advisory circular) 120-74B lays out this potential problem: “Caution: A potential pitfall of pre-taxi and pre-landing planning is setting expectations and then receiving different instructions from ATC. Flight crews need to follow the clearance or instructions that are actually received, and not the ones they expected to receive.”

Critical flight deck redundancy can be lost when pilots attempt to do the right things at wrong time. There are activities that need to be done before takeoff, such as loading the flight management computer and going through a checklist. Likewise, after landing, one pilot often is off the ATC frequency and calling the FBO or operations. Although these things may be necessary, a sharp pilot will choose when and where to do them, considering the importance of doing them during the lowest-risk periods.

Review of incidents and accidents reveal that we are more vulnerable to missing things when one pilot is heads-down, off ATC frequency, or otherwise out of the loop. In 2013, the Flight Safety Foundation published A Practical Guide for Improving Flight Path Monitoring. The document defined Areas of Vulnerability (AOV) as those areas of operation where there is an “increased likelihood of a flight path [or taxi] deviation or the increased severity of potential consequences if such a deviation occurs.” Because approaching an active runway is considered a high AOV, a good prioritization of tasks may be for both pilots to suspend doing everything other than making sure the aircraft stops short of the runway, or, if it is about to cross, both pilots agree and confirm clearance to cross.

Another vulnerability occurs when pilots do the wrong things at the wrong time. Avoiding distractions by complying with the sterile cockpit rule is strong defense against runway incursions and other safety problems. As NTSB noted in the Comair wrong runway departure crash, there was constant non-pertinent chatter during taxi, which “likely contributed to their loss of positional awareness.”

We all make mistakes–I’ve certainly made more than a few myself. However, a combination of flight crew vigilance, attention to detail, and SOP compliance can help minimize errors, or when one is made, neutralize the error before it leads to something serious. Add to that list the need to refocus and get back to basics. **BCA**

Sizing Up SMS

Smaller operators contemplate the costs of the FAA's proposed Safety Management System regulation

BY **BILL CAREY**


NTSB

NTSB accident investigators inspect the wreckage of a Guardian Flight Pilatus PC-12 that crashed on Feb. 24, 2023, near Reno, Nevada, killing the pilot, two medical crew, a patient and his wife.

Small companies that make money operating aircraft and helicopters face the prospect of airline-style regulation as the FAA's long-anticipated Safety Management System (SMS) rule for Part 135 and 91 operators advances through the federal rulemaking process.

In January the FAA published a notice of proposed rulemaking (NPRM) to update and expand its Part 5 requirement for SMS implementation beyond airlines to include Part 135 charter operators, Part 91.147 air tour operators and certain Part 21 type certificate and production certificate holders. At the request of business aviation associations, the agency postponed an earlier comment deadline it had scheduled to April 11.

If adopted as proposed, the rule would affect about 2,600 charter and air tour operators of all sizes, requiring them to establish formal SMS programs to identify, assess and manage safety risks. Tasks would include developing a code of ethics specifying safety as the highest priority, a confidential employee reporting system, associated documentation and a means to store records. Companies ranging from fleet operators to single-pilot, single-aircraft enterprises would have one to two years after a final rule is published to introduce their programs.

The FAA addresses the issue of scaling the regulation to small operators in the draft rulemaking, seeking feedback on whether the mandate should be limited to a certain subset of operators. It acknowledges that some Part 91.147 operators conduct relatively few flights—the agency had considered exempting those with fewer than 100 flights per year—and that some Part 135 operators use only one pilot-in-command.

A review of NTSB reports from 2015-20 shows that Part 135 companies employing a single pilot were involved in five accidents resulting in a fatality or serious injury, the FAA says. There was one accident involving fatalities of a Part 91.147 operator with fewer than 100 flights per year. On March 11, 2018, the pilot of a Liberty Helicopters' AS350-B2 Ecureuil ditched the helicopter in the East River in New York City after the front-seat passenger's harness tangled with and activated a floor-mounted engine fuel shutoff lever. The pilot was able to escape from the helicopter, but his five passengers drowned.

"As a fundamental matter, the flying public expects safe carriage from operators offering flight services for hire," the FAA states in the NPRM. "Irrespective of whether an operator employs one pilot or a thousand, that company has the same responsibility to conduct safe operations."

A Fait Accompli

Part 121 airlines have been required to have SMSs since 2018, based on a final rule the FAA published three years earlier. That smaller operators will be required to implement SMS programs is considered a fait accompli; bizav associations have focused their response to the NPRM on ensuring that the eventual regulation is scaled, or right-sized, to the resources of the companies they represent.

During industry forums designed to generate feedback from the operator community, concerns have been raised (as expected) over the cost of the approaching mandate, but also

JET LOGISTICS


Part 135 air medical provider Jet Logistics has adopted the International Standard for Business Aircraft Operations, a framework for safety and operational processes.

over the applicability of safety measures that companies have implemented on their own or through voluntary programs.

"We take safety very seriously—we haven't implemented a formal SMS due to the cost of doing so," said one operator who spoke during a National Air Transportation Association (NATA) webinar in February. NATA, which represents aviation businesses including Part 135 certificate holders, says 95% of those operators have fewer than 100 employees.

The operator asked: "Am I going to have to hire a compliance person? I've got myself as DO (director of operations) and my chief pilot and four or five pilots underneath us. We don't need a 200-page SMS. How is the FAA going to scale its requirements to take into account the fact that I can't pay a $60,000 salary to a compliance officer to make sure that we're meeting what the FAA wants us to do."

Another operator asked if the safety practices his company already follows will be satisfactory to the FAA. "We're a small company," he explained. "We've morphed over the years, but we're three aircraft [and] eight pilots right now. We do everything on pen and paper. We don't do any kind of electronic risk [analysis] or any of that. Is that good enough?"


The FAA's proposed SMS regulation for Parts 135 and 91 operators is "a good start" but doesn't go far enough, NTSB Chair Jennifer Homendy told *BCA*.

BILL CAREY/AVIATION WEEK

In the NPRM, the FAA says it "does not anticipate that small organizations will need additional management and staff to satisfy the requirement elements of safety risk management. For example, smaller organizations, with few aircraft operating in a limited geographic area, might record and track the results of the safety risk-management process with paper records or digital files using common word processing or spreadsheet applications."

The FAA estimates that about 200 operators either have accepted systems or applied for acceptance under its SMS voluntary program for Part 135 carriers, representing about 10% of the community, judging by numbers that have been made public. The International Business Aviation Council lists 359 U.S.-based operators registered through its International Standard for Business Aircraft Operations (IS-BAO) program, a voluntary standard dating to 2002.

During a session that NBAA held at its Schedulers & Dispatchers Conference in Nashville, Tennessee in January, the relevance of the IS-BAO standard came up. W. Ashley Smith Jr., founder and president of Part 135 air medical provider Jet Logistics, said his company adopted the voluntary standard when it planned to begin flying to Bermuda, which required an internationally recognized SMS.

Jet Logistics had started implementing an SMS through the FAA's voluntary program but abandoned the effort after finding that it was detracting from the multi-tiered IS-BAO process, he said. Based in Johns Island, South Carolina, the company operates a fleet of 16 Citation, Lear and Hawker jets for patient and donor organ transport.

"What concerns me is that the FAA will do one of two things," Smith told *BCA*. "They will either just simply make Part 5 applicable to us, which would make it complicated and overly burdensome, or they will try to mirror something like their voluntary program, which is also complicated and overly burdensome. That's why I talk about: is there a way we could sell them on IS-BAO, because a lot of industry has already embraced it and already started down that path. The problem is that the FAA does not like to outsource things."

NTSB's Most Wanted List

Rolling out the SMS paradigm to all revenue passenger-carrying operations tops the aviation portion of the NTSB's 2021-23 Most Wanted List of Transportation Safety Improvements. The safety board first recommended that SMS programs be implemented by Part 121 airlines in 2007; it called for the same requirement for public aeromedical helicopters in 2009, Part 135 charter operators in 2016 and air tour operators in 2019. In March 2021, the board adopted an investigative report that recommends SMS programs be required for all moneymaking Part 91 operations, including parachute-jump flights, historic aircraft experience flights and sightseeing balloon trips.

In May 2022, the NTSB issued Safety Recommendation A-22-15, which calls on the FAA to develop guidance on scaling SMS programs "that includes methods and techniques for implementation and specific examples applicable to several operational sectors, including air tours." A reference in the SMS proposed rulemaking to a draft revision of AC 120-92, an FAA advisory circular that contains information on scalability, "does not address the call for specificity outlined in Safety Recommendation A-22-15 because it remains too general," the NTSB states in comments on the NPRM.

Safety Recommendation A-22-15 was one of eight new and several reiterated recommendations the NTSB made following its investigation of the Dec. 26, 2019, collision into terrain of a Safari Aviation Airbus AS350 B2 sightseeing helicopter on Kauai, Hawaii, killing the pilot and six passengers. The board determined that the pilot's decision to continue flying into instrument meteorological conditions under visual flight rules was the probable cause of the accident. Safari Aviation's lack of safety management processes to identify hazards and mitigate the risks was a contributing factor.

In its comments on the current NPRM, the NTSB says it "strongly" supports the expansion of SMS requirements to include Part 135 operations "without exceptions for the size of the operator," as well as to operators conducting air tours under Part 91.147. The board faults the proposed rule for not including other operations under Part 91. "We remain steadfast in the position taken in our [March 2021] special investigation report that SMSs are necessary to improve the safety of all Part 91 revenue passenger-carrying operations, and we urge the FAA to address this omission in the final rule," the board states.

"The air tours is a good start, but we want to see the rule broadened," NTSB Chair Jennifer Homendy told *BCA*. "It is a great first step because it is something we've focused on for a long time, but we'd like to see some additions." **BCA**

The Crosscheck: The Need for Terrain Warning

Technical improvements are being developed for low-altitude, low-visibility flight

BY **ROGER COX**

TAWS inhibit switch involved in the 2015 Ketchikan accident.

NTSB

On June 25, 2015, a Promech Air de Havilland Canada DHC-3, registration N270PA, collided with terrain about 24 nm east-northeast of Ketchikan, Alaska. The pilot and all eight passengers were killed and the aircraft was destroyed.

At the time of the accident, Ketchikan International Airport (KTN) was reporting wind 130 deg. at 15 kt. gusting to 23 kt. with visibility six mi. in moderate rain and mist. The lowest cloud layer was at 800 ft., with a broken deck at 1,200 ft. and an overcast covering at 2,700 ft. AGL. Weather cameras pointed toward the accident area showed that higher ridge elevations were obscured by clouds.

The flight was a Part 135 sightseeing tour being conducted under visual flight rules. It could legally operate with two mi. visibility under a 1,000 ft. ceiling (w14 CFR 135.205).

The single-turbine-powered Otter was required to be equipped with a Class B terrain-alerting and warning system (TAWS). The Chelton FlightLogic electronic flight instrument system (EFIS) had an auditory and visual caution/warning system that would warn the pilot if he was approaching too close to terrain. However, when investigators examined the wreckage, they found the system had been disabled by an "Inhibit" toggle switch.

It wasn't the first time that Alaska pilots had experienced a controlled flight into terrain (CFIT) accident with their TAWS system turned off. It had also happened in Aleknagik, Alaska, in August 2010, and in Saint Mary's, Alaska, in November, 2013. Just after the Promech Air accident, a SeaPort Airlines Cessna 207A had a CFIT accident in Juneau, Alaska, with its TAWS inhibited, and while the NTSB was investigating the Ketchikan crash, another Part 135 aircraft struck a mountain near Togiak, Alaska, with its TAWS inhibited.

Pilots at Promech Air and other Alaska Part 135 operators complained that the TAWS equipment issued continuous squawk alert warnings at altitudes below 700 ft. AGL, and these were distracting when they were flying at 500 ft., or sometimes lower. As a result, they were inhibiting the warning system most of the time.

To address this problem, the NTSB wrote Safety Recommendation A-17-35. The board asked the FAA to find ways to provide effective terrain warnings while minimizing nuisance alerts for single-engine airplanes operating at low altitudes. The FAA assigned the problem to a group called the General Aviation Joint Steering Committee (GAJSC). Standards organization RTCA also convened a special committee (SC-231) to develop solutions and consider changes to standards affecting TAWS. The committee met with Alaskan operators in 2019 to further understand their practical needs.

In 2020, the FAA issued an exemption from 14 CFR 135.154(b)(2), TAWS, to members of the Alaskan Air Carriers Association. It allowed those nine carriers to operate single-engine, turbine-powered aircraft with 6-9 passenger seats in Alaska under VFR conditions using Class C TAWS with a display, rather than Class B TAWS. Class C TAWS with a display maintained the necessary level of safety while reducing the nuisance alerts, the agency said.

In 2021, the FAA told the NTSB it was focusing on two changes: preventing

NASA Viable Escape Maneuver Display.

NASA

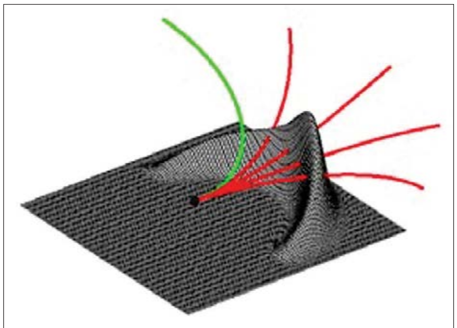
the pilot from tampering with proper TAWS functioning (the inhibit function); and developing TAWS lateral escape maneuvers commonly needed in Alaska. They also changed the TAWS alerting threshold to 500 ft. AGL.

Vertical And Lateral Escape Maneuvers

In January of this year, the FAA said it was working with the General Aviation Manufacturers Association (GAMA) to develop software to override and un-inhibit TAWS. The FAA also was working with NASA to develop guided terrain escape maneuvers to be incorporated into TAWS.

A look at RTCA's 2020 white paper on TAWS gives an idea of how the software will work. Current TAWS logic commands a straight-ahead climb even when terrain varies or there are icing conditions above. The new focus is on combined vertical and lateral escape maneuvers. The software will have to compute a set of flight paths, read terrain elevation data from a suitable source, compare the altitude of the predicted escape paths to the terrain elevation data, and choose the best action. High-resolution, high-integrity terrain data will be needed.

The white paper provided some illustrations. Red lines indicated flight paths with possible terrain conflicts and green lines indicated feasible escape paths. A yellow line would indicate the only remaining viable path when terrain clearance is in doubt. There may need to be new voice call outs, like "terrain ahead" and "terrain left" or "pull up left, pull up left." The visual display will have to be enhanced. Real-time performance assessments will also be needed.


RTCA

RTCA lateral and vertical CFIT escape illustration.

Escape Maneuver Display

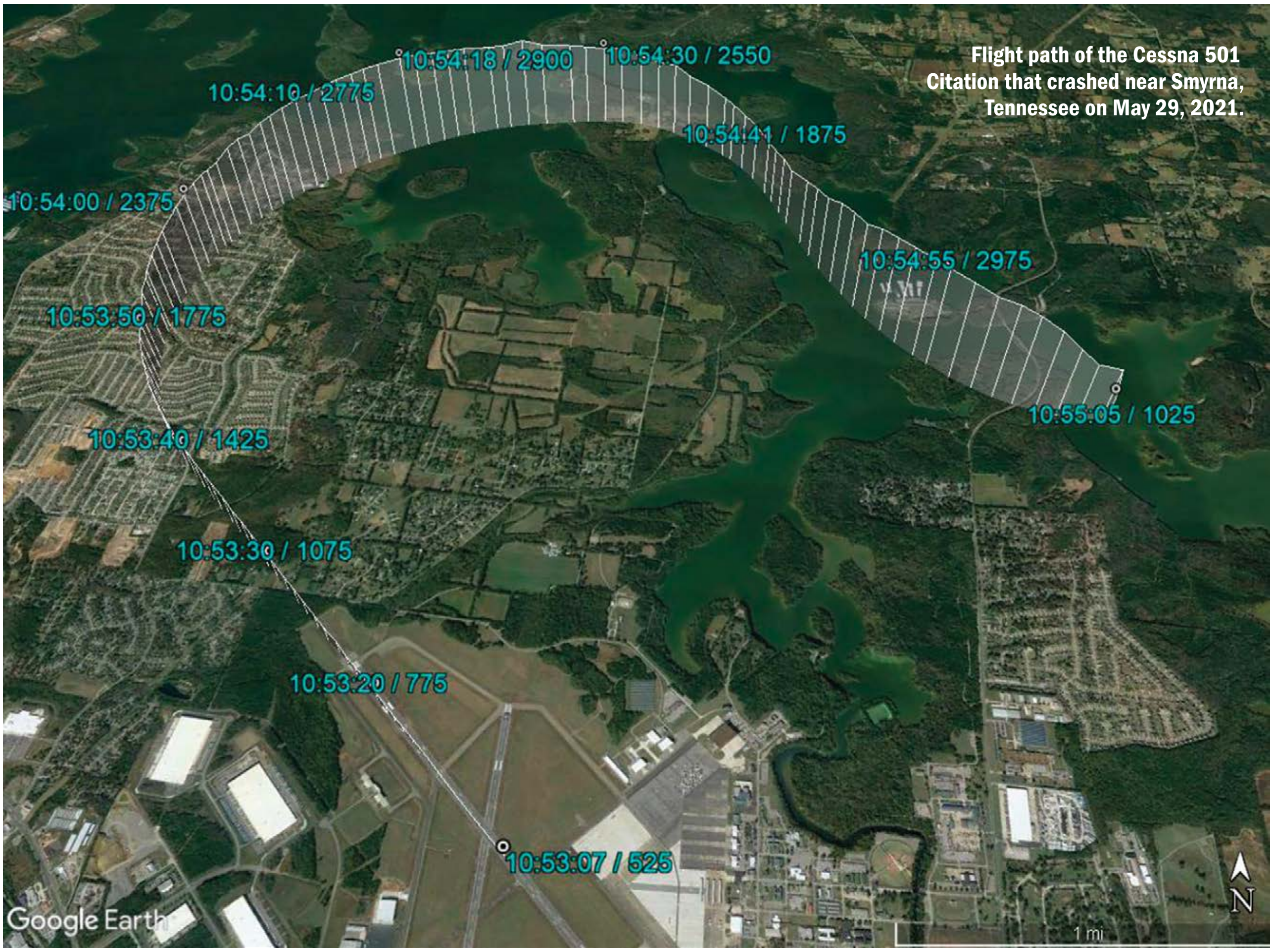
NASA has developed a "Viable Escape Maneuver Display" (VEMD) for flight crew situational awareness. The display is shown as if it were a progression of maneuver options depicted on a cellphone or tablet.

Twenty-four out of 39 Part 135 CFIT accidents that have taken place in the U.S. since 2010 have occurred in Alaska. While the FAA, RTCA, GAJSC and NASA were working on technical solutions to CFIT accidents, there were six more fatal Part 135 CFIT accidents in Alaska. The latest, in 2021, was a DHC-2 Beaver in Ketchikan. As a reciprocating-powered airplane, it was not even required to have a TAWS. That has to change.

If an airplane is carrying passengers on a commercial sightseeing flight, it needs to have state-of-the-art terrain-avoidance technology. This is especially true in Alaska, and the sooner this changes, the better. **BCA**

Type Rated but Not Ready

Cessna 501 Loss of Control Near Smyrna, Tennessee



Flight path of the Cessna 501 Citation that crashed near Smyrna, Tennessee on May 29, 2021.

NTSB

BY **ROGER COX**

A Cessna 501 Citation pilot and six of his friends and family were killed when he lost control of the airplane and crashed within 3 min. after takeoff near Smyrna, Tennessee on May 29, 2021. The NTSB recently released its report, which explained what the safety board believed had happened. The board's probable cause was a very common type in loss-of-control accidents. More challenging is trying to figure out why it happened.

On the morning of the accident the pilot topped off the fuel tanks and filed an IFR flight plan for Palm Beach International Airport (PBI). Around 10:20 a.m. he boarded the passengers, one of whom was a commercially certificated pilot with about 310 hr. of flight time. At about 10:27, he called Smyrna ground control for his clearance. He was cleared to PBI via radar vectors then as filed, to maintain 3,000 ft. and expecting flight level 330 10 min. after departure. His read-back was correct, and a minute later he called for taxi. He was cleared to taxi to runway 1, but was recleared to Runway 32 upon his request.

The current weather at Smyrna Airport (MQY) was wind 310 deg. at 10 kt, visibility 10 mi., overcast skies at 1,300 ft. AGL (above ground level), with a temperature of 14C (57F) and a dew point of 12C.

Smyrna Tower cleared the Cessna for takeoff at 10:51:55. "Citation ah six six bravo kilo Smyrna tower after departure turn right heading zero nine zero maintain three-thousand runway three two cleared for takeoff caution mower right of runway departure end."

The pilot replied: "OK, we're cleared for three two and we're going zero nine zero at or above three-thousand for six six bravo kilo."

The tower corrected him, "No, maintain three-thousand," and he replied "and we'll maintain three-thousand six six bravo kilo."

After takeoff, the tower said "Citation eight bravo ah six bravo kilo contact Nashville departure,” and the pilot acknowledged.

Two minutes passed. Not hearing the Citation pilot check in, Nashville departure said “November six six ah bravo kilo departure are you on frequency?”

The pilot replied “ah six six bravo kilo with you.”

At 10:54:30 departure said “November six six bravo kilo say altitude you are radar contact three north of Smyrna fly heading of ah one three zero.”

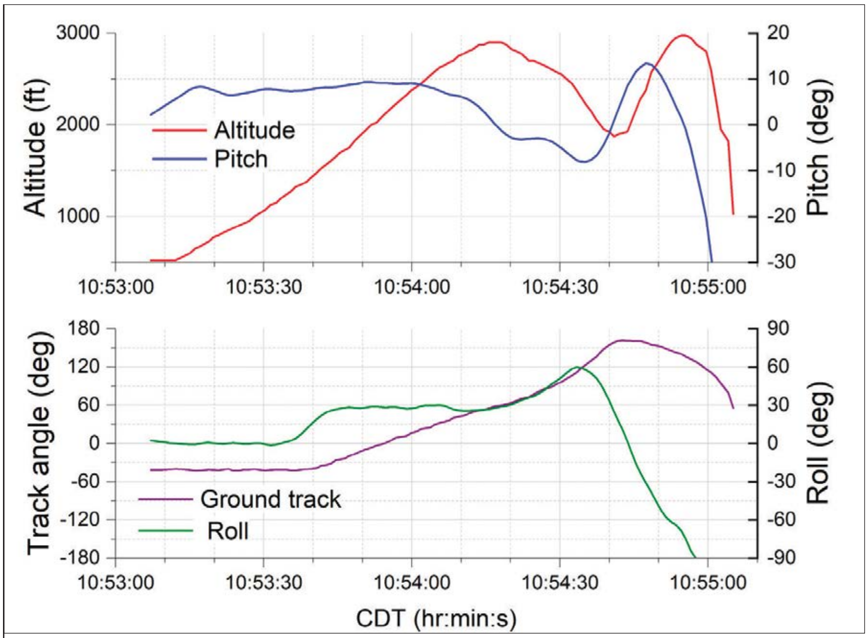
Fourteen seconds later, departure repeated his call,”November six six bravo kilo did you copy your heading one three zero?”

The pilot replied “One three zero six six bravo kilo.” It was his last transmission.

An NTSB performance specialist used recorded ADS-B data from the FAA and an aerodynamic model of the airplane to create a physics-based estimate of the aircraft’s trajectory. The Cessna took off from Runway 32 and initially climbed straight ahead at 2,000 fpm. There was an overcast cloud deck at 1,300 ft AGL, and just as the pilot entered the overcast he began a right turn to his assigned heading while continuing his climb. Twenty seconds later he began gradually reducing pitch. But instead of leveling off at his assigned altitude of 3,000 ft., he began descending after reaching 2,900 ft.

At this point the pilot was displaying the well-known characteristics of somatographic illusion. As the FAA’s Pilot’s Handbook of Aeronautical Knowledge says in Chapter 17, Aeromedical Factors, “A rapid acceleration, such as experienced during takeoff, stimulates the otolith organs in the same way as tilting the head backwards. This action may create what is known as the “somatogravic illusion” of being in a nose-up attitude, especially in conditions with poor visual references.”

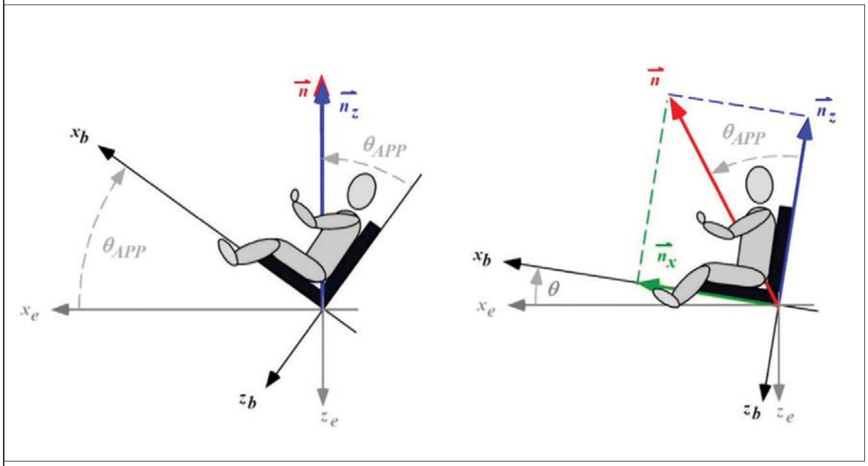
As the aircraft descended, the right bank increased to 60 deg. and the airspeed increased to 290 kt. Somatographic illusion also explains why the pilot overbanked. At 1,900 ft. the pilot reversed his pitch, again increasing it to an excessive 13 deg., and he reversed his roll, this time to an excessive 60 deg. left. He began his final overcorrection upon reaching 2,975 ft, pitching down 20 deg. and accelerating to over 350 kt. before striking the surface of Percy Priest Lake.



NTSB

Altitude, pitch, track and roll of Cessna 501 Citation.

The NTSB’s examination of the wreckage and both engines showed no malfunctions or failures that would have prevented the pilot from operating normally. Neither the pilot nor his pilot-rated passenger reported any medical conditions or medication use that could account for the accident. Investigators concluded the pilot experienced spatial disorientation during a time of high workload and failed to properly use his instrumentation. The agency’s probable cause was “The pilot’s loss of airplane control during climb due to spatial disorientation.”



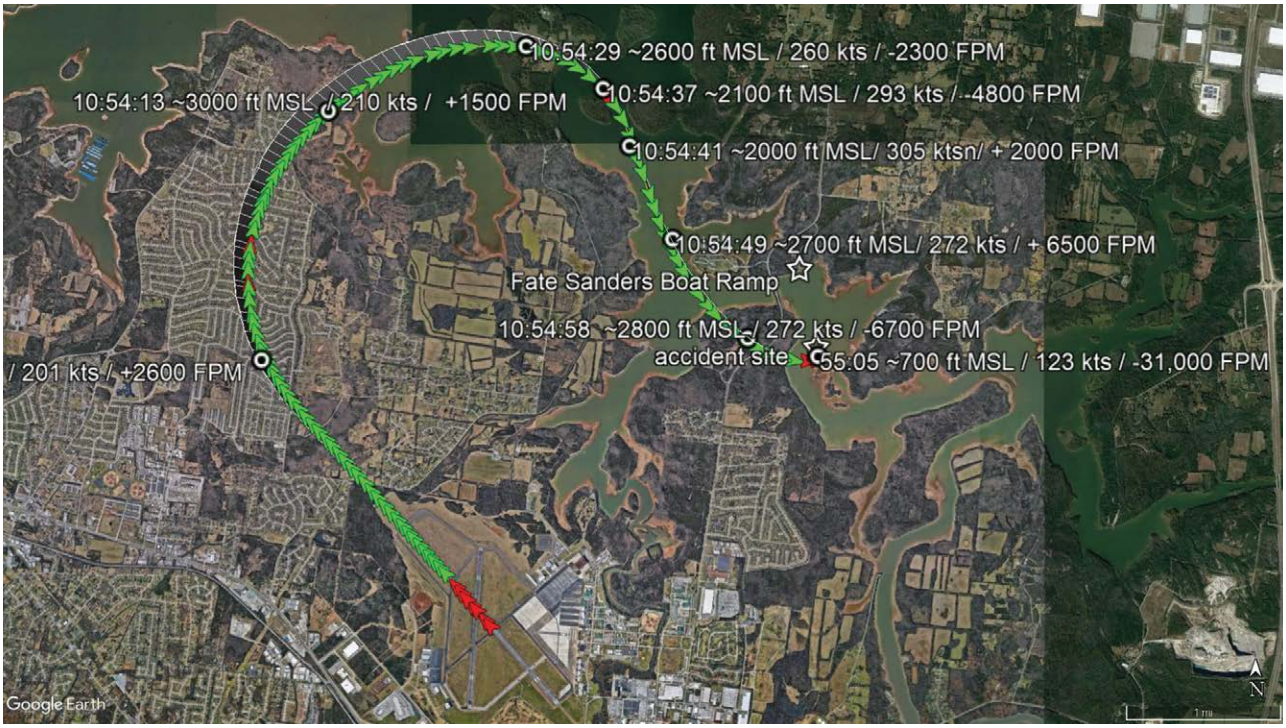
NTSB

Apparent angles in unaccelerated and accelerated flight.

The pilot was a retired actor who had starred in Tarzan movies. He lived with his family in Brentwood, Tennessee, not far from MQY. He held a commercial pilot’s certificate and an instrument rating, and had also qualified as a helicopter pilot at the private pilot level. He had obtained a CE-500 type rating in March of 2020, 14 months before the accident. His logbook showed he had accumulated a total 1680.5 flight hours, of which 83 were in the aircraft involved in the accident. Of his 39.8 instrument flight hours, 5.9 were logged in the Citation. He had an FAA class II medical certificate, dated November 12, 2019, that stated he “must wear corrective lenses.”

The pilot’s stepdaughter said in an interview that she had flown with him and that he was very cautious and would not fly in any conditions that would make

NTSB AND GOOGLE EARTH



Track of the accident aircraft over GoogleEarth imagery.

a passenger feel uncomfortable in the slightest. He was maintenance-conscious and recently had spent almost $100,000 upgrading the airplane. The aircraft was in the shop from November 2020 until February 2021.

A family friend who was pilot-qualified said he had flown with the pilot in the Citation in late March, not long before the accident. He expressed concern about the pilot's relative inexperience with the Citation and about the possibility that the airplane had been overloaded on the morning of the flight. According to this friend, the pilot had acquired a series of aircraft, each more complex than the last. His first airplane was a Cessna 172, the next a Beech Baron, and the third a Mitsubishi MU-2. According to FAA registration records, the Citation, tail number N66BK, was registered to a limited partnership in Brentwood on March 2, 2020.

WIKIPEDIA COMMONS

An earlier photo of the accident aircraft, registration N66BK, at Okeechobee County Airport in Florida.

An official at Flight Safety International's Atlanta Training Center said in a letter to the NTSB that the pilot involved in the accident had attended a Citation II Part 61.63 Initial course at Atlanta between January 13-24, 2020. "He was not issued a type rating as he did not meet the requisite performance level to achieve a recommendation for the check." He added that the pilot "completed 7 simulator sessions, for a total of 14 hr. of pilot flying time and acted as pilot-monitoring for a total of 12 hr. over the first 6 sessions. The last session was limited to 2 hr. of pilot flying."

An instructor pilot who flew with the Cessna pilot in his MU-2 said he flew the MU-2 pretty well for his hour level. That instructor later flew with the pilot in the Citation from February 24, 2020 to March 8, 2020, for a total of 11.4 hr. He said he saw no issues with the pilot's ability to fly the Citation in instrument meteorological conditions (IMC). He noted that the pilot was more familiar with the Garmin 750 installed in the MU-2 than the Garmin 430/530 in the accident aircraft. He added that in his opinion, the pilot needed more one-on-one training than the FSI simulator training provided.

The designated pilot examiner (DPE) who conducted his type rating checkride on March 20 said he was a very competent pilot. His oral exam was "really good," and during his flight test he performed very well. The DPE also verified that the accident pilot did have a valid class II medical certificate.

Aside from the pilot's failure to complete the FSI simulator training course, most of the comments about the pilot's skill and judgment level were positive. However, comments from another instructor who flew with him after he received his type rating told a different story.

That instructor, the chief instructor at the Wings of Eagles flight school in Smyrna, said he had flown with the accident pilot for about 25 hr. after he received his type rating. The instructor knew the pilot from having earlier conducted his original multi-engine training at the flight school. The instructor had about 10,000 hr. of jet time and about 3,000 hr. in CE-500 series airplanes. He said his flying with the pilot was not really instruction, but was about helping him get more comfortable flying the airplane.

The instructor said that the pilot was "always behind the airplane. The airplane was moving faster than what he could keep up with and he would miss things." He was not a professional pilot, and he did not like to fly fast. He was a safe pilot, excellent at using checklists, but had trouble multi-tasking and maintaining situational awareness. He depended heavily on his iPad to visualize where the airplane was in time and space.

On one occasion, the instructor had taken the controls away from him because he was about to bust an altitude. The pilot preferred to hand-fly the airplane rather than learn the steps needed to use the autopilot. He also wanted to fly to bigger cities like New York and Las Vegas, but the instructor told him he was not ready to operate in those fast-moving environments.

The instructor noted that it is very easy for a pilot in that aircraft to mistakenly turn off the avionics master switches after takeoff rather than the igniters because they are located right next to each other. The pilot had accidentally done this twice on flights they had flown together. The instructor had listened to the ATC recording of the accident flight and could hear that the igniters were still on during the last ATC transmission. He said the aircraft was equipped with back-up instruments that would be usable if the avionics master switch was turned off.

Instrument Currency versus Ratings

The investigation showed that the pilot was conscientious and had good motor skills. He didn't have the experience to complete a demanding initial jet training course, but he trained for and passed a type rating in the Citation, which was not easy. If the skies had been clear, he probably would have made it to PBI as planned. His missing competencies were autopilot skills, adequate instrument currency, and the necessary seasoning in a high-performance airplane.

The Citation was originally designed to be flown by two pilots. The FAA relented long ago and allowed the CE-501 and many other small turbine-powered airplanes to be flown by a single pilot. With that limitation, the pilot's proficiency with the autopilot is a must. But the accident pilot had not mastered using the autopilot.

The pilot had owned the airplane for 14 months, but had only logged 83 hr. in it. That's an average of six hours per month. Taking away the 36 or more hours he had receiving dual instruction or accompanied flying, he had only 47 hr. flying it alone—about 3 hr. a month. 14 CFR 61.57(c)(1) requires six instrument approaches, holding, and navigational tracking to be accomplished within the preceding six calendar months. The was down for maintenance for about three months, from November 2020 to February 2021. Without the pilot's logbook, which was not provided in the accident report, we don't know if he was instrument-current. Even if he was, 61.57 is a bare minimum and not nearly enough for a pilot new to an airplane to be proficient.

Finally, a type rating check is not easy, but a student who knows the Airman Certification Standards (ACS), studies and practices the required maneuvers has a good chance of passing. However, it must be noted that the rating does not provide seasoning or currency.

Any pilot can experience spatial disorientation. You must always be able to scan, read and follow the working flight and navigation instruments. That means you need highly developed instrument flying skills recently practiced before you take off into IMC. **BCA**

Advertisers' Index

Hazardous Materials

Think You've Never Carried any Hazmat? You'd be surprised . . .

BY **PATRICK R. VEILLETTE, PH.D.**

You might think "hazmat" is not an issue for business aircraft and that you've never carried a hazardous material on board, but guess again. If you've carried fly fishermen, hunters, campers, scuba divers or skiers headed for an extreme skiing adventure, you've probably carried hazmat. Have you ever carried a survival kit that contains a flare gun, or how about fingernail polish, batteries or a thermometer? These are examples of apparently "innocent" items that can pose a risk to an aircraft and its occupants.

It is entirely possible that your passengers will not recognize the potential hazard of an item in their luggage. This occurred to me on the ramp at Bozeman, Montana, when picking up clients to fly back to California. As I walked into the FBO to greet the clients, their baggage included the characteristic carrying cases for exquisite fly rods. They had been fly fishing on some of my favorite waters nearby, which also happen to coincide with grizzly bear habitat. Wise outdoor adventurers carry bear spray cannisters for self-defense in that terrain.

After establishing a positive rapport with the clients about the flies they successfully used on these waters, I asked, "I always had the spooky feeling that I needed to watch over my shoulder during each cast to see if a grizzly was behind me. You were carrying bear spray, of course?" I did this with a tone and body language that insinuated they were "wise outdoorsmen" by having bear spray, to which they quickly answered, "Oh, you bet!"

Instead of focusing on a recitation of the federal regulation prohibiting the carriage of that hazmat, in a couple of sentences I explained the considerable risk to our safety if one of those cannisters released its noxious agent in the confines of the aircraft cabin. It quickly convinced these clients that we couldn't carry bear spray on the aircraft.

Hazmat Regulations

The statutory definition of a hazardous material is something harmful to persons, to goods or property, or any substance that can cause a hazard to control of the aircraft during the flight. This could be a corrosive liquid that spills and seeps onto the control cables, causing corrosion on those cables and compromising their strength. It could be an explosive that can cause an intense fire that may burn through structural members. Hazmat also can be a substance that is noxious to aircraft occupants, such as spilled fingernail polish, which produces an odor that can affect respiration. While the potential hazard of a hazmat may not seem like an issue during flight, it can certainly become an issue during an emergency egress on the ground. For instance, consider the hazard created by firearm ammunition that may discharge during a post-crash fire.

BACKCOUNTRY ACCESS

This backpack is used by skiers in avalanche-prone terrain. It contains a high-pressure bottle with compressed air to inflate rapidly in case of an avalanche. Pilots transporting this equipment need to ensure that the pressure bottle is empty.

Title 49 of the U.S. Code of Federal Regulations (otherwise known as the Hazardous Materials Regulations, or "HMR") deals with the transportation of hazmat and applies to aircraft of U.S. registry, anywhere, and any aircraft operating in the U.S. in air commerce. These regulations provide guidelines for communicating the presence of a hazmat in a package, how to classify it, how to package the hazmat properly, how to mark the package correctly, how to put the right labels on the package, how to notify future handlers about the hazmat, how to certify that it has been handled the right way, and finally, how to select the proper transportation mode to be used.

Lithium Batteries

Probably the most common hazmat carried on business aircraft these days are lithium batteries. There are several videos of lithium batteries combusting that will convince anyone who has any lingering doubts about the inflight fire risk they pose. These videos show the intense heat produced by a lithium battery fire and also illustrate that the standard fire-fighting equipment normally available in aircraft are insufficient for controlling these fires.

Many of our modern computing and communication devices are powered by lithium batteries. These items should be kept in carry-on baggage. If you have watched the videos of lithium battery fires, then you can plainly see the unacceptable risk posed if these are packed in a section of the aircraft that cannot be accessed immediately.

Spare lithium batteries must be carried with the passenger in the aircraft cabin. Any lithium-powered devices or spare batteries need to be protected from damage, accidental activation or short circuits. Battery terminals should be protected by manufacturer's packaging or covered with tape and placed in separate bags to prevent short circuits. Damaged, defective or recalled lithium batteries must not be carried, due to the safety concern of overheating or catching on fire.

Recreational devices such as hoverboards and self-balancing scooters are also powered by lithium batteries. The same precautions must be followed for these as well. Any device that exceeds 160 Wh (watt-hours) is prohibited from carriage. This pertains to most unicycle scooters and Segway-type scooters.

Outdoor Adventurers

Many of business aviation's customers utilize our fleets of aircraft for transportation to and from outdoor recreation locations. Outdoor recreation activities may include equipment that can be a hazard to the aircraft and/or its occupants. Some of these threats are obvious, but some are not. An example of the latter is the new evolution in special avalanche-protection equipment for adventurous skiers. In recent years, skiers who venture into avalanche-prone back country terrain have begun wearing self-inflating backpacks that will form a protective cocoon around the skier if caught in an avalanche. Inflation is provided by a cartridge of compressed noninflammable gas.

Some of you may have flown campers and hunters who packed portable propane cylinders for their camping stoves. Or you may have carried scuba tanks for divers. If an improperly secured canister fell over in turbulence, the pressure could propel the canister around the cabin uncontrollably with the destructive force of a missile. Compressed gases also have the potential to form a violent flammable mixture.

Something as innocent as a package of matches can create quite a problem in flight if vibrations cause the matches to ignite, or if steel wool comes in contact with the ends of a battery.

Flammable solids such as these and cans of heating fluid require special handling.

MYSTERY RANCH SPRAY HOLDER

The release of bear spray in the enclosed interior of an aircraft could disable the occupants.

Firearm ammunition is also a "hazmat." Small arms ammunition for personal use must be packed in fiber, wood or metal boxes, or packaging specifically designed to carry small amounts of ammunition.

Some of you have probably carried fishermen back from Alaska with their coolers of fresh-caught halibut and salmon. Often these containers have dry ice to keep the delicious contents cool for the trip. Dry ice sublimates (i.e., turns directly from a solid into a gas) to gaseous carbon dioxide at typical temperatures and pressures in an aircraft cabin. Excessive carbon dioxide concentrations can cause aircrew incapacitation.

Small amounts of dry ice are allowed as long as the package is properly packed, is properly marked, the weight of the dry ice is less than 5.07 lb., and it must be carried in checked baggage. Dry ice intended for personal use to keep perishable food cool is allowed in carry-on baggage provided the package allows the release of carbon dioxide gas (obviously, a sealed container could develop dangerous pressure levels in flight), and doesn't exceed 4.4 lb. per passenger.

Potentially Dangerous Liquids

The most obvious example of a flammable liquid commonly carried on business aircraft is alcohol. Other examples of flammable liquids include paint, paint thinners, benzene, liquid cement, some cosmetics, and camp stove gas. The hazmat regulations allow alcohol as carry-on baggage as long as it is less than 140 proof. Interestingly enough, a few alcoholic beverages (such as rum 151) exceed 140 proof and thus are prohibited in aircraft. Be advised that the rules regarding passengers bringing their own alcohol are a different set of rules from the hazmat regulations.

Consumer commodities for household use, to include hair dyes, fingernail polish and aerosol cans, could cause extreme annoyance or discomfort to a flight crew member. An avid reader described an incident in which a passenger spilled a bottle of fingernail polish remover while in cruise flight. The vapor from the spilled fluid was so noxious that the crew had to perform an immediate precautionary landing. Post-flight inspection found a considerable amount of damage to the underlying structure caused by the spilled fluid.

If a package contains liquids, you must keep the package upright. In hazmat procedures, packages with liquids are marked with arrows that show the proper orientation of the package, and these directions must be followed. If you suspect that the package containing a liquid hazmat has been stored improperly on its side, you really must open the package and inspect it. You might be dismayed to learn that some containers have been designed and certified for carrying hazmat liquids but that the lids have sometimes been a weak point in the

PATRICK VEILLETTE

Containers of freshly caught halibut and salmon often utilize dry ice to keep the contents cool for the trip. Dry ice sublimates to gaseous carbon dioxide at typical temperatures and pressures in an aircraft cabin, which could pose a hazard for aircrews.

design. You should always keep packages containing liquids in the proper orientation during loading, storage and en route. Always secure these items so they won't tip over in flight.

Medical

Infectious substances, drugs used in veterinary or human treatment, biological products, vaccines, urine samples and medical waste require special precautions and training for flight crews involved in transporting these materials.

Some medical equipment may have radioactive components. Radioactive substances are measured and classified according to the amount of radioactivity that they emit, and a "Transport Index" is assigned to this amount. The total amount of the Transport Indices on the aircraft establishes the required separation from passenger compartments. This chart can befound in 49 CFR.

Undeclared Hazmat

Undeclared hazmat is a serious issue. Any person offering hazmat for transportation is responsible for properly identifying, describing and classifying the material. In addition, they are also responsible for properly completing the communications and packaging requirements prior to offering the shipment for transportation.

It is vital for pilots and any other company personnel who have duties that may include the loading and handling of baggage to become familiar with clues indicating potential hidden hazmat. Employees should be especially vigilant when screening all cargo and baggage to prevent the inadvertent acceptance and transportation of unauthorized materials.

If you work for an air carrier certificate-holde r authorized to carry hazmat, you cannot accept a hazmat shipment unless the shipment is properly described in the shipping papers, required certifications are on the shipping papers, the package is marked and labeled as required, and the shipment is authorized to be carried on an aircraft.

Regulation 49 CFR 175 requires that packages containing hazardous materials that might react dangerously with other packages may not be placed next to each other. They should also not be positioned so that a leaking package could allow a dangerous interaction. There is a Stowage Compatibility Chart in 49 CFR 1 75 that describes which classes of hazmat cannot be carried next to other classes of hazmat. For example, corrosive materials should not be stowed next to or in contact with flammable liquids and solids, explosives, blasting agents, flammable solids or oxidizers. Oxidizers should not be carried next to explosives, flammable liquids and solids and oxidizers.

If the shipping container is damaged in any way, you need to be suspicious. Before loading any cargo, you should inspect each package for holes, leakage or other obvious signs that the packing is starting to fail.

Hazardous Material Regulation (HMR 175.10) does grant some exemptions. For example, it is possible to carry a tire assembly with a serviceable tire provided the tire is not inflated to a gauge pressure exceeding the maximum rated for the tire.

Under HMR 175.10, self-defense sprays are exempted from the hazmat requirements if the units contain less than 4 oz. It must have a positive means to prevent accidental discharge and must be carried in checked baggage only.

The list of other exempted items is contained in HMR 175.10 and includes such things as medicinal items, oxygen, implant medical devices, personal smoking materials, incubator units, and wheelchairs, hair curlers, and barometers, just as examples.

Take Hazmat Seriously

Air carriers operating under 14 CFR 135 are required to have a formal hazmat training class and procedures that conform with the 49 CFR. Whether you hold an air carrier certificate or not, clearly you are held responsible for obeying these regulations, and as a matter of good risk-management practice, even if there wasn't a set of regulations about this, it would make good sense to follow the regulatory guidelines. Like many of the FARs, nearly every line in 49 CFR is also written in blood. Hazmat is something to be taken seriously, and like most aviation problems, prevention is always the best option.

The bottom line is that you can't be too careful about the items you carry in the aircraft.

In the event that you experience an aircraft emergency and need to perform a precautionary landing, notify the nearest ATC facility that you have these hazmat items on board. It's helpful to tell the controllers where these items are located and the quantity or weight. This information will be passed along to the ARFF incident commander so that they will take the proper precautions for suppressing any fire or when approaching the aircraft. **BCA**

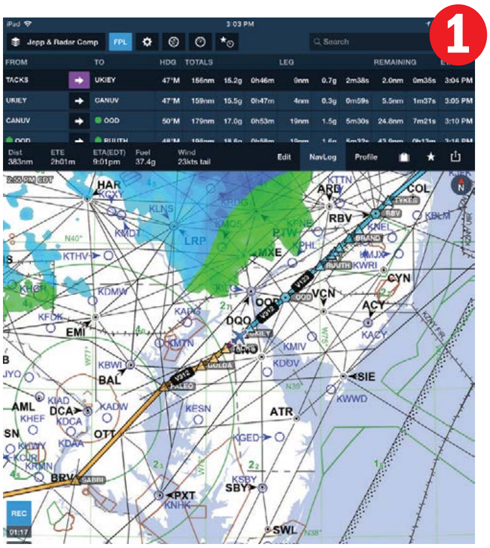
Marketplace

By Matthew Orloff

Flight Planning Services

Service options to help pilots plan flights—from short to long.

1



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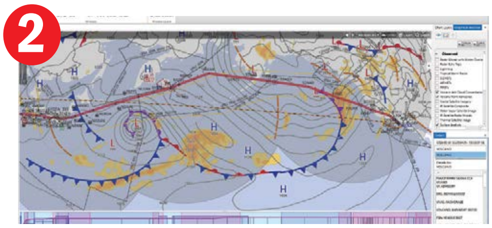

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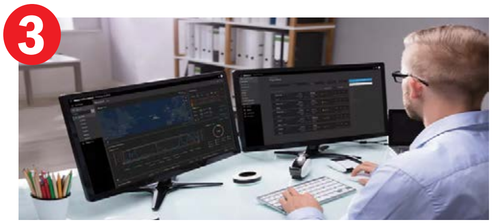

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5

1. From GA to BizAv

Company: **Foreflight**

Product: Foreflight Dispatch includes schedule-to-mobile integration along with tools for complex planning. It recently integrated with Jeppesen International Trip Planning Services to further support trip planning, fuel and ground-handling needs globally. Other additions to the Dispatch application included weight-and-balance improvements, fuel tankering and EAPIS services. After introducing its runway analysis service, Foreflight also developed engine-out procedures for more than 60% of the common business aviation fleet.

https://marketplace.aviationweek.com/company/foreflight

2. More than Approach Charts

Company: **Jeppesen**

Product: Jeppesen's flight planning services are available through a Web interface (Jetplan.com) and via PC software (JetPlanner). Both platforms allow users to graphically depict routes, overlay weather and navigation information, and track a flight in progress. International trip planning is available, with 24/7 customer assistance. The company says its goal for its flight planning service is to calculate an optimized plan for a specific aircraft and routing to file with ATC.

https://marketplace.aviationweek.com/company/jeppesen

3. Connected and Integrated

Company: **Honeywell**

Product: Honeywell Forge Aircraft Datalink Services claims the fastest data link speeds available, to help reduce pilot and dispatcher workload. Pilots can convert and upload flight plans from many of the popular third-party flight planning services, and coverage does not require changing current data-communications hardware.

Aircraft with the ability to take advantage of the FAA's NextGen Departure Clearances via data link can receive clearances.

https://marketplace.aviationweek.com/company/honeywell-aerospace-0

4. Trans-Oceanic

Company: **ARINCDirect Collins Aerospace**

Product: ARINCDirect is popular for transoceanic missions and has the ability to change or amend a route on the plotting chart. The plotting chart generates all intersections that are close to a particular area and loads a new route, which can be verified with the aircraft's FMS. The plotting chart also will automatically populate the equal time points, and at the end of a trip, the software generates a master document that is required after every oceanic trip.

https://marketplace.aviationweek.com/company/collins-aerospace-arincdirect-solutions

5. Staying Ahead

Company: **Universal Weather and Aviation**

Product: Universal Weather and Aviation's has many strategic partners, including data link and connectivity services partners Honeywell Forge and ARINCDirect. Flight planning collaborations include AviationManuals and APG. The company has advanced access to the status of NAS and current Traffic Management Initiatives that affect national airspace air traffic flow, and says it participates in A-CDM to stay abreast of emerging FAA air traffic management tools and procedures.

https://marketplace.aviationweek.com/company/universal-weather-aviation-inc

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Cabin Interiors **https://marketplace.aviationweek.com/product/sd-plane-simple-antenna-systems**

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James Person
Guest Columnist

Connectivity Rules

Tips For Selecting A Bizav Connectivity Provider

TODAY'S BUSINESS AVIATION OPERATORS AND OWNERS EXPECT high-speed, quality internet service that provides experiences comparable to those on the ground. That includes media streaming, live HD video conferencing, downloading large files, email, web browsing, and live inflight TV services.

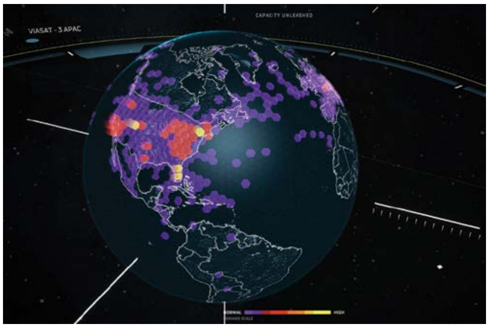
While many of these services weren't available only a few years ago, a host of companies now offer reliable business aviation connectivity, delivered by very different methods.

With so many providers, features and package options, how do you choose the best one for your crew and customers' needs?

Let's take a look at four areas you'll likely want to take into consideration as you choose an aviation connectivity partner.

WHERE YOUR AIRCRAFT TRAVELS

If your aircraft only flies over land, there are more options. Air-to-ground (ATG) connectivity, which provides internet services using ground-based towers, requires the aircraft to be in range of a tower. An ATG system works in the continental U.S. and parts of Canada, but not over oceans.



VIASAT

A satellite-based—or Satcom—system connects to the internet by sending data to a satellite, then down to a ground station and back. This kind of connection can provide a much broader, even global, service. Satcom providers include those operating in nongeosynchronous-orbit (NGSO), including low Earth orbit (LEO), and geosynchronous equatorial orbit (GEO).

While NGSOs may offer lower latency than GEO-based services, GEO satellites have the bandwidth and flexibility to provide more capacity in specific regions, typically those that are densely populated or see periodic high demands for bandwidth. That includes busy airports, like New Jersey's Teterboro. The limited capacity and coverage of each fast-moving NGSO satellite make meeting such spikes in demand a challenge.

A GEO carrier like Viasat, for example, already has some ability to focus bandwidth with its ViaSat-2 satellite, and each satellite in its upcoming ViaSat-3 global constellation is expected to be able to temporarily concentrate capacity at geographic points of demand. That ability will provide a much better connectivity experience.It also provides coverage where 90% of business jets fly, and its upcoming ViaSat-3 global constellation is expected to expand coverage around the world.

CAPACITY NEEDS

Consider the usage needs and desires of everyone on your aircraft, including your pilot and crew. How much will they be online and for what purposes?

If it's primarily business passengers, you'll need a provider and plan that can accommodate multiple connected devices, and support virtual private networks (VPN), document downloads, cloud uploads and high-quality video conferencing.

ATG and GEO-based satellite services can both provide video conferencing. LEO-based services are not yet widely available, and these constellations likely will struggle to meet demand in densely populated areas or during high traffic. The key to a quality video conferencing experience is capacity, which is where GEO satellites have a distinct advantage.

Leisure passengers will likely want to use Zoom or another live video chat service, stream movies and live sports, and access social media—at the level of quality they are used to.

Data usage needs likely will change based on who's on board. Search for a provider with flexible data plans to accommodate those shifts.

FUTURE-PROOFING

Online needs and systems are constantly evolving. Passengers, pilots, and crew members likely will increase their use of inflight video tools, virtual/augmented reality systems, and business, collaboration, and productivity applications.

Business jet owners and operators should look ahead to their future connectivity and usage demands, and the ease of upgrading systems to meet them.

Consider also whether your destinations may change in the future. An ATG system may work well today and cost less, but it will lose connectivity only a few miles from shore.

An operator should make sure that a connectivity solution will also work in the future. The Viasat K_a-band solution guarantees business jet owners backward and forward compatibility, ensuring the antenna and in-cabin systems can scale as Viasat launches new satellites.

INSTALLATION AND ONGOING COSTS

Installation costs vary widely based on the system chosen and the aircraft in question. Costs include not only money but downtime—for the initial installation and for repairs and upgrades down the road.

Most business aviation operators and owners typically can't afford to let aircraft sit idle for long. A connectivity solution that can cope with technology changes can help keep costs and downtime to a minimum.

Monthly plan costs also vary widely. Make a list of your connectivity must-haves. Then shop around and compare to find the plan that best suits your needs and finances. **BCA**

James Person is Viasat's senior director of global business development for Business and VVIP aviation.

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