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## 301 KNOTS! TURBINE DUKE

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# 301 Knots!

The Royal Turbine Duke's upgrades include a Garmin avionics suite, an MX20 MFD and weather forecasting software.

## TAKE THE BEECH DUKE, ADD TURBINES, AND YOU GET THAT MAGICAL NUMBER

By Bill Cox
Photography By James Lawrence

It's a magic number and one not often seen in turboprop corporate aircraft. A bare handful of propjets can touch 300 knots in cruise—the Piper Cheyenne 400LS, Commander 1000, Mitsubishi Solitaire, Beech Starship and King Air 350, and the Socata TBM 700.

Now, there's one more. The Royal Turbine is the latest product of the fertile imaginations of Darwin Conrad and Jeanie Sadler of Rocket Engineering in Spokane, Wash. In case you hadn't noticed, the Royal Turbine depicted on these pages is a Beech Duke with Pratt & Whitney PT6A turboprops in place of the standard piston, TIO-541 Lycoming engines.

Right up front, the most obvious difference is sheer, brute power. The standard, turbocharged Duke engines provided 380 hp per side to a critical altitude of about 17,000 feet. Conrad's replacement P&W turboprops put out 550 shp to the same or higher altitude.

Fans of turboprops know Darwin Conrad as the engineer responsible for creating the Malibu Jetprop. Conrad, Sadler and partner Warren Wood began converting Malibus and Mirages to the P&W PT6A-21 in 1997, and since then, they've upgraded an impressive 18% of Piper PA-46s to turbine power. That's about 160 airplanes, and Conrad and company aren't done yet.

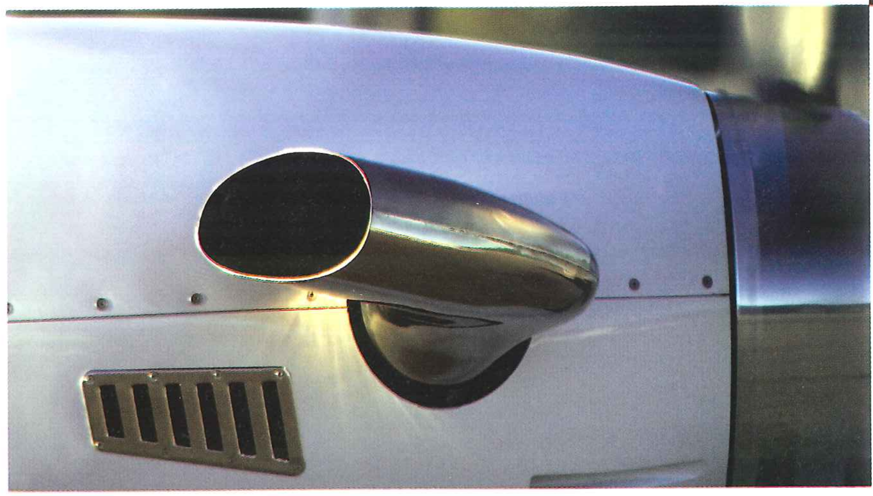
As demand for the Jetprop conversion inevitably began to wane, however, the engineer knew he'd need some new products, and that led to the development of the Turbine Air, a Beech B36TC converted to the same P&W engine. To date, Rocket has converted 10 Bonanzas to turbine power in a little over one year of production.

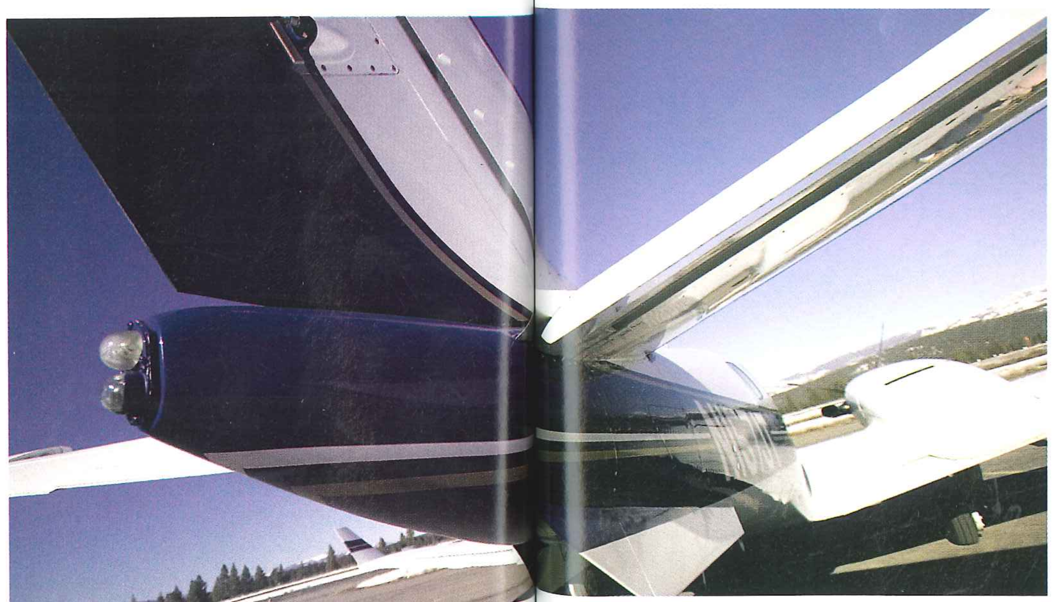
The Royal Turbine turboprop conversion is the latest of Conrad and Sadler's brainchildren, and it takes as its foundation an airplane that has long had a following equally as fanatical as that for the Bonanza. Despite such enthusiasm, the pricey Duke was only a limited success. Beech initiated production of its top piston twin in 1968 and shut down the line only 14 years later, more than coincidentally about the same time Piper terminated the Aerostar and Navajo, and Cessna ended production of the 310, 340, 402, 414 and 421.

In total, Beech delivered just under 600 Dukes, 350 of which were the later, improved B60s, built between 1974 and 1982. The B60 carried more fuel than the straight 60 and the A model. Today, most of those last 350 airplanes sell for $150,000 to $300,000.

If that seems a bargain, it is—except for one major problem. Beech fitted the Duke with a pair of TIO-541 engines, a model that was to prove one of the least reliable in the industry. Original TBO was only 1,200 hours, and reaching even that was questionable. In the early '70s, new crankshafts, cylinders and other upgrades increased TBO to 1,600, but again, most Duke owners had little chance of reaching TBO. No matter how well the engines were treated and maintained, Dukes rarely got past 1,000 hours before needing significant tops or even major overhauls.

**By replacing a standard Beech Duke's Lycoming engines with a pair of Pratt & Whitney PT6A turboprops, Rocket Engineering has created a much more powerful aircraft that boasts 550 shp of brute force on each side. Fuel capacity increased to 267 gallons—that's 35 gallons more than a stock Duke's—and $V_{mc}$ was raised to 91 knots—10 knots more than the original.**



The engines were so unreliable that many Dukes spent much of their time on the ramp or in the shop. Like all sophisticated, medium twins, Dukes suffered other ills associated with pressurization, hydraulics and electrics as they aged, but the engines were, by far, the major problem.

Nevertheless, Duke owners almost unanimously adored their airplanes. The swept, stiletto shape was an immediately recognizable winner. When the airplanes were up and running, they manifested the same delightful handling as the Baron plus significantly better climb and cruise performance. (Beech even condescended to mount the throttles in the proper, far-left position rather than in the center console as on the Barons.)

Up high with everything trimmed out, the Duke was alleged to be capable of 233 knots, although 215 to 220 knots was probably more realistic, meanwhile pouring 45 gph through the engines. Pulled back to 63% (yes, 63%) with 232 gallons in the tanks, Dukes could still manage 195 to 200 knots, endure for 5.5 hours and range out more than 1,000 nm.

Conrad reasoned that things could only get better and more reliable (if more expensive) by replacing the troublesome TIO-541s with P&W turboprops. With his experience installing and flying the PT6A-21 and -35 in the Malibu Jetprop, he knew the P&W engine was about as bulletproof as they come, rated for 3,600 hours between overhauls and willing to run that long with very little service.

"Better still," says Conrad, "whatever service is required for the first five years other than normal, periodic maintenance is done by Pratt & Whitney as part of the warranty. That means most operators will be able to fly for at least five years before they'll even be susceptible to any significant engine maintenance."

Predictably, converting a piston airplane to turbine power wasn't exactly a slam dunk. In 2002, Conrad and Sadler launched into a development program to replace everything from the firewall forward on the prototype Duke. The P&W turbines were collectively about 550 pounds lighter than the Lycomings, but that didn't all translate to additional payload. The original Duke B60 carried 232 gallons of avgas, adequate for the Lycomings, but more than a little short-legged at the Royal Turbine's 75 gph fuel burn (at max cruise and 23,000 feet). As a result, Conrad increased fuel capacity to 267 gallons of heavier jet fuel, reducing the theoretical payload improvement to 153 pounds—still impressive.

The lost weight came out of a fairly forward CG position, and that shifted the balance point well aft. In order to rebalance the envelope, Conrad relocated both batteries to the nose, as far forward as possible. Also, mounting turbine engines repositioned the props three inches farther forward. Collectively, these changes offset the lighter engines and restored the balance.

The increase in power from 380 hp to 550 shp per side caused an increase in $V_{mc}$. Minimum single-engine control speed on the Royal Turbine has been set at 91 knots, compared to about 81 knots on the original Duke.

We launched for the flight levels out of Truckee-Tahoe Airport, in California, on one of those crystalline, Chamber of Commerce days. "Launched" is the operative term in this case, as the Royal Turbine quickly wound the VSI around to 4,000 fpm at a climb speed of 120 knots. Keep in mind that was from Truckee's scenic strip just north of Lake Tahoe, 5,900 feet up in the pine country of the Sierra Nevada.

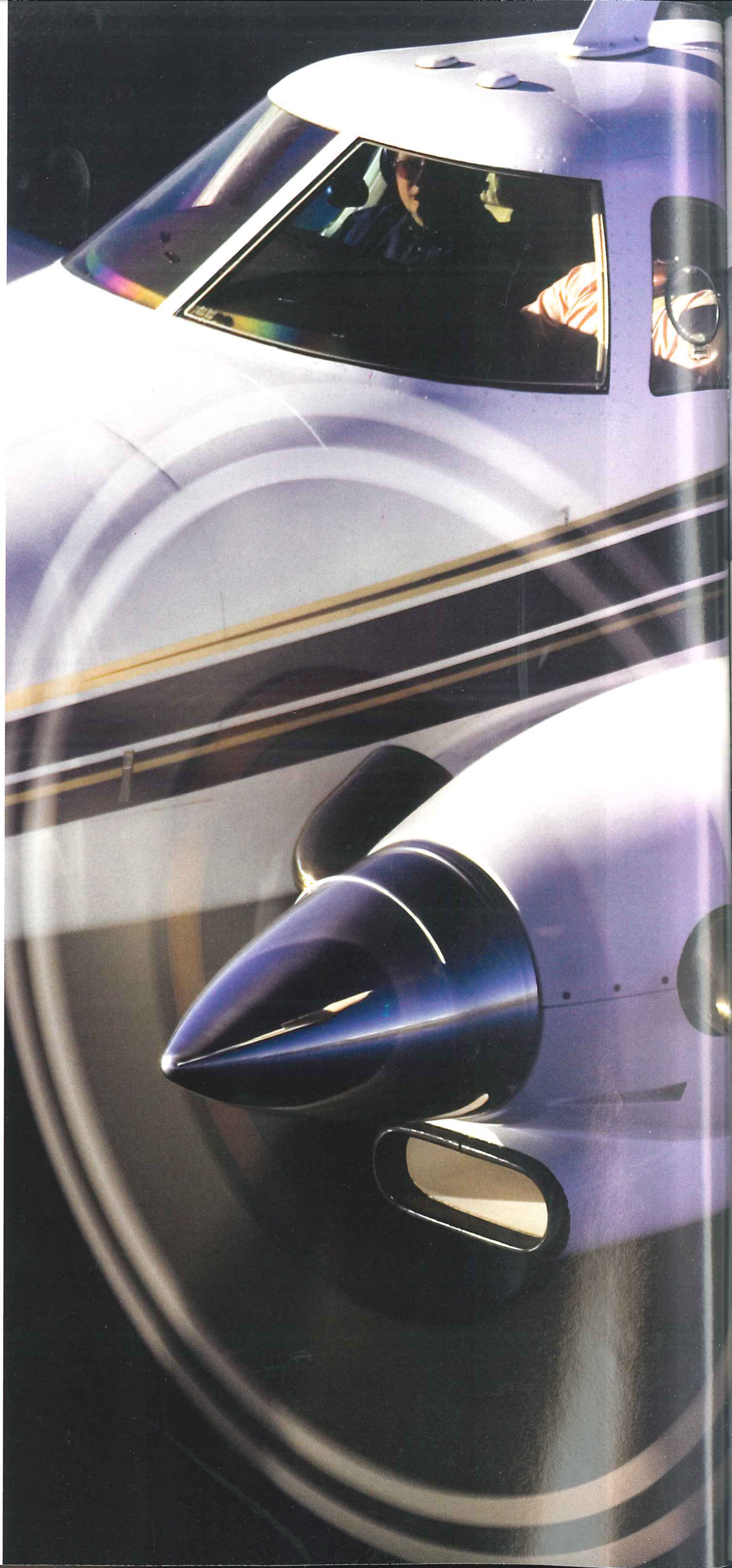
The airplane's cruise climb at 175 knots was even more interesting at 2,000 fpm. We were flying with three aboard plus half fuel, so the airplane wasn't nearly up to gross, but it wasn't exactly light, either. Conrad commented that he had seen nearly 4,500 fpm flying alone on flight tests with 100 gallons aboard.

At such spectacular climb rates, it doesn't take long to reach big altitudes, and we leveled seven minutes after takeoff at 23,000 feet, the airplane's optimum speed height. Flying in smooth air, I let the Royal Turbine run out to its maximum indicated airspeed. It took probably five minutes for IAS to peak, but the final number was 197 knots at 1 degree C. That works out to a true of 301 knots at 75 gph total burn.

If you weren't in as much of a hurry, you could plan to cruise at FL260 at more like 270 knots on about 62 gph. Cabin altitude at this height with the standard 4.6 psi pressurization system fully pumped up is 11,000 feet. With a full 267 gallons aboard, such a trip would allow an easy three hours plus reserve for 1,000 nm range, roughly the same as the stock airplane, but considerably quicker.

On the way downhill from our cruise checks, Conrad suggested I stop momentarily at 21,000 feet and shut down the right engine. Level and trimmed with the right mill feathered, right wing five degrees up, ball half out of center and the left thrust lever against the stop, airspeed finally stabilized at 240 knots true. This suggests single-engine service ceiling (SESC) is well above that height. (Conrad lists SESC as 27,000 feet, but even that may be conservative.) Normal multi-engine service ceiling, incidentally, remains the Duke's original 30,000 feet.





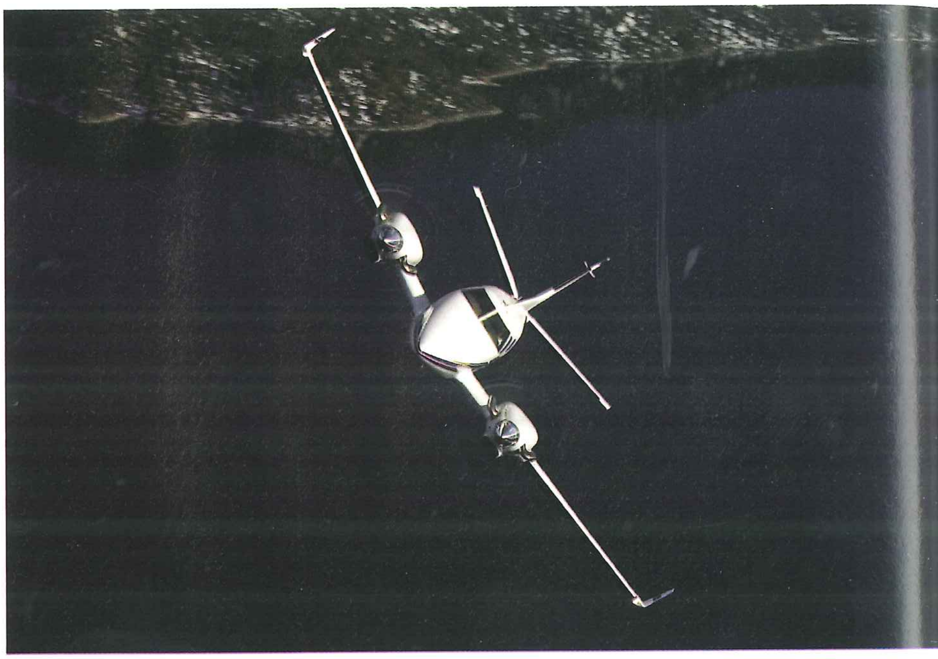
**COMPARISON CHART**

| | 1982 Royal Turbine | 1982 Beach Duke B-60 | 1985 Piper Cheyenne IIIA | 1979 Cessna Conquest II |
|---|---|---|---|---|
| Price* | $1 million** | $320,000 | $1 million | $1 million |
| Max Seats | 6 | 6 | 11 | 11 |
| Payload (lbs.) | 731 | 596 | 927 | 1018 |
| Max Climb, SL (fpm) | 4000 | 1601 | 2236 | 2435 |
| Max Cruise Speed (kts) | 300 | 246 | 312 | 295 |

*Estimated **Conversion price is $887,000

*Sources:* Aircraft Bluebook Price Digest, *Spring 2005, and Royal Turbine test flight*

**The Royal Turbine Duke's engine swap allows it to reach 300 knots.**



In addition to strong climb and 300-knot cruise, another important payoff on the Royal Turbine is a significant improvement in payload. Conrad reports the prototype airplane started with an empty weight of 5,012 pounds against a gross weight of 7,000 pounds (with the VGs installed). Subtract 1,392 pounds of fuel, and the unconverted Duke was left with only 596 pounds of payload, barely enough for three folks plus baggage.

After Conrad's turbine conversion, empty weight is now 4,480 pounds. Add the weight of 267 gallons of jet fuel (at 6.7 pounds per gallon), and the Royal Turbine winds up with a payload of 731 pounds, an easy four folks plus baggage.

Conrad plans to offer two engine options on the Royal Turbine. Both PT6As are flat-rated for 550 shp, but the -35 will maintain that power to 21,000 feet while the -21s begin to lose thrust at 16,000 feet. The difference with the -35s installed will be better climb at high altitude and about 25 knots more cruise in the middle flight levels.

Conrad has been through the STC certification wars many times, and he's as familiar as anyone can be with the FAA's requirements. He has already worked his way through many of the flight and engineering tests, and expects to have the Royal's STC in hand by mid-summer 2005.

Pricing on the conversion is preliminary, but Conrad speculates the entry-level PT6A-21s will cost about $767,000. Conversion with the -35 engines will cost approximately $887,000. "Basically, the -35 conversion is the same as that of the -21s," explains Conrad. "We merely pass along the higher engine costs to the customers. Either way, plan on about 90 days of downtime for the conversion."

In other words, start with a $150,000 to $200,000 Duke, buy the Royal Turbine conversion for $887,000, and you could be in a 300-knot, six-seat, twin turboprop for just over $1 million, albeit one fitted with two new engines. Okay, the airframe is hardly new, but a million bucks won't buy you anything like the same performance from a 20-year-old Piper Cheyenne III or a 25-year-old Cessna Conquest II. Also, you'll typically be flying behind older, unwarranteed engines and may be susceptible to higher maintenance.

It's interesting that the least expensive Royal Turbine's price makes it far less expensive than the oldest SOCATA TBM-700, a single-engine turboprop. Of course, some pilots prefer two engines, and others, movie stars, executives and captains of industry, are mandated by employment contracts not to fly in any single-engine airplane. The two most important questions are: 1) How much turbine reliability are you willing to pay for?; and 2) How much hourly operating cost can you afford?

As avgas becomes progressively more expensive and less available, more pilots of upscale singles and twins are looking for alternatives. Turboprops are here and now, and Conrad's Royal Turbine effectively brings the reliability and performance of a high-performance turboprop to the piston crowd. PJ