TURBINEPILOT

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D-JET DAWN

A first look at the first single-engine very light jet to hit the market

BY THOMAS A. HORNE

PHOTOGRAPHY BY MIKE FIZER

The economic downturn has affected all general aviation manufacturers, but one in particular soldiers on with a large measure of confidence. In spite of the bankruptcy of a major engine supplier for its piston line (Thielert Aircraft Engines), the costs associated with developing its own replacement engines for the Thielerts (the Austro AE 300 turbodiesels, which serve in the newly certified DA42 NG), and building a Lycoming-powered version of its DA42 (the DA42 L360), Diamond Aircraft continues to advance its new single-engine very light jet—the D-JET.

Announced in 2003, the D-JET made its first flight in April 2006. Now, preproduction prototypes are being used to finalize the D-JET's design in preparation for certification—which should come in the second half of 2010.

I was invited to Diamond's London, Ontario, Canada, factory so that I could fly D-JET serial number 003. In doing so, I became the first aviation journalist to fly not only the D-JET, but the very first to fly a single-engine personal jet, period.

Testing, testing

Serial number 003 goes by its C-GUPJ (Ultimate Personal Jet) registration. Diamond experimental test pilot Howard Judd was my minder. This third D-JET prototype is dedicated principally to high-speed flight tests, which focus on high-altitude performance validation and the refinement of handling characteristics. (The first D-JET was a proof-of-concept airplane; serial number 002—C-GVLJ—is primarily for aerodynamic development and powered by the originally selected Williams FJ33-15 engine).

First came a briefing on bailout procedures from Dave Marsh, Diamond's manager of experimental flight test. This was not the final, conforming prototype, and so this experimental airplane's flight characteristics had yet to be finalized. However small the probability, pilots of test aircraft must be ready to bail out should the need arise. The egress system uses a motor to drive the seats aft, which puts the occupants next to the cabin door. Yank the door handle, unlatch the seatbelt harness, and out you go. The helmet's oxygen-mask hose breaks away from the ship's system with a quick-disconnect fixture, but you continue to receive oxygen via a "bailout bottle" integrated into the parachute. A lanyard connecting the parachute to the seat frame serves as a static line to deploy the parachute. If that fails, a barometric chute release will automatically open the parachute at a safe altitude. So suiting up for the flights was an education in itself.

A mockup of the D-Jet's panel (left) features the Garmin G1000 avionics suite and a glareshield-mounted GFC 700 autopilot/flight control system. A keypad beneath the thrust lever is used to make entries on the G1000. Lighting and temperature controls are on an overhead panel (above). Diamond came up with a clever design for the two-piece airstair door, in development when this story was written (below). When the door opens, a panel deploys to both shield the engine inlet and provide a passenger handrail.

Judd told me about this airplane's somewhat heavy control feel and response in pitch. This is a reflection of the smallish elevator horns. The horns provide aerodynamic counterbalancing when the elevator is displaced, and also affect control forces. The smaller the elevator horns, the more stick force it takes to displace the airplane from trim speed, and more stick force will be required for such maneuvers as steep turns and the landing flare. Serial number 002 has already been tested with larger elevator horns, and its control forces are lighter and more in keeping with Diamond's final design.

Serial number 003 was also fitted with vortex generators at the wing root, and "T strips" on the aileron trailing edges. The former preserve airflow attachment around the engine air inlets; the latter are installed to test aileron forces and roll rates.

Diamond's many airframe tweaks are meant to make sure the D-JET meets FAR Part 23 certification rules and ensure that the airplane has a control feel that customers stepping up from piston aircraft will find familiar.

Climb and cruise

Startup is stone simple: Master and generator switches on, fuel pump on, and rotate the ignition switch to the Start position. Soon comes the jet whine, and after setting up the Garmin G1000 it's time to taxi. Takeoff is equally straightforward. Select 20 degrees of flap, push the thrust lever forward, rotate at 85 knots, and away you go. Judd and I saw initial climb rates in the area of 3,000 fpm at our maximum takeoff weight of 5,650 pounds. Passing through 10,000 feet, doing 250 KTAS, climb rate was still a healthy 2,300 fpm.

For our cruise performance data we used the ship's air data system, which is fed by the test boom's pitot-static and total air temperature instruments. At FL250, and with thrust set at 99.7-percent N_1 (maximum continuous power), an ITT of 784 degrees Celsius (comfortably below the 855-degree redline), a fuel burn of 506 pph/75 gph, and a static air temperature of minus 23 degrees

Celsius (11 degrees warmer than the ISA value of minus 34 degrees C at that altitude), our true airspeed worked out to 323 KTAS. That's eight knots faster than Diamond's projected max cruise speed of 315 KTAS. In other words, we were beating the book—even under ISA +11 conditions. It seems a fair bet that the D-JET may well end up having max cruise speeds more in the area of 320 KTAS when all is said and done. It all depends on balancing the airframe's final drag and the derating of the Williams FJ33-5A engine to reduce fuel burn while maintaining performance. For long-range cruise, we turned in 252 KTAS burning 332 pph/50 gph. Diamond officials said airframe drag reduction would further decrease the fuel burn in production airplanes. By minimizing drag, Diamond can refine the engine's FADEC to reach target speeds while running at lower power settings—and therefore lower fuel flows.

With power back, I cycled the power lever from full power to idle thrust. The nose rose and fell slightly in response to power—nothing out of the ordinary. Obviously, Diamond has done a lot of work in adjusting the engine's exhaust and thrust line to minimize pitch and trim changes; little trimming is needed when lowering gear and flaps, as well.

SPECSHEET

Diamond D-JET

Base price (well equipped): $1,890,000

Specifications (preliminary)

Powerplant	(1) Williams International FJ33-5A, 1,900-lb thrust
Recommended TBO	4,000 hr
Recommended hot section inspection	2,000 hr
Length	35 ft 1 in
Height	11 ft 7in
Wingspan	37 ft 6 in
Wing area	159.8 sq ft
Wing loading	31 lb/sq ft
Power loading	3.2 lb-mass/lb-thrust
Seats	2+3
Cabin length	11 ft 8 in
Cabin width	4 ft 9 in
Cabin height	4 ft 6 in
Basic operating weight	3,650 lb
Max ramp weight	5,690 lb
Max takeoff weight	5,650 lb
Zero fuel weight	3,950 lb
Max useful load	2,240 lb
Payload w/full fuel	500 lb
Payload w/full fuel, as tested	N/A
Max landing weight	5,216 lb
Fuel capacity	260 gal (257.8 gal usable) 1,740 lb (1,727 lb usable)
Baggage capacity, forward (external)	125 lb, 25 cu ft
Baggage capacity, aft (external)	125 lb, 15 cu ft
Baggage capacity (cabin)	125 lb, 10 cu ft

Performance

Takeoff distance over 50-ft obstacle	2,350 ft
Max demonstrated crosswind component	20 kt
Rate of climb, sea level	2,550 fpm
Cruise speed/range with 45-min IFR reserve @Max range setting, 25,000 ft	1,350 nm @240 kts (300 pph/44.8 gph)
Cruise speed/range with 45 min IFR reserve @Max cruise setting, 25,000 ft	856 nm @315 KTAS (500 pph/75 gph)
Max operating altitude	25,000 ft
Sea-level cabin to	9,200 ft

Limiting and Recommended Airspeeds

V_R (rotation)	83 KIAS
V_1 (takeoff decision speed)	83 KIAS
V_A (design maneuvering)	175 KTAS
V_{FE} (max flap extended)	160 KIAS
V_{LE} (max gear extended)	200 KIAS
V_{LO} (max gear operating)	
Extend	200 KIAS
Retract	200 KIAS
V_{REF} (reference speed, final approach)	88 KIAS
V_{MO} (max operating speed)	250 KIAS
M_{MO} (max Mach number)	0.56 M
V_{S1} (stall, clean)	95 KIAS
V_{SO} (stall, in landing configuration)	67 KIAS

For more information, contact Diamond Aircraft Industries, 1560 Crumlin Sideroad, London, Ontario, Canada N5V 1S2; telephone: 519-457-4000; www.diamondaircraft.com.

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, sea level, gross weight conditions unless otherwise noted.

Glide

The D-JET has but one engine, so good glide performance was top on Diamond's long list of objectives. Simulating a flameout with idle thrust, I trimmed for the glide speed of 115 KIAS/160 KTAS at 15,000 feet, and then saw a descent rate of between 600 and 850 fpm. This means that close to the ground, the D-JET would have sink rates similar to those of a complex piston single. Diamond projects glide distances ranging from 67 nm at FL250 to 14 nm at 5,000 feet.

In case of a loss of pressurization, of course, emergency descent rates are much higher. With gear down and pitching to redline, descending from FL250 to a breathable safe altitude of 10,000 feet wouldn't take long at all. This is one reason why Diamond chose 25,000 feet as the D-JET's maximum operating altitude.

"The engine has plenty of excess thrust at 25,000 feet, but Diamond wanted the airplane to fly lower for a number of safety reasons—one of them being a quick emergency descent," Judd said. He also said that during tests in San Angelo, Texas, it was customary for test pilots to end stall-test flights with simulated dead-stick landings 20 to 30 nm away. "It was easy," Judd added.

Maneuvering and landing

As I discovered during the air-to-air photo mission, this particular D-JET has somewhat heavy control forces, but nothing to squawk about. It reminded me of late-model Mooneys, without the adverse yaw—a bit of muscle to roll out of level flight, hold altitude in a steep turn, and flare for a landing. But as already mentioned, Diamond promises that control forces in production airplanes will be lightened. Even so, it's worth saying that a bit of control heaviness can help make a good instrument platform: set the airplane up, and it stays put.

There are no surprises when it comes to landings. If you can land a big piston single or twin, you'll have no trouble with the D-JET. Our procedure calls for gear down below 160 knots, landing flaps below 130 knots, and 100 knots on downwind and base legs. On the final approach course, with approximately 60 percent N_1, reference speeds settled in at 90 knots. Use power to cross the threshold at 88 knots, and touchdown should come at 75 knots.

The D-Jet interior features a three-seat cabin with a single aft-facing seat and two forward-facing seats (right). The fold-down steps of the airstair door will not intrude into the cabin. Instead, the door's interior will have a smooth surface, complete with a side rail. The result: plenty of room for everyone.

Systems

There's not enough room to delve into all the D-JET's systems, just a few that distinguish the design. First is the airplane's new medium-bypass-ratio Williams FJ33-5A engine. Its 1,900 pounds of maximum thrust is 336 pounds more than the Williams FJ33-15 engine originally selected.

The original engine produced 1,565 lbs of thrust. But Diamond found this thrust rating insufficient. The higher available thrust of the -5A was a better fit, and is useful for several reasons. One is to allow an upward creep in gross weight, to maintain the promised useful load while ensuring that target performance numbers are met. Another is the need for adequate bleed air to inflate the D-JET's deice boots (the TKS "weeping wing" system was considered, then rejected principally because of its high weight penalty). Still another is to provide adequate anti-ice heat to the bifurcated engine inlet ducts at the wing roots. Finally, the new engine promises 4,000-hour TBOs (the -15s have 3,500-hour TBOs), and offers an upgrade path for more performance (initially the engine will be released with a FADEC-programmed derated max thrust) as well as other improvements being added to the Williams FJ44-4 engine—the same engine used in Cessna's Citation CJ4.

Diamond Aircraft Industries President Peter Maurer emphasizes another important reason for the engine change. "We didn't want to produce an initial series of airplanes with the smaller engine and less capability and then later be forced into the larger engine for competitive reasons. Doing so would have orphaned the early series and adversely affected their resale value. It was important to us to protect the customers' investment to maintain their long-term trust," Maurer said.

D-JETs come with an engine fire detection and suppression system. This is a two-shot system, which means that pilots can douse a fire using one or both Halon 1301 extinguisher bottles.

Finally, the D-JET will use a stick pusher for stall protection. This system senses when the stall angle of attack is near, then automatically applies nose-down pitch. Diamond is going with the pusher system to prevent any chance of a deep stall. Deep stalls can occur in any T-tailed airplane at very high angles of attack, when the elevators can be rendered ineffective by turbulent airflows caused by wake interference from the wing and fuselage. Moreover, FAR Part 23 requires spin testing for single-engine airplane certification, but the D-JET avoids this complex, hazardous, and time-consuming flight test program by using a pusher, which greatly simplifies compliance with the spin rule. The D-JET also has ventral strakes that help prevent deep stalls by creating nose-down pitching moments at deep-stall angles of attack. That's because the strakes are still flying in undisturbed air.

The D-JET idea

Maurer made a triangular sketch illustrating the balancing act of developing a light jet. The apexes were labeled "low cost," "high-altitude performance," and "comfort" with all three being mutually exclusive. Maurer said that although Cessna and Embraer, for example, emphasize high-altitude performance and comfort, cost is sacrificed. The D-JET's strengths are its low cost and comfort. At $1.89 million, it's priced much less than competing light jets, and offers plenty of shoulder, leg, and elbow room in both its cockpit and three-seat cabin. The baggage compartment capacity isn't shabby, either.

And although the D-JET may be a single-engine design, it's hard to ignore its big-airplane aura. The airplane sits tall on the ramp, has an airstair door, and has the presence, control feel, and power response of a much larger jet. There's a definite impression of mass and substance that's lacking in other airplanes in the D-JET's weight category.

"We are trying very hard to make it a landmark design—sort of like a Bonanza for the twenty-first century," Maurer said. "It's the best fit for the owner-flown personal jet market, and while yes, you can still get into the weather at 25,000 feet, you will have plenty of weather information in the cockpit to avoid it. Taking an owner-flown airplane—especially a single-pilot one—up to 41,000 feet may give you some edge in speed, but we think that there is a safety advantage in the D-JET's cruising altitude. Cruising at 41,000 feet is like walking a roofline—it's not a forgiving environment if something goes wrong. Flying at 25,000 feet is more like walking on a wide plateau in terms of risk."

Training is another component of the D-JET program, and Diamond has already contracted with Airline Transport Professionals (ATP) to conduct type-rating and recurrent training at selected sites around the nation. Simulators from Diamond's own simulation division will be used in the coursework, which can take up to two weeks in the case of a pilot without turbine experience. ATP has 20 Diamond D-JETs on order that it will use for training, as well as in its Airline Career Pilot Program. ATP also will offer monitored D-JET operating experience—think "mentoring."

The D-JET program is progressing in more ways than one. A conforming prototype is the next airplane set for testing, and Diamond has 300 firm orders on the books as of this writing. Factor in that the D-JET has already outlasted many of its competitors, and you have all the signs of an airplane that owns its own very promising niche.

E-mail the author at tom.horne@aopa.org.

WHAT IT LOOKS LIKE

Imitating unicorns

By Dave Hirschman

Flight test engineers, it turns out, don't have a secret fascination with unicorns. The long, straight probes known as *flight data booms* that are attached to the pointy ends of flight test aircraft aren't for looks. They're meant to collect a wide variety of exceptionally accurate data.

"Air data booms are much more than standard pitot-static probes," said Ed Haering, an aerospace engineer at NASA's Dryden Flight Research Center in Palmdale, California, where airplanes ranging from small UAVs to massive military transports undergo flight tests. "They measure many parameters beyond airspeed, and their measurements can be extremely accurate because they take place in the clean, undisturbed air in front of the aircraft."

In addition to measuring airspeed, air data booms measure angle of attack, sideslip, dynamic pressure, total pressure, and outside air temperature. Some specialized booms also carry sensors that measure humidity, ice, and acceleration forces—all carefully calibrated and compared to other measurements from GPS, inertial navigation systems, and ground radar.

Air data booms are usually mounted on the nose of test aircraft, but other possible locations include aircraft wings and horizontal stabilizers.

Comparing the information from air data booms to less accurate indications from cockpit instruments allows aircraft manufacturers to correct for position errors and other erroneous signals. Airspeed indicators, for example, often give faulty or erratic indications at extremely high angles of attack.

"High angles of attack tend to produce errors in [standard aircraft instrumentation]," Haering said. "A standard pitot-static system has a hole in the front that measures ram air pressure, and a hole in the side that measures static pressure. But high angles of attack tend to disrupt the normal airflow and produce erroneous readings."

A few companies such as SpaceAge Control, also in Palmdale, specialize in making air data booms for specific missions and tailor them for the size and speed of each test aircraft. Supersonic aircraft have their own set of requirements.

But if air data booms are so great, why aren't they standard equipment in all airplanes? Why limit them to test aircraft? Air data booms are expensive. They're often connected directly to flight test instrumentation that's separate and independent from cockpit instruments. And stealthy military aircraft shun them because they're easy for radar to identify. Besides, aircraft nose cones are the preferred domain for weather radar, and a long metal pole would surely interfere with their images.

Air data booms also tend to collect airframe ice, and they require a great deal of electrical current to heat.

"The probe itself is a relatively simple but indispensible tool for flight tests," Haering said. "But they're not the best thing for everyday flying."

E-mail the author at dave.hirschman@aopa.org.

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