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PILOT REPORT

Aircraft Report: The Raisbeck King Air 200

Is it really faster, quieter and better-performing than a Beech original?

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For 13 years, James D. Raisbeck, president of the company that bears his name, has been defying the odds. Raisbeck Engineering's specialty is building modification kits, or "systems" as Raisbeck prefers to call them, for Beech King Airs.

Most modifiers don't survive a third as long as Raisbeck Engineering, let alone thrive as this Seattle-based firm has done. The proportion of Raisbeck-equipped Beech King Air 200 aircraft, for example, has increased from five percent in 1985 to 35 percent of the active King Air 200 fleet today, the firm's records show.

When B/CA reported on Raisbeck systems in the June 1985 issue (page 75), we documented the performance improvements of the Raisbeck Mark VI modified Beech Super King Air 200. We concluded that the Raisbeck-equipped King Air was quieter, faster and more fuel efficient than the factory-stock model.

The Beech King Air, devoid of Raisbeck technology, has remained the most successful turboprop aircraft ever designed for general aviation. The Super King Air 200 arguably is the quintessential Beech turboprop; its share of the turboprop market soars well above all competitors. However, the number of Super King Air 200 aircraft manufactured yearly has dropped more than 90 percent since its peak of 219 in the general aviation boom year of 1981.

About two and one-half years ago, Beech introduced an improved Super King Air 200 series to help reverse the model's sagging sales. The improved 200 is fitted with four-blade McCauley propellers, a passive noise attenuation system and myriad detail improvements—but nothing to measurably increase its cruise speed.

Thirty-one updated aircraft were built in 1993, and an estimated 17 were scheduled for production in 1994.

Owners of the $3.7-million Super King Air 200 are decidedly unhappy about the performance of the new McCauley four-blade props, especially regarding the recurring problems with keeping the props in synchronous phase—essential for minimizing noise.

Raisbeck doesn't hesitate to praise Raytheon Aircraft Company for building the "finest and safest" general aviation turboprop aircraft yet designed. He also is equally swift to add that his performance-enhancement systems improve several King Air models' runway performance, all-engine and engine-out rate of climb, cruise performance, cabin noise and yaw stability.

"Whether we're talking about a good used 1974 Super King Air 200 or a brand new, 1995 Improved B200, for less than $85,000 including installation, our Enhanced Performance Package will open up worlds of increased operational flexibility, productivity and return on investment," proclaims Raisbeck. "It just makes good business sense."

More Super King Air 200 aircraft have been equipped with Raisbeck systems than any other model in the King Air series. So we decided to concentrate our efforts on this aircraft to learn if four popular Raisbeck systems, available as a package, really work as advertised. Here's what we found:

QUIET TURBOFAN PROPELLERS

Prior to BB-1439, first of the "Quiet King Airs" produced in late 1992, Super King Air 200 aircraft were fitted with 98.5-inch, three-blade Hartzell propellers. Those comparatively large diameter props, turning at 1,700 to 2,000 rpm in flight, create substantial noise in the cockpit and cabin. In 1985, B/CA measured a sound level of 92 dBA in the cockpit of a stock Super

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King Air B200 during cruise at FL 310—seven dBA higher than the 85 dBA maximum continuous noise allowed by the Occupational Safety and Health Administration (OSHA) for workplace environments.

Working in concert with Hartzell, Raisbeck Engineering designed a 94-inch, four-blade propeller. And, according to an independent firm's tests, that prop yields a seven dBA reduction in cruise sound levels in the aircraft cockpit and up to 10 dBA less in the passenger cabin, depending upon position.

The cockpit noise level of a Super King Air 200 fitted with the Raisbeck props is 85 dBA during cruise at 1,600 rpm, per the findings from an independent firm's 1985 study. B/CA's 1985 cockpit noise measurements of 82 to 86 dBA were consistent with the Raisbeck-provided numbers. Of equal importance to some operators, the Raisbeck props significantly reduce fly-over noise.

Raisbeck test data submitted to the FAA also document that the props produce more thrust at low speed than the factory-standard three-blade props. Results further show an 18-percent reduction in the distance to liftoff for a Super King Air 200 equipped with Raisbeck/Hartzell propellers, compared to the stock three-blade props.

In addition, the props produce more low-speed thrust than the factory- standard three-blade propellers, resulting in a certified V_{MC} increase from 86 KIAS to 91 KIAS. So effective are Raisbeck props at low speed, that aircraft equipped with them must be fitted with autofeather. Otherwise, should an engine failure occur, asymmetric drag and, thus, yawing moment, would occur. Most newer Super King Air 200 aircraft, though, are already equipped with the optional autofeather feature.

The Raisbeck props increase engine air inlet pressure. Such an improvement results from a reshaped blade airfoil that produces more thrust near the blade hub and, therefore, more ram effect into the engine inlet. According to the firm's 1984 FAA certification flight tests, available engine torque was increased three to six percent after the test aircraft was fitted with Raisbeck/Hartzell propellers. The resulting torque increase yields the same true airspeed at 1,600 rpm and an increase of four to six knots true at 1,700 rpm cruise power, compared to the stock aircraft cruising at 1,700 rpm.

Because Raisbeck wanted to provide an incentive for customers to buy a package of performance enhancements, Raisbeck never published the improved runway performance and horsepower numbers of the Super King Air 200 equipped with the Raisbeck/Hartzell props alone. The Enhanced Performance Package includes (1) props, (2) modified engine air intake systems, (3) recontoured inboard wing leading edge structures and (4) aft fuselage ventral strakes.

Operators with whom we spoke who fly Raisbeck/Hartzell-equipped Super King Air 200 aircraft were unanimous in their praise for the reduced sound levels. Bruce Snyder, flight department manager of Flightcraft, Incorporated of Seattle, told B/CA, "The props have made a marked difference on our charter aircraft. Our passengers can tell the difference [in sound level]. Subjectively, the props have paid for themselves in two to three years of operations."

We heard similar comments from several other Raisbeck customers, including one operator who had trouble with the new, quieter 94-inch McCauley four-blade props fitted to current versions of the Super King Air 200. The operator, who wished not to be identified, said that Beech retrofitted his aircraft with Raisbeck/Hartzell four-blade props because the McCauley props could not be kept in synchronous phase for minimum noise. (Raytheon declined to comment on its retrofit offer.)

According to the operator, "The McCauley props were 45 degrees out of phase." (An out-of-phase condition causes the blade tips of both propellers to pass the fuselage at the same time, creating maximum internal noise and vibration.)

In contrast, the operator claimed that "The new Raisbeck/Hartzell props hold phase within six degrees," thereby eliminating much of the synergistic noise generated by two props operating at the same rpm and out of phase.

The operator additionally claims that the Raisbeck/Hartzell-equipped aircraft accelerates quicker than it did with the factory-original McCauley four-blade props. However, B/CA could not verify these claims because Beech opted not to recertify the takeoff distances of the latest Super King Air B200 equipped with McCauley four-blade props. The deciding factor for Beech on this issue was that the aircraft meets or exceeds the performance of the earlier model.

RAM AIR RECOVERY SYSTEM

The engine air inlets on Pratt & Whitney PT6A turboprop engines, such as the -41/-42 engines on Super King Air 200/B200 aircraft, have two primary purposes that often are in conflict. First, the shape of the air inlet has to provide high volumetric efficiency to the engine intake plenum. Second, the air inlet geometry has to be able, when needed, to deflect ice and foreign objects away from the engine air inlet.

King Air 200s, among other PT6A- powered aircraft, are equipped with air inlet systems that sacrifice volumetric efficiency to ensure protection against ice and FOD ingestion, according to Raisbeck. A Pratt & Whitney Canada official told B/CA that inlets similar to those of the stock Beech 200 have an efficiency of

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Raisbeck designed DABS to improve the yaw stability of the Super King Air 200.

about 70 percent in cruise (absent the ram effect of the prop). Deploying the ice vanes, however, puts a sharp kink in the airflow path en route to the engine, resulting in a large drop from the estimated 72-percent volumetric efficiency on the 200's inlet. The kink causes particulate matter to bypass the engine air inlet due to centrifugal force and flow back into the slip-stream through an open exhaust door.

To the contrary, Raisbeck's Ram Air Recovery System (RARS) develops a claimed ram recovery of 96 percent in cruise. (Notably, the newer design pitot cowl inlets fitted to King Air C90B, 300 and 350 aircraft have much better ram-air-recovery efficiency than the 200's engine inlets.)

RARS, developed in cooperation with Pratt & Whitney Canada in the 1980s, has four main features:

(1) A curved trailing-edge extension of the ice vane door that parallels the air-flow path to the engine inlet,

(2) A fixed turning vane in the air-flow path to direct air to the engine,

(3) A substantially more porous and repositioned ice-shedder vane screen, and

(4) Air-duct seals to prevent efficiency-sapping leaks.

The curved vane-door extension and fixed turning vane promote a Coanda effect, which is the use of a comparatively small, high velocity stream of air to steer the main airflow.

P&WC told B/CA that such an inlet could, in theory, develop 90-plus percent efficiencies, but the engine manufacturer does not have flight-test data to support Raisbeck's specific claims.

Raisbeck further maintains that RARS has as high a volumetric efficiency with ice vanes deployed as the stock Beech inlet with ice vanes stowed. This claim may be substantiated indirectly. Raisbeck flight-test data show that even with the ice vanes deployed, a Super King Air 200 equipped with RARS develops 95.5 percent as much torque as a stock system with ice vanes stored. When the ice vanes are deployed in the RARS, there is one-fourth less loss of efficiency compared to the stock system, according to FAA certification flight tests.

The increased torque has an additional, bootstrap effect on ram rise related to higher indicated airspeeds. More speed causes more ram recovery effect. When the combination of higher inlet efficiency with the vanes deployed is coupled to the increased airspeed, Raisbeck's claim of equal torque becomes credible.

In addition, the maximum engine torque of 2,230 foot-pounds is available at much higher density altitudes than with the stock Beech inlet. One operator claimed that RARS reduced ITTs by 20 to 40 degrees for the same torque settings.

What's the bottom line? RARS yields a nine-knot increase in true airspeed, as reported by Raisbeck flight-test data.

ENHANCED PERFORMANCE LEADING EDGES

The stock Super King Air 200's inboard wing section—the airfoil between the engine nacelle and the fuselage—keeps flying long after the outboard section stalls. As a result, in clean air, the horizontal stabilizer operates the highest possible stalling angles of attack. Therefore, the stall is defined more by wing roll-off than by the actual aerodynamic performance of the entire wing, Raisbeck says. The certified stalling speed, then, is a conservatively high 99 KIAS at 12,500 pounds, according to the FAA-approved Airplane Flight Manual (AFM).

At high speed, the exceptionally high lift coefficient of the inboard wing section results in a tradeoff. The inboard-wing section produces little, if any, lift at cruise angle of attack, Raisbeck flight-test research has shown. The outboard wing sections must provide almost all of the lift because the inboard section acts as little more than an engine pylon and wing spar carry-through structure.

Raisbeck's enhanced performance leading edge (EPLE) for the inboard wing section, compared to the stock King Air 200's leading edge, has a larger radius that is closer to midway between the upper and lower wing surfaces. The Raisbeck-equipped inboard wing section actually stalls at a lower angle of attack than the stock inboard wing section, but the airplane stalls straight ahead rather than rolling off on a wing. Somewhat ironically as a result, the certified stalling speed is reduced to 89 KIAS at 12,500 pounds—10 knots slower than the stock configuration—due to the more docile stall characteristics.

The reduced stall speed has a direct impact on the Vyse. The EPLE system drops single-engine takeoff speed from 121 KIAS to 103 KIAS.

Also, the reshaped EPLE produces more lift at high-speed, low angle-of-attack cruise compared to the stock version, per the Raisbeck flight-test data. The improved lift at cruise speeds offloads the outboard wing section, resulting in less induced drag. Furthermore, a recessed pocket of the EPLE structure that houses the deice boot results in lower-form drag. So, the outcome is five more knots of cruise speed and lower stalling speeds.

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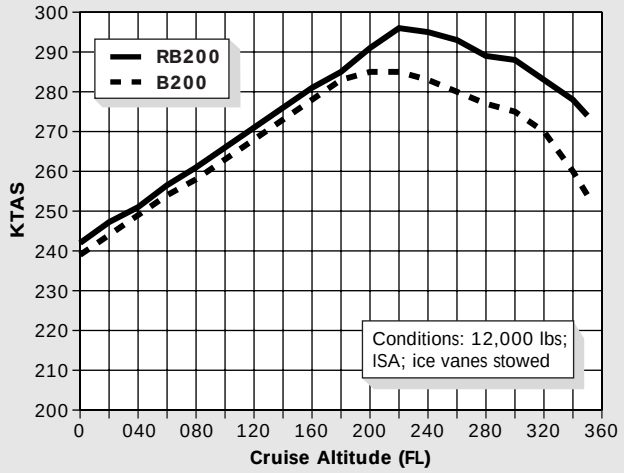
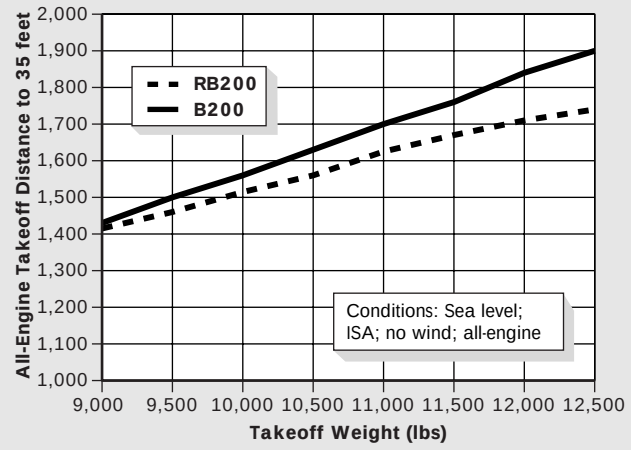
CRUISE SPEED COMPARISON
(Maximum Cruise Power—1,700 RPM)



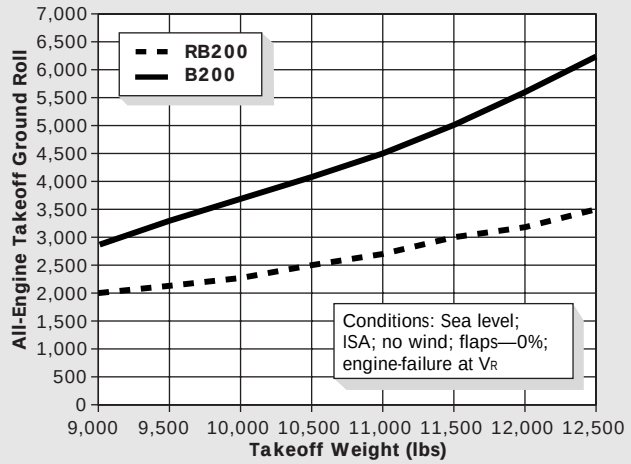
Source: Airplane Fight Manuals

TAKEOFF DISTANCE—FLAPS 0%
(Raisbeck-Equipped vs. Original B200)



Source: FAA Aproved Pilot's Operating Handbooks

ACCELERATE-GO DISTANCE COMPARISON
(Raisbeck Equipped vs. Original B200)



Source: FAA-Approved Pilot's Operating Handbooks

DUAL AFT BODY STRAKES

Raisbeck designed DABS to improve the yaw stability of the Super King Air 200 and to reduce form drag due to air separation below the aft fuselage. The increased yaw stability allows the King Air 200 to be dispatched and flown up to its 35,000-foot certificated ceiling with an inoperative yaw damper.

However, Raisbeck clearly urges operators to fly the airplane with the yaw damper engaged for greater passenger comfort. But even without the yaw damper, a DABS-equipped King Air 200 will damp at least 95 percent of the yaw amplitude in seven cycles at the aft-most allowable center of gravity, according to data submitted to FAA certification flight tests. (Only when the aircraft is dived to MMO from its service ceiling does the DABS-induced yaw damping decrease to 84 to 89 percent effective in seven cycles.)

DABS also reduces drag because it apparently captures the wing root/ fuselage vortices, aligns the force of the airflow and re-attaches it to the aft body, thereby eliminating the suction caused by the separation. The result? Two knots more airspeed.

HIGH FLOTATION GEAR DOORS

A sizable number of Super King Air 200 aircraft are fitted with optional high-flotation main landing gear (HFG), allowing aircraft so equipped to operate from unimproved landing facilities. The HFG's larger tires and wheels, however, don't fully retract into the wheel wells in the engine nacelles. And Beech's stock, abbreviated main-landing-gear doors for HFG-equipped aircraft only cover the struts, thus leaving part of the large diameters tires to drag along in the slipstream.

According to Beech's FAA-approved AFM, HFG drag costs the Super King Air 200 at least 12 KTAS in maximum cruise speed.

As a solution, Raisbeck offers fully enclosed HFG doors that completely eliminate this drag penalty. Therefore, HFG-equipped aircraft can climb and cruise as fast as aircraft with standard landing gear, according to Raisbeck's flight-test data.

MEASURING PERFORMANCE PACKAGE IMPROVEMENTS

If we examine them individually, the elements of the performance group package—props, RARS, EPLE and DABS—produce relatively small improvements. All of the customers with whom we spoke, though, said the performance package as a whole produces Raisbeck's claimed numbers. The package sells for $71,950, and it takes approximately 195 hours to install. Notably, all domestic Beech turbine service centers, including the company-owned United Beechcraft facilities, are authorized to sell, install and service Raisbeck systems.

Raisbeck claims a 15- to 24-knot speed boost when cruising at 1,700 rpm at FL 350, depending on weight. Most operators with whom we spoke, however, cruise at the quieter 1,600 rpm and at lower altitudes where smaller speed increases may be expected. "We picked up nine knots. At [flight level] 240, we can cruise at

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270 knots true. . . . We've had zero problems [with the system]. . . . It absolutely makes Raisbeck's published numbers," volunteered Gary Tragessor, formerly the chief pilot for Princeton, Idaho-based Bennett Lumber, which operates a 1978 Model 200. Other operators who reported nine- to 10-knot speed increases made similar comments. "It's a great investment," said George Rhine, director of aviation for Shaw Industries, located in Chattanooga.

When operators choose to fly at FL 310 to FL 350—usable on an everyday basis—they can expect the Raisbeck-equipped Super King Air 200 to perform more like a Super King Air 300, but to burn less fuel and have more range. A Raisbeck-equipped B200 can climb to FL 330 in 21 minutes, versus 30 minutes for the stock B200, according to the two flight manuals.

Many Raisbeck systems buyers are looking for improved airport performance. James R. McDonald, assistant chief of maintenance for Occidental Petroleum in Bakersfield, California, said that short-field performance, more docile one-engine inoperative handling, improved stability, as well as better performance, were prime reasons for installing the Raisbeck systems. A Raisbeck-equipped Super King Air 200's one-engine-inoperative accelerate-go takeoff distance, for example, is 3,480 feet at MTOW—45 percent shorter than the unmodified aircraft.

Vref also drops from 103 KIAS to 97 KIAS, and the landing distance (over a 50-foot obstruction) shrinks from 2,850 feet to 1,970 feet.

As for ease of installation, Dan Bryant, chief of maintenance of North Slope Borough Search and Rescue in Barrow, Alaska, told us that Raisbeck systems were "some of the best laid-out kits you've ever seen." Another operator praised Raisbeck for excellent technical support, especially the 1-800-537-7277 toll-free telephone line. Many customers will attest that product support is a top priority for Robert P. Steinbach, Raisbeck's vice president of sales and service.

Raisbeck systems are even becoming popular with new Super King Air 200 buyers. Mørefly A/S of Ålesund, Norway, for example, recently bought seven new Super King Air 200 aircraft and equipped them all with Raisbeck's performance package, including HFG doors.

Why don't we see Raytheon offering similar changes to the Beech Super King Air 200? Some operators told us, "There's not a strong acceptance of aftermarket enhancements." One operator explained, "Beech is reluctant to admit that someone else can design a product that can make their aircraft better." In a veiled reference to potential product liability exposure, another operator, who is a former Beech employee, allowed, "Beech has to look at the long-term consequences of any change to the basic design."

Nonetheless, Raisbeck asserts, and Aircraft Technical Publishers (a Brisbane, California supplier of AD data) confirms, that his firm has never been faced with an AD for its King Air systems. In addition, Raisbeck has not had to issue any mandatory Service Bulletins for the King Air systems.

Raisbeck also points out that none of his King Air systems has ever been found to contribute to an accident—even in the decidedly unscientific findings of civil liability suits.

On one hand, Raisbeck's critics say he has taken certain liberties in promoting his systems. They argue his marketing zeal stretches the limits of his credibility, and that his brochure engineering has led to some heated, closed-door discussions regarding the real merits of Raisbeck systems.

Raisbeck, on the other hand, irks his critics, according to his customers, by apparently shooting from the hip, yet consistently scoring engineering bull's-eyes. They claim that Beech should have incorporated new technology on the Super King Air B200 long ago.

For the record, Raytheon Aircraft Company officials declined to comment on Raisbeck systems.

One conclusion emerges from the murky middle ground between these two extremes: So long as Raytheon continues to build Super King Air B200 aircraft in their present form, Raisbeck will have plenty of future customers. **B/CA**

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