BD-10 FLIES LIKE CIVIL 'FIGHTER'

WILLIAM B. SCOTT/MOJAVE, CALIF.

Designed for the general aviation pilot who wants a fast aircraft for personal use, the two-seat kit-built BD-10 promises low operating costs, simple maintenance

Bede Jet Corp.'s two-place, turbine-powered BD-10 establishes a new benchmark in general aviation aircraft design, combining military fighter-like performance, reasonable acquisition cost and operating economies that rival those of propeller-driven light twins.

The BD-10 also is a prime example of the significant advances being made by today's kit-built aircraft industry. Essentially free of outdated, rigid government certification regulations and a liability tail, builder/owners who willingly assume the risks associated with assembling an aircraft they will later fly are enjoying the best that designers and modern technology can provide to private civil aviation.

Bede Jet Corp. is proving that point with the BD-10—clearly a pilot's aircraft that promises low operating costs and simple maintenance. Powered by a single, highly reliable 30-year-old General Electric J85-17 turbojet engine, Bede's prototype is capable of supersonic speeds (not yet demonstrated), but is simple enough that any fixed base operator equipped to handle small business jets can maintain it. This civil "fighter" will climb from sea level at 20,000 ft./min., then sip fuel as it cruises at 45,000 ft. to a destination approximately 1,000 naut. mi. from home.

The BD-10's basic, simple systems also have proved reliable during 250 hr. of prototype aircraft operation. "So far, the maintenance is considerably less than that of a [Beech] Bonanza, and more than that of a [Cessna] 182," Jim Bede, chairman and co-owner of Bede Jet Corp., said.

Developed specifically for the general aviation owner/pilot who wants an affordable, fast jet for personal use, the BD-10 already is finding other niches, many overseas. Its approximately $700,000 full-up acquisition price and simplicity have attracted foreign nations that envision using kit-built BD-10s as military trainers, high-performance pilot proficiency aircraft, subscale target drones and unmanned decoys. At least one airline has expressed interest in the aircraft as an ab initio and proficiency trainer.

JUDSON BROWNER PHOTOS

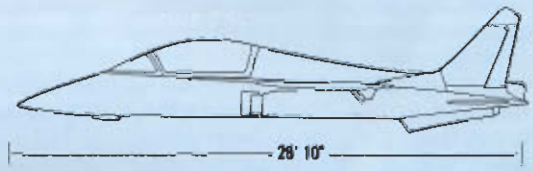
BD-10 prototype stands 8 ft. at the tail and has a single nonafterburning General Electric J85 engine. A large canopy provides excellent visibility.

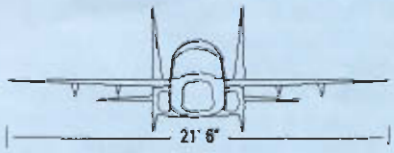
In the U.S., military pilots have evaluated the BD-10 prototype, and some defense officials have discussed the possibility of leasing a few aircraft as an economical high-performance proficiency trainer. There also have been "light discussions with possible joint venture partners" about the BD-10 being a JPATS trainer candidate, Bede said.

This *AVIATION WEEK & SPACE TECHNOLOGY* editor flew the BD-10 prototype from the back seat recently, providing a quick look at the aircraft's performance, forgiving handling qualities and simple operation. I flew with Skip Halm, Bede's chief test pilot and director of flight operations and one of my former USAF Test Pilot School instructors. We decided to focus on spot-checking the aircraft's performance and handling qualities at two altitudes, obtaining limited quantitative data to support the qualitative assessments typically made on a brief Aviation Week demonstration flight.

Because Halm and Bede's Mojave site manager, Patrick D. Wilson, had flown the prototype from Albuquerque, N.M., to Mojave Airport earlier that morning, our preflight was abbreviated. Wilson briefed me on the spartan aft cockpit's few instruments and controls as I strapped into a parachute. Although the BD-10's sleek

Two-place BD-10 blends well-engineered simplicity and excess turbine power to give general aviation pilots high performance in a kit-built aircraft.





PERFORMANCE SPECIFICATIONS

Capacity	2 Persons
Empty Weight	2,250 lb.
Maximum Gross Weight	4,440 lb.
Take-off Distance	850 ft.
Landing Distance	1,800 ft.
Maximum Rate of Climb at Sea Level	20,000 ft./min.
Maximum Cruise Speed	Mach .90 518 ktos. 595 mph.
Maximum Speed (Projected Max Design)	Mach 1.4
Stall Speed Landing Configuration	78 kias.
Engine	GE CJ-610 or J-85 Pratt & Whitney JT-12
Usable Fuel	1,762 lb. 263 gal.
Range at 45,000 ft. (Projected)	1,350 naut. mi.*

*With 45 min. @ 10,000 ft. reserve

appearance would let it poss for a military trainer, the prototype is not equipped with ejection seats. Military versions could be fitted with ejection systems, if desired, but they would add weight.

Holm started the engine from the front cockpit, activated the electrical system and was ready to taxi in 2 min.—a mark of the aircraft's systems simplicity. Mojave Airport temperature was about 73F, barometric pressure was 31.10 in. of mercury and winds were light and variable. We carried about 800 lb. of fuel, putting our gross weight at approximately 3,800 lb.

Holm made the takeoff to demonstrate the BD-10's full-power performance by climbing at a constant 200 kt. indicated airspeed from brake release to high altitude. A "bleed-rate" altitude versus airspeed schedule would produce a more optimum climb rate, but 200 kt. is what a typical general aviation pilot would use, Holm said.

Despite air traffic control constraints that forced us to make a 60-deg.-bank turn immediately after takeoff and break the climb into two segments, we still required only 6 min. to go from brake release to 29,000 ft. Holm noted that, without any turns or delays, the BD-10 consistently climbs from gear-up to 10,000 ft. in about 35 sec.

Low-altitude climb rates were reminiscent of a modern military fighter. My plans to record altitude versus time throughout the climb were abandoned early. With the vertical velocity indicator pegged at 6,000 ft./min. during the steep-angle ascent, it was impossible to read and closely correlate altitude and time from brake release.

General aviation pilots familiar with reciprocating engine-powered twins will require training and practice to get used to the BD-10's acceleration, speed and climb rate. Holm said most pilots will climb at a lower power setting to "hold the rates and angles down. We like to stay at about 96% in the ATC environment. Too much fuel is wasted at 100%, because we get to altitude so fast that [controllers] are still talking to the next center. It seems to work better to climb at 94%. Even with full fuel, we still get to 17,000 ft. in no time."

We leveled off at 29,000 ft.—consistent with our clearance from Edwards AFB controllers to remain below 30,000 ft.—slowed to 150 kt. and started a level acceleration to 300 kt. The BD-10/J85 combina-

tion has a relatively flat power curve, but acceleration was a bit slow until we passed 180 kt. Total time to reach 300 kt. was about 80 sec., approximating a 2 kt./sec. average rate at 29,000 ft. Later, a repeat of the same acceleration test at 15,000 ft. produced a 4.5 kt./sec. rate.

Handling quality checks at 29,000 ft./300 kt. showed the BD-10 had a "deadbeat" response to pitch and roll stick pulses, but a rudder doublet produced seven overshoots as the nose oscillated left and right for a few seconds. "It's fairly loose at this altitude," Holm commented. "It wallows some in turbulence, but not bad enough [to require] a yaw damper. It's not a problem to hand-fly it here. Most people would just climb to 45,000 ft. and get out of the turbulence."

Compared with other single-engine, relatively high performance light aircraft, the BD-10's dutch roll or "fishtailing" characteristics at high altitude were not objectionable. Most of the rudder-kick response was in the yaw direction, with some rolling motion. Jim Bede explained that the bank-to-yaw angle "damping ratio" is fairly small because the wing has no dihedral or upsweep from the root to the tip. Since the wing is above the center of gravity, the BD-10 "acts a bit like a high-wing aircraft,"

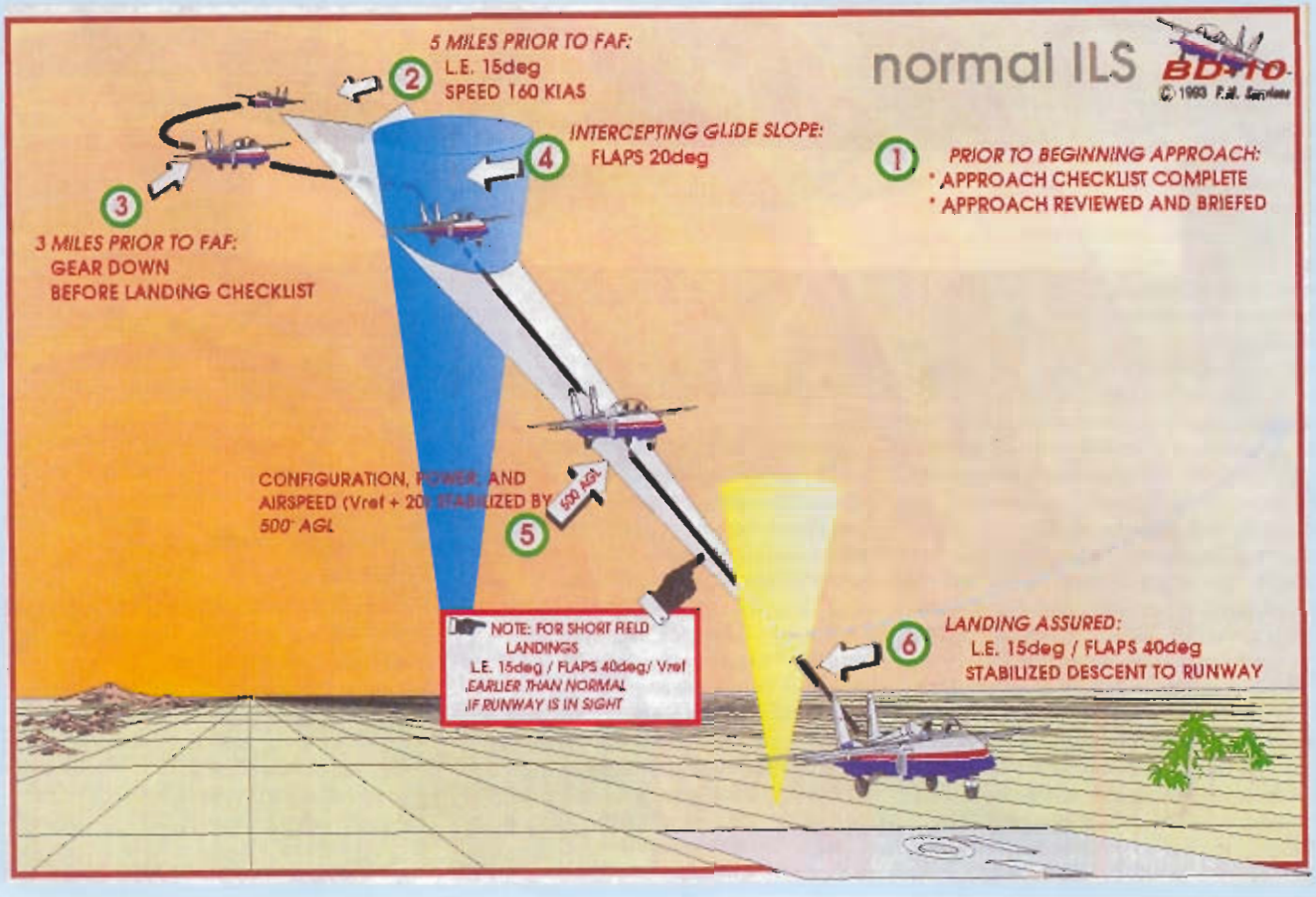
BD-10 buyers can choose to install the bare necessities or sophisticated electronic flight instrument systems with autopilot.

he said. "All the dihedral is in the [leading edge] sweep."

Holm demonstroted the aircraft's turn performance twice—in a constant-g and a wind-up turn. Holding 290 kt. and 3.5g (1g below the current aircraft operating limit) at 29,000 ft. required minimal power to maintain a constant-airspeed, level turn with no apparent buffet. The pilot then performed a 3g wind-up turn at 29,000 ft., decelerating at a 2-3 kt./sec. bleed rate from 300 kt. to about 105 kt. When the first nibble of buffet appeared at 255 kt., Holm held 3g and extended the leading edge slats 3 deg. Although buffet continued, he was able to "pick up the turn rate again," he said.

Slats were extended to 15 deg. below 200 kt., allowing speed to drop to 105 kt. while using power to hold a constant 3g turn. At about 170 kt. and 30-35 deg. of bank, with 15 deg. of slats out, we "fell off the 3g point, but went on down to full aft stick at about 105-107 kt. with full power," Holm said. "That means, in a dogfight, I could keep turning with [an adversary] down to that low speed, 'shoot' him and still be turning at 29,000 ft." Excellent low-speed handling at high altitude is considered a significant advantage during close-in training engagements, he noted.

I flew an idle, 250-kt. descent, getting a feel for the aircraft as we set up for a repeat of the same tests at 15,000 ft. Without deploying speedbrakes, we descended at about 1,000 ft./nout. mi. over a 3-min. period, demonstrating that the BD-10 will have no problem dropping quickly from high altitude when requested by controllers. Because the prototype was not pressurized, the large canopy fogged over from the aft end forward as we entered warmer air, but cleared quickly. Produc-



tion aircraft will be pressurized. Handling qualities checks at 15,000 ft. duplicated those at 29,000 ft. A 3.5g turn at 300 kt. produced no buffet. Production aircraft will be able to pull more gs at lower altitudes as soon as testing clears the envelope to a higher level. The wind-up turn, using a 1-2 kt./sec. bleed rate produced a minimum airspeed of about 100 kt. with power on, while still holding 1.7g in the buffet; slats again were extended as airspeed decreased.

I performed a stall series at 15,000 ft., using an idle power setting. With slats and flaps extended, we were still flying—in the buffet—at 70 kt. Although the aircraft wing-rocked a bit below 100 kt., Holm warned me not to be "heavy-handed with ailerons." At this flight condition, he said, the aircraft could depart from controlled flight if a pilot commanded large roll inputs. Still, the aircraft was quite forgiving with full aft stick at these speeds, tolerating aggressive inputs without threatening to depart.

ADDING POWER immediately stopped the wing rock and restored full control as we accelerated. The nose never dropped with a clean break—a requirement for light aircraft certification—but buffet, deck angle and flight control response provided considerable warning to the pilot.

With slats out, the BD-10 was still maneuverable at speeds approaching stall. Adding flaps at each level of buffet onset allowed us to maintain essentially level flight throughout the deceleration.

The aircraft's excess power and its ability to get a pilot out of trouble immediately was demonstrated graphically at this point. At 70 kt. and full aft stick, I advanced the throttle to full power and we immediately started to climb as I turned the controls back to Holm. At about 100 kt., he dumped the nose over to level the aircraft and performed an immediate 360-deg. snap-roll. I did not time it, but the roll was not slow—less than 2 sec., I estimated.

What that maneuverability and excess thrust mean for the general aviation pilot, Holm later explained, is that "if you just screwed up a landing—slammed onto the runway and bounced back into the air—you can go to 100% power, hold the stick full aft and still keep flying. A guy can do a lot of stupid things close to the ground in this airplane, add power and still get out OK."

A quick loop—again demonstrating low-speed handling and the ability of slats to maintain good handling qualities—set us up for a simulated flameout landing to Mojave's Runway 25. With the throttle at idle and slats at 3 deg. to simulate zero thrust, I descended and crossed the runway perpendicularly at about 5,500 ft. Turning downwind, I was high and fast as we dropped the landing gear and turned toward the runway, flaps still retracted as we approached the threshold.

Holm took control, executed a go-around, and again demonstrated how forgiving the aircraft was to mishandling at final approach speeds before making a smooth full-stop landing on Runway 30. From that spot, I performed a takeoff, rotating at about 100 kt., and banked right to a closed pattern.

THE LARGE CANOPY and excellent visibility were both an asset and a liability as I turned base and final. My sight picture from the aft cockpit was substantially different than from trainers and fighter-type aircraft, and I tended to stay too high. I expected a more-nose-up attitude through the descending turn. Simply pointing the nose at the desired landing spot is the best technique, Holm said.

With gear and flaps down, flight control response rates seemed to decrease, but were forgiving, not sluggish. My airspeed indicator was mounted on a small panel near the right canopy rail, out of my scan pattern as I leaned to the left to see around Holm. I relied on his airspeed calls, but still touched down firmly with about 60% power and little or no flare. Holm said this was proper for a spot landing, although I had intended a smoother one.

The aircraft is an absolute delight to fly, but most general aviation pilots definitely will need some training and practice before they feel comfortable with the BD-10's speed and attention-getting performance. Although my hands-on time was limited, I felt the aircraft was much easier to fly than most reciprocating twins. It handles well and will accommodate the typical proficiency levels of an average 100-hr./year businessman/pilot. Still, this will be the closest thing to a fighter that most noncommercial civil pilots will ever experience.

"THIS IS A WHOLE new concept of civil aviation," Holm said. The BD-10 "gives the GA pilot a nice, safe aircraft in the pattern, and one hell of a performer for someone who just wants to go someplace. It's a great 'GO' airplane."

Bede professes a more realistic, humble view. "I don't think this airplane satisfies everybody's needs or solves everybody's problems. It's a good balance of performance, utility, simplicity and low cost," he said. "But it does fill a certain niche." ■

BEDE KEEPS COSTS DOWN

MOJAVE, CALIF.

Simplicity and low cost were the guiding principles for Bede Jet Corp.'s small band of BD-10 design engineers during 10 years of development.

"It bugged me to keep seeing world-class companies telling everybody how expensive it was to develop something new," Jim Bede, the company's chairman and co-owner, said. "It seemed like this was an absolute law of nature—you could not make something new without a huge investment. I now get a kick out of the formulas that project the cost of developing a new aircraft. I ran the BD-10 through those and found that we should have spent $86 million. But we demonstrated that it can be done for far less."

The twin-boom, two-place, single-engine jet aircraft uses the same turbojet—without afterburner—that has powered USAF/Northrop T-38 Talons for 30-plus years, and all materials have proved their worth in aerospace applications. "They're just arranged in such a way that we get a lot out of them," Bede said.

The structure is approximately 60% aluminum, 35% composites and 5% "other aircraft-quality materials," he said. Systems are of simple design, yet provide necessary redundancy for safety. For instance, fuel is located generally around the aircraft's center of gravity and is gravity fed automatically, precluding complicated fuel management. All controls are mechanical push-rods and bearings that require minimal inspection and maintenance, according to Bede officials. A 24-v. electrical system will handle a full suite of avionics—including electronic flight instruments and an autopilot.

The company provides buyers with a complete kit containing all materials needed to build the airframe. Three engines can be fitted to the aircraft—the General Electric J85 or CJ-610, Pratt & Whitney JT-12 or Williams FJ-44.

"From a purely engineering standpoint, these [3,000-lb.-thrust class] engines are totally oversized," Bede said. "They're too big for this [BD-10] configuration, and they can't cruise at their optimum specific fuel consumption [SFC] design point. But the pilot/operator is more concerned about fuel flow than SFC. In the same flight environment, the BD-10's fuel flow is about 40% that of a Lear. The BD-10's tailpipe temperature runs considerably cooler, too, and that extends engine life to about 15-20 years of [general aviation-type] operation." Excess power also was seen as a dependable "escape mechanism" for pilots, as well.

Bede adds, "This aircraft defies the 'law' that you can't get a leap in performance until you get better engines. We're using a 30-year-old engine design. Except for some of the materials, anybody could have designed this aircraft in the last 30 years. The secret is in the combination." ■