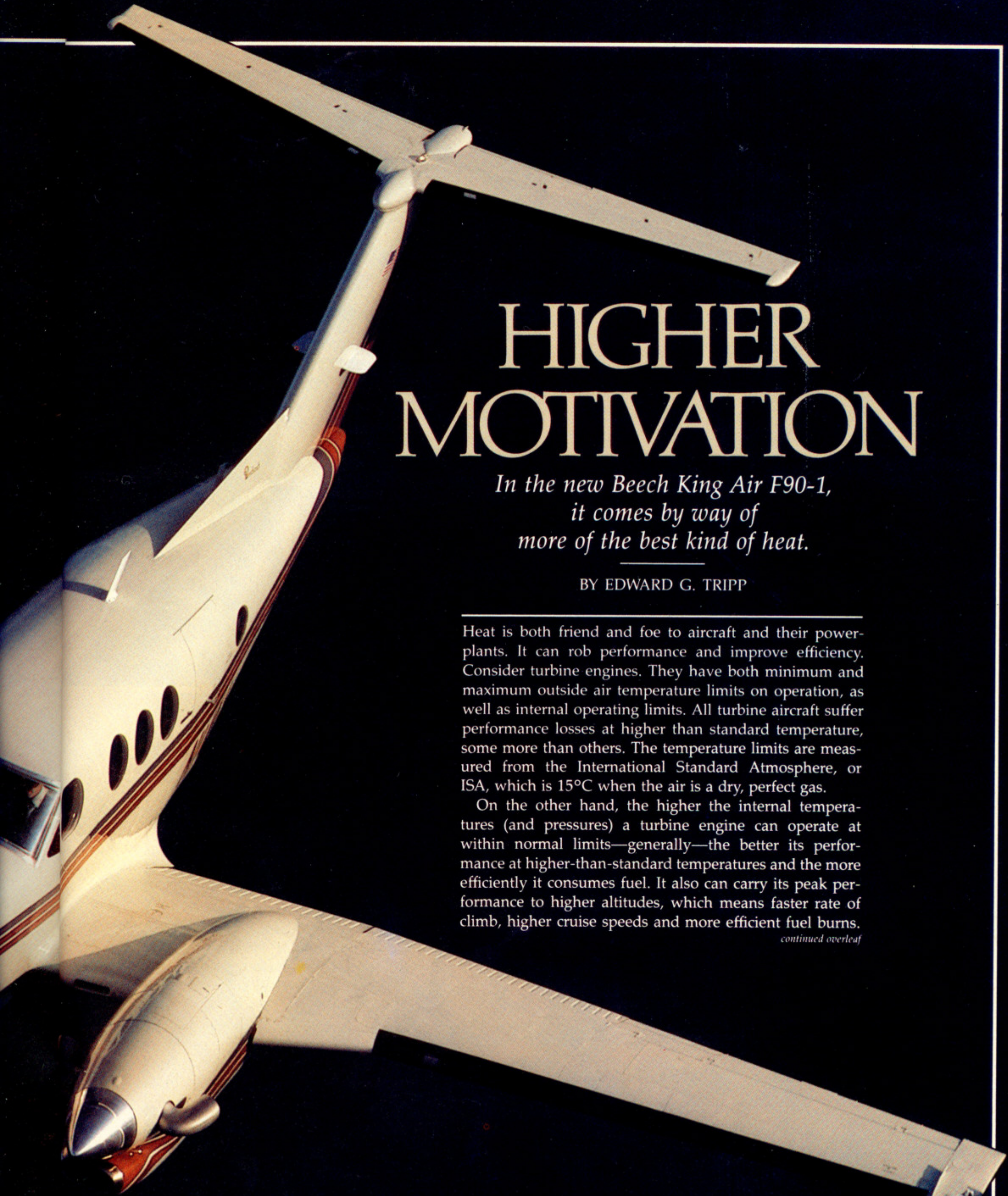

HIGHER MOTIVATION

In the new Beech King Air F90-1, it comes by way of more of the best kind of heat.

BY EDWARD G. TRIPP

Heat is both friend and foe to aircraft and their powerplants. It can rob performance and improve efficiency. Consider turbine engines. They have both minimum and maximum outside air temperature limits on operation, as well as internal operating limits. All turbine aircraft suffer performance losses at higher than standard temperature, some more than others. The temperature limits are measured from the International Standard Atmosphere, or ISA, which is 15°C when the air is a dry, perfect gas.

On the other hand, the higher the internal temperatures (and pressures) a turbine engine can operate at within normal limits—generally—the better its performance at higher-than-standard temperatures and the more efficiently it consumes fuel. It also can carry its peak performance to higher altitudes, which means faster rate of climb, higher cruise speeds and more efficient fuel burns.

continued overleaf

PHOTOGRAPHY BY PAUL CHAUNCEY

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Turbine engines in use today are primarily torque-limited at lower altitudes. At a given point, temperature becomes the power-limiting factor. The higher the ambient temperature, the lower the altitude at which power reductions are necessary and the lower the performance.

The other critical area where performance is affected by higher-than-standard ambient temperature is takeoff.

Beech had the dual effects of heat very much in mind when company engineers went to work to upgrade the performance of the F90. The model was introduced in late 1979 to replace the conventional tail E90 (see November 1979 *Pilot*, p. 89). It featured higher speed and payload, improved handling characteristics and a wider CG range than its predecessor.

The aircraft landed in a competitive market with several key areas in which it lacked performance. At the time of introduction, Beech established the F90's competitors as the Mitsubishi MU2 Solitaire, the Commander 690B, the Cheyenne II and Cessna's Model 441 Conquest.

The F90 was the slowest, somewhat less fuel efficient, had the lowest pressure differential and was not competitive in balanced field length calculations because of longer accelerate/stop, accelerate/go distances. Despite the F90's fairly high empty weight, it offered a higher available payload for typical trip segments (300 nm) and the

cachet of being a King Air, with a towering T-tail to boot.

In the past four years, 200 have been sold, and two have been retained by Beech as R&D vehicles. Beech also tested a Garrett-powered version that would have been dubbed the G90 but decided not to put it on the market.

The heart of the dash-one designation for this year's F90 is the A designation on the Pratt & Whitney PT6A-135A that powers the aircraft. Internal changes compared to the –135 increase the power rating modestly from 850 shp to 885 (flat-rated at 750 shp for the F90) and the ambient temperatures at which takeoff and maximum continuous, and max climb and cruise power can be obtained (from 85°F to 93°, and from 98°F to 105°). The changes also provide an average of eight percent more power at cruise altitudes.

The changes include longer impellers in the inducer and second and third stator stages, staggered power turbine blades to improve airflow and metallurgically improved—in a process called directional solidification—compressor turbine blades. The latter increases temperature margins. The engine has a single-line fuel system.

The bulk of the other changes are in and around the engine compartment, too. The most obvious is the redesigned cowling. The air inlet area has been reduced from 116 square inches to 60; the exhaust stacks have been streamlined, the ram air scoop for the oil cooler has been replaced by a NACA inlet. These changes have reduced frontal area, thus drag, and improved air flow (called inlet ram recovery in the jargon). The cowl has been made easier to remove and provides easier preflight inspection.

The air inlet lip now is continuously heated, with exhaust air drawn from one side, routed through the lip and exhausted out the other side.

The ice separator vanes, which when extended act as an inertial separator to keep the engine from ingesting anything but air, have been changed from mechanical to redundant electric motor activation, with a mechanical backup system.

The company claims these changes provide a 32-percent increase in efficiency at cruise in dry air and 30 percent in icing conditions (performance loss in icing conditions was one of the largest reasons for complaint by customers). Cruise speeds have increased by an average of 13 knots, rates of climb and service ceilings have been marginally improved.

Although the takeoff roll has been reduced by only 40 feet, the above changes plus the approval of an 11-knot-lower decision speed have reduced the gross weight, no-flap accelerate/stop distance by 655 feet.

In addition, pilot work load, particularly in icing conditions, has been reduced.

While the performance improvements might seem small, the improvements in balanced field length, greater efficiency, faster climb to altitude and higher cruise speed all add up to significant advantages. The improvements in higher temperatures and icing conditions improve the flexibility and reduce anxiety for operators. This has been achieved by improving efficiency, not by increasing horsepower (the age-old method for improving performance).

All the other factors remain unchanged: weights, critical speeds and maximum pressure differential. There are a few changes in the cockpit: For instance, many of the monitoring and caution annunciators have been relocated to the center of the panel, just above the power quadrant (critical items are still located on an annunciator panel on the glareshield). But any pilot moving from an F90 to a −1 would feel at home immediately.

Procedures, systems and techniques remain the same except for the changes listed above (such as the always-heated inlet lip). From preflight through start and initial checks to shutdown, it is a straightforward turboprop to the properly trained pilot. It is well laid out for single-pilot operation, with a great deal of systems backup to help when things go sour.

As a for instance, when all the aids are working, an engine failure at rotation is much less of an adrenaline-pumping experience than it is in the typical piston twin (if the automatic feathering option is installed, that is). The auto feather detects variations in thrust, moving the propeller toward the feather position. Rudder boost goes to work to decrease pilot effort during the initial asymmetric thrust condition. The primary task for the pilot is to keep the airplane flying under control without having to worry nearly as much to identify the affected engine and hasten through the emergency, immediate action items that he should have memorized.

Even if the automatic systems are not working, and despite the weight of the F90, a well-trained and mentally prepared pilot should be able to handle an engine-out situation with relative grace, thanks to a gross-weight single-engine climb rate of more than 600 fpm, three times that of the typical piston twin.

Beech does an excellent job in cockpit design: Systems and subsystems are grouped logically, and the amount of time spent hunting for gauges or switches is minimized.

My brief introductory flight in the dash-one F90 is a pretty good example of the cockpit design and basic good flying qualities of the model. I had not flown any King Air for more than a year and had not flown an F90 for more than two when, after a walkaround with Roy Lawrence of Beechcraft (who flew N14KA for the photo mission) and a discussion of the principal changes to the F90, the two of us climbed into the cockpit to fly a simulated trip profile.

We had agreed to an IFR departure from Beech Field; climb to Flight Level 240; quick descent to middle altitudes for some airwork, including steep turns, stalls and simulated missed approaches; a descent for some instrument approaches with simulated emergencies; visual approaches and maximum performance takeoff and landings; with operation of some of the aids, such as the Sperry SPZ-200A autopilot and Sperry Stars IVD flight director system tacked on.

It typically takes me 10 hours of operation to feel comfortable in a new aircraft after a thorough checkout or a school, depending upon the category of aircraft. With big, sophisticated aircraft with many systems, it takes a total of 50 hours to approach proficiency.

The only initial difficulty I had in the F90 cockpit was the relatively short track in the pilots' seats, which makes for not quite enough room if you are over six feet tall.

It was humid and already approaching 80°F in Wichita the day I flew. I started the takeoff roll before the bit was quite in the teeth (the free-turbine design of the PT6 requires power stabilization to get the propellers working to avoid differential surges from the two engines), but directional control was good. After rotation at 95 knots, the aircraft was flying within about five knots; and we accelerated to initial climb speed of 120, then on to 140 knots for better forward visibility. ATC made us step climb, and I was experimenting with a range of speeds, both of which slowed down the ascent. Nevertheless, we were leveling at 240 less than 20 minutes after takeoff.

Even without using all the available aids and with

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Pilots sliding into the best seats in the house for the first time are in for a treat. Good systems design and layout reduce learning time, work load.

Beech King Air F90-1
Base price $1,392,750
Price as tested $1,706,690
AOPA Pilot Operations/Equipment Category*:
All-weather $1,500,000 to $1,800,000

Specifications

Powerplants 2 Pratt & Whitney of Canada, Ltd. PT6A-135A; 750 shp
Recommended TBO 3,500 hr
Propellers 2 Hartzell four-blade, constant-speed, full-feathering and reversing, 92 in dia

Length	39 ft 9.6 in
Height	15 ft 1.7 in
Wingspan	45 ft 10.5 in
Wing area	279.7 sq ft
Wing loading	39.14 lb/sq ft
Power loading	7.3 lb/hp
Seats	6-10
Cabin length	12 ft 9 in
Cabin width	4 ft 6 in
Cabin height	4 ft 9 in
Empty weight	6,590 lb
Empty weight, as tested	7,184 lb
Max ramp weight	11,030 lb
Useful load	4,440 lb
Useful load, as tested	3,846 lb
Payload w/full fuel	1,267.5 lb
Payload w/full fuel, as tested	673.5 lb
Max takeoff weight	10,950 lb
Zero fuel weight	9,600 lb
Fuel capacity, std	3,172.5 lb/470 gal
Oil capacity, ea engine	14 qt
Baggage capacity	403 lb, 70 cu ft

Performance

Takeoff distance, ground roll	2,012 ft
Takeoff distance over 50-ft obst	2,808 ft
Accelerate/stop distance, zero flaps	3,829 ft
Accelerate/go distance, zero flaps	5,058 ft
Max demonstrated crosswind component	25 kt
Rate of climb, sea level	2,455 fpm
Single-engine ROC, sea level	632 fpm
Max level speed, 11,000 ft	278 kt

Cruise speed/Range w/45-min rsv, std fuel @ avg cruise weight of 9,500 lb (fuel consumption, ea engine)

Max cruise power	
18,000 ft	275 kt/1,156 nm (324 pph/48 gph)
26,000 ft	265 kt/1,439 nm (249 pph/36.9 gph)
Max range power	
18,000 ft	217 kt/1,397 nm (215 pph/31.9 gph)
26,000 ft	224 kt/1,612 nm (198 pph/29.3 gph)
Max operating altitude	31,000 ft
Max operating temperature	ISA + 37°C
Single-engine service ceiling	15,300 ft
Landing distance over 50-ft obst, w/o reverse	2,977 ft
Landing distance, ground roll, w/o reverse	1,895 ft

Limiting and Recommended Airspeeds

Vmca (Min control w/one engine inoperative)	87 KIAS
Vsse (Min intentional one-engine inoperative)	100 KIAS
Vx (Best angle of climb)	90 KIAS
Vy (Best rate of climb)	115 KIAS
Vxse (Best single-engine angle of climb)	109 KIAS
Vyse (Best single-engine rate of climb)	115 KIAS
Va (Design maneuvering)	170 KIAS
Vfe (Max flap extended) Approach	183 KIAS
Full	146 KIAS
Vle (Max gear extended)	183 KIAS
Vlo (Max gear operating) Extend	183 KIAS
Retract	165 KIAS
Vmo (Max operating speed)	253 KIAS/.48 Mach
Vr (Rotation)	107 KIAS
Vsı (Stall clean)	94 KIAS
Vso (Stall in landing configuration)	77 KIAS

*All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, at sea level and gross weight, unless otherwise noted. *Operations/Equipment Categories are defined in June 1983 Pilot, p. 96. The prices reflect the costs for equipment recommended to operate in the listed categories.*

configuration changes and steep turns at low speeds, the F90 is very tractable. During one departure, Lawrence failed an engine immediately after takeoff. Effort was low during the clean-up. The approach was flown as though nothing had gone amiss, and reverse was used on the remaining engine during the landing with good directional control.

Of course, only hard, continuous operational experience can take the measure of an airplane. But the good systems and excellent organization of the entire King Air series, and their straightforward flying habits, get them off to a good start. The improved performance of the F90-1 should help it find its niche in the middle of the four- to five-passenger turboprops. □

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KING AIR SPOTTER'S GUIDE

King Air Model C90-1

Conventional tail; Length: 35 feet 6 inches
5 cabin windows on right: 3 closely grouped
(easiest way to tell 90s from B100, B200, which have 5 closely grouped windows); 4 windows on left
2 Pratt & Whitney PT6-21 engines, 550 shp ea.
Exhaust stacks high on cowling
3-bladed props feathered in stop position
237 knots at 12,000 feet, 231 knots at 21,000 feet
4-8 passengers

King Air Model F90-1

T-tail; Length: 39 feet 9½ inches
5 cabin windows on right: 3 closely grouped as on C90-1; 4 on left
2 Pratt & Whitney PT6A-135A engines, 750 shp ea.
Exhaust stacks high on cowling
4-bladed props feathered in stop position
217 knots at 18,000 feet, 224 knots at 26,000 feet
4-5 passengers

King Air Model B100

Conventional tail; Length: 39 feet 11 inches
7 cabin windows on right: 5 closely grouped as on B200; 6 windows on left
2 Garrett AiResearch TPE331-252B engines, 715 shp ea.
(only production Beechcraft with Garrett engines)
Exhaust stacks low on cowling
4-bladed props flight position in stop position
265 knots at 12,000 feet, 262 knots at 21,000 feet
6-13 passengers

Super King Air Model B200

T-tail; Length: 43 feet 9 inches
(Optional configurations: 200C—square cargo door; 200T—modified for aerial photography, thunderstorm research)
2 Pratt & Whitney PT6A-42 engines; 850 shp ea.
Exhaust stacks high on cowling
3-bladed props feathered in stop position
285 knots at 18,000 feet, 278 knots at 25,000 feet
6-13 passengers

Model 1900

T-tail; Length: 57 feet 9½ inches
Tailettes, stabilons unique to 1900
10 cabin windows on right; 9 on left
2 Pratt & Whitney PT6A-65B engines, 1,120 shp ea.
Exhaust stacks high on cowling
3-bladed props feathered in stop position
263 knots at 12,000 feet
19 passengers