TURBINE BONANZA

A bold alternative to piston power soon will face its toughest test: the marketplace.

BY J. JEFFERSON MILLER

Some within the general aviation industry believe that the advent of the single-engine turboprop is inevitable. They point to a number of attributes that eventually will sell pilots on the turbine-single concept. These include the performance and reliability advantages of turbines, and perceived economy of operating a turbine single versus a piston twin.

Others believe that the steep initial cost of turbine power will forever limit the market for personal- and business-use turbine singles to a handful of high-rolling entrepreneur/pilots.

Several companies have experimented with turbine-single prototypes designed with business and personal transport in mind. None have yet reached

PHOTOGRAPHY BY ART DAVIS

the market. While many of these projects have drifted into limbo (most notably Beech Aircraft's Lightning), one company continues to forge ahead with plans to introduce its version of a business-class turbine single.

The company is the Allison Gas Turbine Division of General Motors. Its airplane is a Beech A-36 Bonanza, re-engined with a 420-shp Allison 250-B17C turboprop powerplant.

Pilot previewed the Turbine Bonanza in the September 1984 issue (see "Turbine Bonanza," p. 80). At the time of that report, the prototype Turbine Bonanza (a 1979 A-36) had flown only about 100 hours, and much design work and testing remained to be done.

Now Allison is nearing the end of flight testing. A second prototype has been completed—a 1985 A-36 that closely resembles what will be the production-version Turbine Bonanza. And certification is expected by the company later this year.

Allison's immediate plans for marketing the airplane include establishing a distributor network of four retail outlets in North America. The distributors will handle the sale of turbine kits and the conversion of Bonanzas to turbine power. Allison has four confirmed orders and deposits from individual purchasers, but all future orders will be taken through the distributors.

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Prop, engine inlet and stainless steel louvers that duct air to oil cooler all have passed icing tests.

The first six Turbine Bonanza conversions will be done by Soloy Conversions of Olympia, Washington. Soloy has worked closely with Allison to develop the turbine modification for the Bonanza. Soloy's turboprop conversion of a Cessna 206 also uses an Allison 250 series engine. (See "Turbine 206," August 1984 *Pilot*, p. 28.)

Cost of a conversion is currently set at $200,000, not including the airframe. The cost of a converted 1985 Bonanza would be roughly $450,000. The cost of purchasing a 1979 Bonanza of average worth ($100,000) plus the engine conversion would be about $300,000.

Distributor prices for the conversion are expected to be about 10 percent higher, according to F. Jack Schweibold, manager of light aircraft operations and chief test pilot for the Allison Gas Turbine Division.

During the first six months of production, conversions will be limited to A-36 Bonanzas produced since 1979. The reason for the 1979 cutoff is that the turbine installation requires a 28-volt electrical system. Pre-1979 Bonanzas have 14-volt electrical systems. After the initial six-month production period, A-36 Bonanzas of earlier vintage probably will be accepted for conversion, Schweibold said, although their electrical systems would have to be converted to 28 volts.

Allison also is considering developing turbine conversion packages for the Beech T-34 Mentor piston-powered military trainer and the F-33 Bonanza. The V-tail Beech Bonanza is no longer being considered for conversion because the number of late-model A-36s greatly outnumber late-model V-tail Bonanzas and because certifying the V-tail for the turbine conversion would involve another costly certification program.

Allison's goals for its turbine-single program go beyond modifying Bonanzas. "We want people to accept that alternative power is available for piston-engine aircraft," says R. Frederick Harvey, Allison's director of small aircraft engine products.

A turboshaft version of the Allison 250-series engine is widely used in a number of helicopters. It is the most successful and widely used turbine in rotary aircraft. The turboprop 250-series engine is also used on several foreign aircraft: the Australian GAF Nomad N22B; the Partenavia Spartacus; the Pilatus Britten-Norman Turbine Islander; and the Siai-Marchetti S.F.260TP and S.F.600TP.

Ultimately, Allison would like to have its 250-series engine offered as original equipment on a number of American-made aircraft that currently are powered by piston engines.

Beech Aircraft, which provided some engineering assistance in the Turbine Bonanza program, is, according to Harvey, "looking over our shoulder to see how the program goes." If sufficient sales are generated, Beech may offer the turbine engine as original equipment on the Bonanza.

Allison executives believe the 250-series engine would make an ideal powerplant for the Piper Malibu. To achieve high-altitude performance equivalent to or better than that of the Malibu's turbocharged engine, a new, 500-shp version of the 250 is being developed. Cessna has test flown a P210 Centurion with an Allison 250 engine but has not announced plans to produce an Allison-powered P210.

Allison also has done preliminary engineering work on installing turbine engines on the Cessna T303 Crusader, Piper Chieftain and Piper Saratoga. Whether these projects go beyond the preliminary stage depends largely on the success of the Turbine Bonanza.

Recently, *Pilot* staff members had a chance to inspect and fly the second prototype Turbine Bonanza, which was flown to our Frederick, Maryland, headquarters by Larry M. Chambers, Allison's manager of Bonanza propjet sales. Chambers walked us around the airplane, pointing out salient features of the design and changes made since our last look at the Turbine Bonanza.

The Allison 250-B17C that powers both prototypes and will be used in production models is a free turbine engine, in which the compressor stages and the power turbine (which transmits power to the propeller) are mounted on separate shafts.

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The new Bonanza panel appears to have been designed to accommodate turbine gauges. A fuel totalizer (left of the ADF) enables accurate measure of fuel consumption.

The engine has a recommended time between overhauls (TBO) of 3,500 hours. However, a hot-section inspection of the engine is required every 1,750 hours or 3,000 cycles and costs betweeen $7,000 and $10,000. A complete overhaul is $20,000.

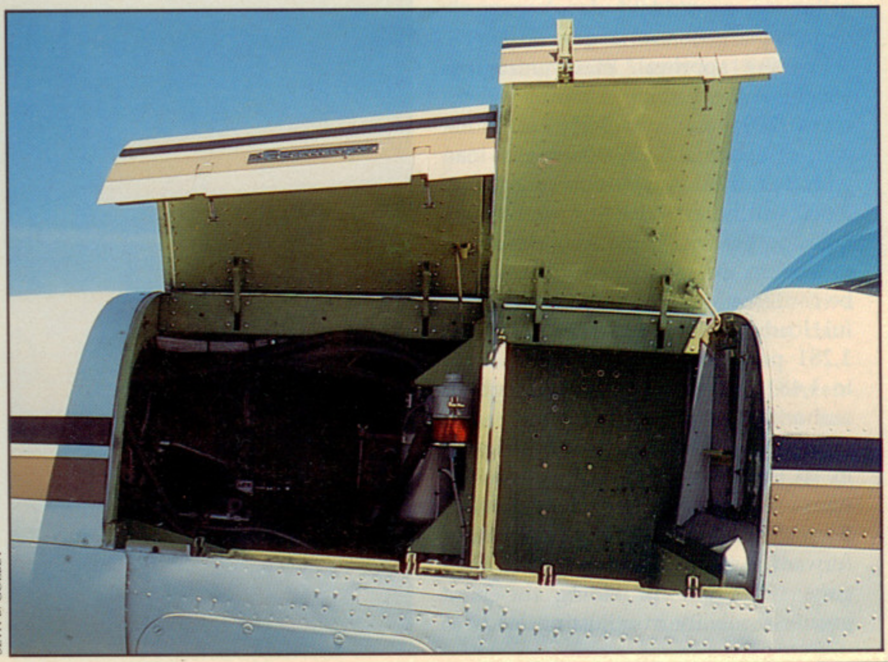
A Hartzell three-blade, fully reversible propeller has been selected for the aircraft. It is electrically deiced, as is the engine inlet. Both the propeller and turbine inlet deicers are required for certification.

Stainless steel louvers that serve as an oil cooler air inlet are located on the lower right-hand-side panel. The louvers were found to provide sufficient airflow during icing tests. Cooling air is ducted out through the cowl flaps. On the first prototype, the oil cooler air inlet was located on the top of the cowling. This arrangement did not provide satisfactory cooling.

Aside from the engine installation, the major alteration to the airframe is a pair of Beryl D'Shannon tip tanks with winglets. A number of NASA-designed winglet configurations were experimented with before the final configuration was chosen.

The winglets, which are two-thirds the size of those on the original proto-

Forward cowling door allows access to the turbine engine and engine accessories. Rear door opens on a baggage locker that can hold up to 150 pounds of luggage.



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type, were designed to increase yaw stability and lift, and improve directional control at low speeds and high power settings. Additionally, the winglets account for a three- to five-knot speed increase. Allison plans to install aileron and flap gap seals in order to pick up about five more knots.

Directional control at high power settings also is enhanced by canting the engine three degrees to the right (versus 1.5 degrees for the piston engine in the standard Bonanza) in order to counteract torque effect.

More than 800 spins have been performed to test the spin characteristics of the airplane with different tip tank/winglet configurations and under a variety of load distributions. Still to be conducted are flutter and vibration flight testing and final handling tests.

Each tip tank can hold 20 gallons of fuel. The Bonanza's main tanks hold 40 gallons apiece. Optional auxiliary tanks, located outboard of the mains, hold 15 gallons each, bringing total fuel capacity to 150 gallons. A single On/Off selector—a certification requirement—makes fuel management a simple matter.

The weight and balance envelope of the Bonanza is expanded by the conversion. But some careful calculations will be required to ensure that the airplane has been loaded within limits.

The Allison engine and Hartzell propeller weigh 200 pounds less than the engine and propeller they replace. The weight saving is offset somewhat, however, by the greater density of turbine fuel, which weighs 6.7 pounds per gallon on a standard day versus six pounds per gallon for avgas.

Pending approval, maximum gross weight of the Turbine Bonanza will increase 200 pounds to 3,860, for a net gain of about 300 pounds useful load with full fuel. A zero-fuel weight of 3,660 will be established, however, requiring that, at gross weights above this figure, the remainder of the weight be carried as fuel in the tip tanks. Useful load of the second prototype is 1,281 pounds—and that will increase to 1,481 if the higher gross weight is authorized.

To maintain the same center of gravity (CG) limits as the standard Bonanza, the propeller arc of the Turbine Bonanza is located 22 inches farther forward. As a means of increasing baggage space and providing the pilot greater flexibility in adjusting loads to

stay within CG limits, the Turbine Bonanza is equipped with a locker behind the engine compartment that can hold 150 pounds of baggage.

Allison engineers initially were concerned about the possibility of exhaust seeping into the cabin and considered rerouting exhaust stacks, an idea that later was rejected. Chambers said that testing shows that, in flight, exhaust passes under the wing on the right side of the cabin, clear of the doors. A cabin air vent on the left wing was sealed to prevent exhaust from entering the cabin from that side.

The panel arrangement of the second prototype is quite different from that of the first Turbine Bonanza. The first prototype adapted the Bonanza's vernier engine controls for use with the turbine, and placed six tiny engine gauges in the two openings where the manifold pressure gauge and tachometer formerly were located.

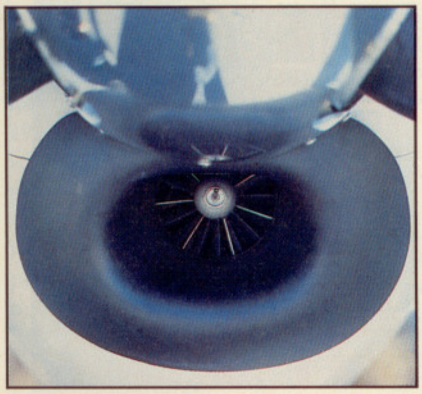
The second prototype has the new Bonanza panel (introduced by Beech in 1984), which eliminates the massive control column crossbar or throw-over yoke found in earlier Bonanzas, opening up instrument panel space and allowing a more orderly grouping of gauges and switches.

Engine gauges for the turbine powerplant are arranged vertically in a typical sequence for turbines. On top is a torque gauge, which measures the force (in pounds per square inch) being exerted by the engine to turn the propeller. Below is the turbine outlet temperature (TOT) gauge (more usual for turbine engines is a turbine inlet temperature gauge). These gauges must be monitored when power is applied so as to avoid exceeding torque or temperature limits. Additional gauges measure compressor speed, propeller rpm, oil pressure and oil temperature.

The vernier engine controls used in earlier models of the Bonanza are replaced in the new panel with levers, which seem more suitable for the operation of a turbine engine. A condition lever serves as both a mixture and propeller speed control. After starting the engine, the condition lever normally is kept in the full-forward (100 percent) position throughout the flight. At this setting, the propeller turns at 2,030 rpm. To shut down the engine, the lever is pulled full aft, shutting off the fuel and feathering the propeller.

Torque, temperature and blade pitch are controlled by the power lever. By moving the power lever sideways from the flight-idle position, around a gate and then aft, the propeller can be shifted into the beta range. A small movement behind the idle stop will place the blades in a zero-thrust position. At the full-aft position, the Bonanza's propeller will produce maximum reverse power.

Despite the logical arrangement of switches, controls and gauges, there is quite a bit to learn for a pilot making the transition from piston to turbine power. Allison or its distributors will offer instruction in the operation and maintenance of the the turbine powerplant. The instruction should go a long way toward reducing the chance of a pilot damaging the expensive turbine engine.



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On start-up, gone is the familiar rumble of the Continental, replaced with the whir of a turbine.

A short round-trip flight between Frederick and Lancaster, Pennsylvania, (about 150 nm) and an air-to-air photography session enabled *Pilot* staff members to sample the performance and handling characteristics of the Turbine Bonanza.

The altered nature of this airplane is quite evident on engine start-up. Gone is the familiar rumble of the Continental, replaced with the whir of a turbine. The Turbine Bonanza takes off in about half the distance of a standard Bonanza. Preliminary figures for a 90°F day at 800 feet indicate a 580-foot takeoff roll for the turbine A-36 versus a 1,090-foot roll for a standard Bonanza with a 300-hp Continental IO-550-C engine.

At a best rate of climb, 100-knots indicated airspeed (KIAS), the Bonanza ascended at 2,000 fpm. The deck angle was high, and gentle S-turns were required to scan for traffic. Deck angle in an 80-knot, best-angle-of-climb ascent was about 22 degrees, nose up, and felt considerably higher, perhaps because of a lack of forward reference. For pilots frustrated by anemic climb rates due to the cooling requirements of some high-performance piston singles, the climb rate of the Turbine Bonanza is a heady thrill.

On the way to Lancaster, 100 knots indicated was held up to a cruising altitude of 11,500 feet. After five minutes of climb, standard operating procedure calls for reducing power to bring the turbine outlet temperature back from its maximum of 810°C to 756°C (the middle of the yellow arc). Rate of climb then decreases to about 1,700 fpm.

A further power reduction is required in cruise, to 738°C—the top of the green arc. At our altitude, this translated to about 80 percent torque. Indicated airspeed was at the top of the green—in this airplane, Vne: 166 knots. True airspeed was 203 knots.

Federal Aviation Administration certification standards require that never-exceed speed be lowered to the value for the maximum structural cruise speed of the standard A-36. At cruise altitudes above 10,000 feet or so, indicated airspeed at the maximum cruise setting is just at or within the green arc. There is no yellow caution range on the modified Bonanza.

Fuel flow at 11,500 feet is 20.5 gph decreasing to 18.5 gph at 19,000 feet, where speed remains at about 200 knots, according to Chambers. We began our descent into Lancaster by reducing power to flight idle and holding 160 KIAS, which produced a 2,000-fpm descent. Unlike a piston-powered aircraft, substantial power reductions and long descents can be made in a turbine-powered aircraft without danger of shock cooling the engine.

Approach speeds for the conventional Bonanza work well in the turbine version: 90 to 100 knots for downwind, slowing to 80 knots for final approach. The Bonanza felt stable at 80 and responded to power changes in about the same manner as the piston-powered airplane. The relatively low inertia of the turbine wheel and compressors (compared to larger free-turbine engines) enables the Allison engine to spool up quickly, going from flight idle to 100 percent power in two seconds. Perhaps because of the effect of the winglets, aileron response seemed better and lighter than in the standard Bonanza.

Using reverse power for stopping enables quite short landings. Test pilots have recorded landing distances as short as 250 feet. Chambers demonstrated a maximum effort landing (locking the brakes and applying full reverse power) that burned rubber and sent unrestrained objects hurtling across the cabin. The airplane stopped within about 500 feet. Consistent use of this technique, however, takes a

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Using reverse power, Turbine Bonanza test pilots have recorded landing distances as short as 250 feet.

heavy toll on brake pads and tires—and possibly on cabin occupants.

The Bonanza has always been one of the most comfortable singles in which to fly, whether as pilot or back-seat passenger. The lower noise and vibration levels of the turbine powerplant make the cabin environment even more pleasant. Air conditioning, which is standard, makes taxiing around on hot tarmac a cool pleasure.

The use of oxygen is the one compromise to comfort that pilots and passengers must make. The Turbine Bonanza is most efficient at altitudes where oxygen is required. And many pilots will want to use the airplane's good climb performance to ascend into the high teens to obtain the most efficient combination of fuel flow and cruise speed.

It is unknown how many pilots will be willing to put up with the discomfort of the oxygen mask to gain all the other advantages of the Turbine Bonanza. At Allison, they are confident there will be a substantial number of takers for the airplane. If the Turbine Bonanza succeeds in the marketplace, it is likely that more singles and light twins will be powered by Allison 250-series turbine engines in the future. □