B/CA Analysis:
Beech King Air C90A

Beech's entry-level turboprop offers improved systems, more usable power and attractive handling qualities for owner-operators as well as flight departments.

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As business aviation has matured, so has the Beech King Air. When the first Model 90 with its 500-shp Pratt & Whitney PT6A-6 engines was certificated in 1964, followed- within about a year by the 550-shp PT6A-20-powered A90, flight departments of major corporations were quick to accept the turboprop aircraft as the logical replacement for the reliable but unpressurized and recip-powered Twin Beech Model 18. And as corporate needs for more interior volume, payload and speed developed, Beech introduced the Model 100 in 1969, the Model 200 in 1974 and the Model 300 in 1984.

During the growth of the King Air series, the Model 90 evolved from Beech's top-of-the-line offering for major flight departments to its entry-level turboprop aimed at the owner-pilot and single-pilot operator. The latest model King Air, the C90A, epitomizes that transition. From its redesigned instrument panel to its pitot cowls, the C90A offers features that should be particularly attractive to the operator who normally flies his aircraft without the services of a copilot.

The C90A's expanded flight envelope, redesigned cockpit and revamped systems should. reduce the workload associated with single-pilot operations. The most obvious aid to the pilot who flies without assistance from the right seat is the relocation of the landing gear handle to a position to the left of the power quadrant, on the lower instrument panel. Instead of stretching across the power, prop and fuel levers to the copilot's side of the panel, the pilot need only reach in front of himself to retract or extend the wheels. While Beech positions the gear handle in the same location on the left subpanel in the F90-1, which was introduced in mid-1983 (B/CA, August 1983, page 44), the C90-1 retained the gear selector in front of the copilot when the aircraft debuted about a year earlier (B/CA, November 1982, page 36).

The C90A's panel layout also is convenient for single-pilot operation. All annunciator and warning lights are situated in the glareshield within easy view of the pilot. No warning devices are positioned just ahead of the power levers as they are in the King Air 300; only the flap-position indicator and the cabin environmental gauges reside there.

Engine and electrical master switches are logically grouped on the extreme left of the subpanel, just to the left of the control wheel shaft. To the right of the pilot's yoke are the light switches, ice-protection switches and the gear handle. The right subpanel contains the cabin light switches and environmental controls just to the left of the right control wheel; the gyro suction, deice pressure, flight-hour meter and oxygen-supply gauges lie to the extreme right of the panel. Thus the switches that the pilot uses most often are situated conveniently within his reach.

System Improvements

Of greater significance than the panel layout, however, are, the system changes Beech incorporated into the C90A. Gone is the electric gear-extension and retraction mechanism that characterized King Airs for many years. The C90A now has a hydraulically operated landing gear that incorporates a pump driven by a 28-VDC electric motor, an actuator for each gear and the various fluid reservoirs needed to ensure proper operation. The gear uplock function is achieved by a system that maintains between approximately 2,950 and 1,600 psi of hydraulic pressure while the gear is retracted; the hydraulic pump cuts out above about 2,950 psi and activates when the pressure falls below about 1,600 psi. A hand-operated pump is used to lower the gear in case the electrically operated pump malfunctions.

While the C90A's hydraulic gear takes between 5.5 and 7.5 seconds to retract, which is longer than the 4.5- to 5.5-second cycle time of the C90-1's electric gear, the system offers the advantage of lower maintenance costs, according to Beech. Only the power-pack motor is time-or-cycle limited: 10,000 cycles are allowed before overhaul. If it works, leave it alone.

The C90A enjoys several of the system features of its more powerful brother, the F90-1. The electrical system, for example, is similar to FAR Part 25 systems, even though the C90A is certificated under CAR 3 (although design changes that have evolved in recent years have been to Part 23 standards). Electrical power is supplied by one 34-amp-hour, 20-cell nicad battery and two 250-amp starter-generators connected in parallel.

With the aid of individual protective devices, these three sources of power each feed four individual buses, which are automatically tied into a single-loop during normal operation. The battery and both generators feed a bus, appropriately called the "triple-fed bus," which routes power to a portion of the avionics, a number of items related to both engines and to the fuel system (as well as to other items). The left and right generators feed their respective buses; and a center bus, which is fed by a cross-tie line between the two generators, automatically connects the two generator buses whenever either generator comes on line.

In a manner typical of most aircraft in this class, a battery bus remains hot at all times in order to provide power for certain essential equipment during emergency conditions as well as for illuminating entrance and aft dome lights.

The architecture of the C90A's electrical system allows automatic load-shedding whenever excessive current is supplied from one source or when both generators become inoperative. If a sensor detects current beyond the appropriate limits of either the generators or the battery, it isolates the appropriate bus but leaves the others operational. If both generators fail, the center bus drops off line, taking with it interior heating, air conditioning, propeller anti-ice and the motor for the hydraulic power pack.

Also new on the C90A is a rudder boost system that applies a fixed bias to the rudder cables whenever bleed-air pressure from the engines differs by a preset value, such as when one engine is not operating. The bias is supplied by either a right or left pneumatic servo, depending upon which engine is experiencing the power loss.

Pitot Cowling New

Like the F90-1 and the Model 300 King Airs, the C90A now enjoys the advantages of a pitot cowling for its 550-shp, PT6A-21 powerplant. Ram recovery — the ability of the nacelle inlet to convert the kinetic energy of the airflow just behind the prop into potential energy (in the form of increased air pressure) in the plenum chamber from which the engine obtains its air — has been increased by about 50 percent with these new cowlings. What all that means is that the higher ram recovery allows the C90A's PT6A-21s to deliver more power to the props for a given amount of fuel, thereby increasing the aircraft's speed and fuel efficiency.

Beech's pitot cowls achieve their greater ram recovery by streamlining the air passage within the nacelle and by improved sealing to prevent air leaks. The C90-1's nacelle had only a moderate ram recovery, in part because the internal passageway that directed air from the nacelle inlet to the engine plenum was not well sealed and allowed some air to pass through the nacelle without contributing to the conversion from high-velocity airflow ahead of the inlet to pressure within the plenum.

The pitot cowls also incorporate electrically activated ice vanes and particle separators in place of the mechanically operated units on older King Airs. Two vanes (not one, as is found on the C90-1) are used to achieve the desired ice and particle protection.

Inlet anti-ice protection is provided by a continuous flow of exhaust gases from the left exhaust stack through the inlet lip and out the right exhaust stack. This arrangement not only keeps the inlet hot and ice-free while requiring no attention from the pilot, it also eliminates the exhaust smudges seen on many Super King Air 200s. Stains on the underside of Model 200 nacelles are caused by exhaust gases exiting from the bottom of the inlet.

With the improved nacelle design, which first appeared on the F90-1 (B/CA, August 1984, page 44), the C90A has a smaller inlet area as well as a recessed, NACA-type air scoop for the oil cooler. Thus, in addition to enhancing power output, the C90A's pitot cowls present less drag than the traditional nacelle used on earlier Model 90s.

Responding to inputs from operators who complained that they needed more speed flexibility while descending into terminal areas, Beech expanded the flight envelope of the C90A beyond the operational limits of its predecessor. The C90-1's red-line speed of 206 KIAS has been replaced by a Vmo/Mmo of 226 knots/0.46 Mach. A sliding barber pole on the airspeed indicator presents the appropriate limits, thereby giving the pilot the ability to descend at higher speeds below FL 210. Between that altitude and the C90A's certificated ceiling of FL 300, the Mach limit of 0.46 is more restrictive than a red line of 206 KIAS.

Approach flaps can be lowered at speeds up to 184 KIAS, compared to 171 KIAS for the C90-1, and the hydraulic gear can be extended at 182 KIAS, compared with the C90-1's Vge of 156 KIAS for its electrically operated gear. Full-flap speed for the C90A is 148 KIAS, 18 knots faster than that of its predecessor.

Flying the C90A

Dense fog shrouded Beech Field in Wichita as we prepared for our departure to Garden City, in western Kansas. The weather there was clear, enabling B/CA to photograph the aircraft, and the roundtrip flight of about 2+30 (including the photo mission) would provide ample time to evaluate enroute performance and handling qualities.

The start procedure for the C90A is typical of turbine aircraft: right ignition and engine-start switch on; condition lever moved from fuel cutoff to low idle as the compressor shaft rotational speed (N1) stabilizes above 12 percent; check for ignition, fuel flow and interstage turbine temperature (ITT) rise (indication within 10 seconds of moving condition lever, but not to exceed 1,090°C); check oil pressure; and move the condition lever to high idle as N1 reaches 51 percent, at which time the ignition and engine-start switch is turned off and the right generator is activated by moving its switch to "reset," then "on." When the load on the right generator falls below 50 percent, the same start procedure is initiated for the left engine. For the pilot transitioning from a recip to a turboprop, the simplicity of starting a turbine will be a pleasant surprise.

With one engine operating at low power, such as just after starting, N1 must be kept sufficiently high to prevent engine lugging due to its 250-amp generator requiring too much power, which in turn would slow N1 and cause an excessive ITT. Beech publishes a simple schedule of minimum N1 versus generator load, requiring 51-percent N1 for loads below 50-percent generator capacity and ranging up to 70-percent N1 (high idle on the condition lever) for loads above 80 percent. With two engines operating, the amperage required for ground activities normally is sufficiently low that generator loads stay below 50 percent and the condition levers can remain in low idle.

The C90A is a simple aircraft to operate in all modes, especially on the ground. Steering is through a mechanical linkage between the rudder pedals and the nosewheel, and it is responsive without being over sensitive. Nosewheel steering and differential power are sufficient for handling the majority of taxiing requirements; differential braking is rarely needed.

Setting power for takeoff requires somewhat the same technique as operating a turbocharged recip that doesn't have a means of limiting manifold pressure. Pratt & Whitney PT6As have the capability of producing too much power on takeoff, exceeding either torque or ITT limits (or both) simply because the pilot advanced the power levers too far during the takeoff roll.

Furthermore, as the aircraft accelerates from a standstill to its initial climb speed, the ram effect of air flowing into the nacelle causes torque to increase even though the power levers remain set. Thus, establishing torque at the limit of 1,315 foot-pounds at the start of the takeoff roll will result in an over-torque situation at rotation, especially with the C90A and other Beech King Airs that employ the new pitot cowl.

For our departure into the obscured ceiling, we advanced the power to about 1,200 foot-pounds of torque and monitored the ITT and torque gauges to see that engine parameters remained within appropriate limits during the departure. As we accelerated, torque approached 1,300 foot-pounds, but ITT remained below its red line of 695°C.

Unfortunately, exceeding torque and temperature limits on a PT6A is easily done, so the single-pilot operator must be aware of the need for extra attention to power management. Transient values of 1,500 foot-pounds torque and 825°C ITT are allowed for only two seconds before engine damage is likely to occur.

Comfortable control forces during rotation plus well-mannered handling qualities at liftoff and during the climb make the C90A a pleasant aircraft to fly — VFR as well as IFR. For our departure, the entry-level King Air responded nicely to an initial pitch attitude of about 15 degrees, which was held until we were confident that all obstacles were cleared and a cruise-climb attitude was established. The aircraft has good dynamic stability in pitch during the climb, resulting in impressive airspeed hold and minimal demands on the pilot concerning pitch attitude. Spiral stability also is good, thus the C90A tends to hold a heading very well.

In our judgment, the workload for our reduced-visibility departure at Beech Field was quite low and well within reason for the single-pilot operator, even one new to turboprops.

We leveled off at 16,000 feet and headed westward at 190 IAS, consuming about 275 to 280 pph per engine, with an ITT of 660°C and 1,200 foot-pounds of torque; outside air temperature was -5°C — about 10 degrees above ISA. This power setting, which resulted in a true airspeed of 243 knots, was higher than Beech's recommended maximum-cruise speed at 1,900 rpm. Our weight was approximately 9,300 pounds. At FL 210, an ITT of 660°C and a weight of approximately 8,700 pounds, we trued out to 241 knots on 477 pph, for a specific range of 0.506 run per pound.

In cruise, the C90A demonstrates very good stability about all axes, and it is indeed a pleasure to fly. The cabin sound levels are comfortable; conversations can be held without straining to be heard. Vibration levels also are low.

While descending toward Garden City, we accelerated to 220 KIAS, yet we remained six knots below the barber pole. Had we been flying an older Model 90, we would have been limited to 206 KIAS. Control feel was still typical King Air: solid and effective.

The C90A exhibits minimal trim changes with flap and gear extension, and it has very good speed stability in the approach configuration. The aircraft handles nicely on final, with power providing good control over glidepath angle; also, there are no adverse tendencies toward Dutch roll. Landing a C90A, like landing its predecessors, is a breeze. Control loads for the flare are noticeable but not excessive, and tracking once on the ground is straight.

Whether selected by the first-time turbine buyer or the seasoned flight department, the C90A King Air is an attractive, capable aircraft that can be flown easily by one or two pilots. Workload during normal operations is kept to reasonable levels due to the aircraft's panel design and improved systems, and such features as rudder bias and automatic load-shedding of certain electrics are significant aids during emergencies.

Also, the C90A exudes the classic stuff of Beech King Airs, and that's appealing no matter how many pilots are in the front office. B/CA

Specifications
Beech King Air C90A

Base price	$1,321,370
Seats (incl. crew)	1+7/9
Engine	
Model	2 P&W PT6A-21
Power	550 shp ea.
Design weights (lb/kg)	
Max ramp	9,710/4,404
Max takeoff	9,650/4,377
Max landing	9,168/4,159
Zero-fuel	9,023 b/4,093
BOW (B/CA equipped)	6,574/2,982
Max payload	2,449/1,111
Useful load	3,136/1,422
Max usable fuel	2,573/1,167
Payload (max, fuel)	563/255
Fuel (max payload)	687/312
Dimensions (ft/m)	(see three-views)
Loading	
Wing (lb/ft2)	32.8
Power (lb/lb)	8.8
PSI	5.0
Limit speeds (KCAS)	
Vmo	226
Va	153
Vdec	98
Vmc	90
Vxse	101
Vyxe	107
Performance (SL, ISA, MGTOW)	
Climb (fpm/mpm)	
All-engine	2,137/651
Engine-out	626/191
Certificated ceiling (ft/m)	30,000/9,144
Engine-out service ceiling (ft/m)	15,591/4,752
Cruise	(see charts)
Range	(see charts)