Business & commercial Aviation

PILOT REPORT

Inflight Report: Pilatus PC-12

Is it all things to all people?

By FRED GEORGE

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The PC-12 is Pilatus Flugzeugwerke AG's newest, largest, most powerful and most sophisticated single-engine aircraft certified for civil use. The "12" stands for 1,200 shp, giving this single-engine aircraft the weight-to-power ratio at takeoff of a twin-engine turboprop.

How large is large? The PC-12's wingspan is longer than that of a Citation II, and the fuselage is only a few inches shorter in length. The aircraft's stalwart construction, though, is even more impressive than its measurements. One buyer, for example, intends to tote Caterpillar diesel engines in his airplane.

The long-travel, trailing-link main landing gear is well-suited to rough field operations, and plenty of ground clearance helps keep tall grass, short brush and foreign objects out of the engine inlet. Carbon wheel brakes save weight and add stopping power at high gross weights.

The windshield is glass with internal electric heating for defrosting. Prop blast eliminates the need for windshield wipers.

On the left side are two doors: one airstair door forward of the wing for crew and passengers, and a cargo door, 52 inches high and 55 inches wide, that's capable of accepting cargo pallets loaded with a fork lift. The forward door has a counter spring, and the aft door has gas struts to offset the weight of the doors when raising them. In addition, a 20-inch-by-27-inch emergency window exit is over the right wing.

The interior is equal in height but slightly longer and appreciably wider than that of a Beech Super King Air B200. There are more than 360 cubic feet of cabin and baggage volume. The standard interior—not shown in our photographs—has a decidedly utilitarian blue jeans, short sleeves and work gloves appeal. Aft of the crew seats are nine passenger chairs at 31- to 32-inch pitch that are upholstered with highly durable fabric and that have reclining backs, headrests and armrests. Each seat has a reading light, an air vent and an oxygen-mask outlet.

Sidewalls are composite, easy to clean and wear-resistant. The carpeting is the jetliner-grade, short-pile variety designed for heavy traffic, and it is fastened to the composite floor panels with hook-and-loop fabric for ease of removal. Floor panels are secured to the airframe by means of one-quarter turn, quick-release fasteners to make fast work of airframe inspections and access to systems, such as EFIS symbol generators.

The aft cabin has a 400-pound, 16-cubic-foot baggage area that is fully accessible in flight and is fitted with a stout luggage net secured at 12 points to the airframe.

Some or all of the chairs can be removed to make room for at least 190 cubic feet of bulky freight that may weigh up to 2,200 pounds. (Packing all 360 cubic feet of cabin and baggage volume aft of the crew compartment with freight could hinder access to the cockpit.) A cargo restraint net can be installed behind the forward four or six seats to haul a combination of passengers and cargo.

TARGETING THE MARKET

None of the 44 PC-12 aircraft ordered by the end of 1994, however, has been intended for freight use. Five have been specially configured for air-ambulance use and sold to the Royal Flying Doctor Service in Adelaide, Australia. The remainder have been ordered with the optional six-seat, executive interior that includes leather-covered passenger chairs, passenger service units with integral oxygen masks, three work tables and an enclosed, aft lavatory with flush toilet. The executive interior adds 113 pounds to the weight (compared to the nine-seat utility version) and $103,000 to the cost of the aircraft, according to the optional equipment list.

Most of the aircraft have been sold to entrepreneurs who view it as a flying sport utility vehicle that can provide both business transportation during the work week and recreational use on the weekends.

SYSTEMS

The PC-12 may be an airborne sport utility vehicle, but it's very well equipped. It has 5.75-psi pressurization that provides a 10,000-foot cabin altitude at the aircraft's 30,000-foot maximum certificated cruise altitude. (The PC-12's highest usable flight level is FL 290 in the United States, resulting in a cabin altitude of just under 9,500 feet.) An air cycle machine provides air conditioning and heating while the engine is running. The air cycle machine is augmented by standard auxiliary electric heating and an optional 94-pound, $17,320 vapor cycle air conditioner that also may be powered by a ground electrical power source.

Up front is a single 1,605-thermo-dynamic-horsepower Pratt & Whitney Canada PT6A-67B turboprop, flat-rated for takeoff to 1,200 shp up to 52°C and 1,000 shp for climb and cruise. The climb/cruise flat-rating starts to drop at about 15,000 feet as the engine reaches its ITT limit for cruise. (See sidebar.)

Most other critical systems are redundant. The electrical system has a primary DC starter/generator and a secondary DC generator, two AC static inverters and a battery as an emergency back-up. The fuel system uses jet pumps to transfer fuel to the engine, augmented by electrical boost pumps in the wing-tank sumps. An electrically powered hydraulic system is used for landing gear actuation, backed up by a manual pump.

Of the singles with which we are familiar, the PC-12 is one of the very few that has a stall-warning stick-

Pratt & Whitney Canada PT81-67B

The PC-12's 1,200-shp turboprop engine is the most powerful growth version of the venerable PT6A that first made its debut three decades ago.

The -67 series has accumulated more than 1.6-million hours in service since initial certification in January 1987. For engines in airline operations, the -67 has now achieved a basic inflight shutdown (IFSD) rate of one in 50,000 flight hours, a notable achievement considering the high cycles of commuter operations.

However, early versions of the -67 were plagued by deterioration of the high-pressure (compressor) turbine blades. As a result, Pratt & Whitney upgraded the material from which the blades are manufactured, eliminating reports of such problems. And the current IFSD reliability rate attests to the problem solving.

The -67B, as configured for the PC-12, has a single power control lever that is used for virtually all ground and flight operations from start-up to shutdown.

A three-position condition lever—with gates for prop feather/idle cutoff, ground idle and flight idle—normally need only be used during engine start and shutdown, and when entering or exiting the runway. The condition lever controls gas generator idle speed, fuel cutoff and prop feathering. In the ground mode, the prop speed averages about 1,000 rpm to 1,050 rpm, and in the flight mode, it maintains a constant 1,700 rpm for most phases of flight.

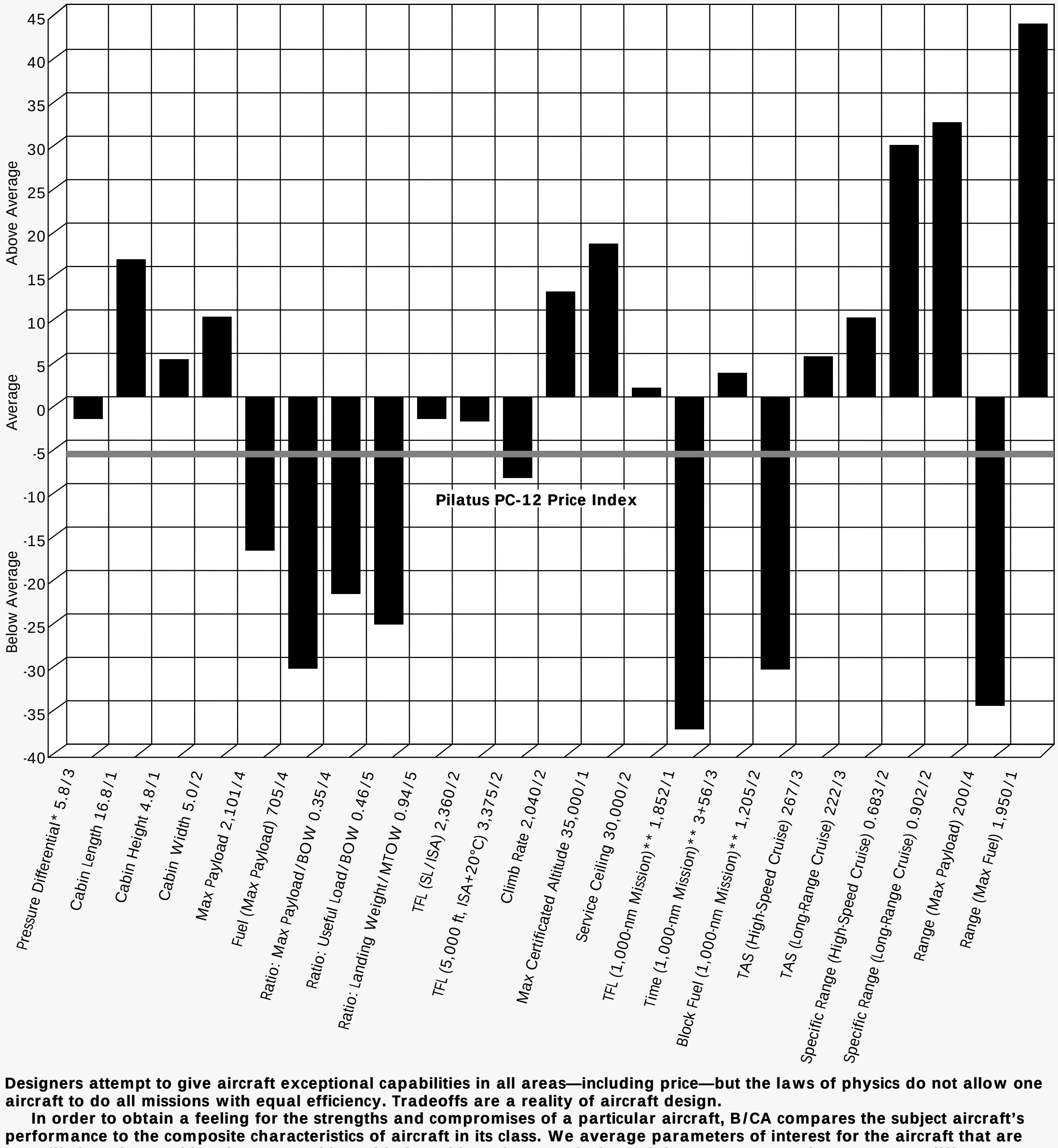
Also, the engine has a manual override control that allows the engine speed to be governed in the event of a partial fuel-control malfunction.

The -67 uses Pratt & Whitney's proven reverse-flow design, with the accessory gear box at the rear of the engine, followed by the engine air inlet plenum. Farther forward are the compressor, combustion and turbine sections, with the exhaust at the front—just behind the reduction gearbox and the propeller. As with other PT6A engines, the -67B has three axial compression stages and a centrifugal compressor. In addition, for better fuel economy and improved density altitude performance, it has a higher pressure ratio than earlier versions. The -67B, for example, has an uninstalled output of 710 shp at 30,000 feet on a standard day, with a specific fuel consumption of 0.493 lbs/shp/lb.

Similar to many other versions of the PT6A, anti-ice protection is provided by constantly heating the engine air intake lips with exhaust gas and an inertial particle separator in the air intake. When the process is activated, it allows ice to bypass the engine air plenum and exhaust overboard.

Pilatus had considered using a composite propeller to save weight, but for production versions of the PC-12, the company elected to use a Hartzell 105-inch, four-blade aluminum prop for durability. Turning at a constant 1,700 rpm, the prop has relatively slow blade-tip speeds, resulting in quiet manners in noise-sensitive neighborhoods.

B/CA COMPARISON PROFILE®
(% Relative to Average)



Designers attempt to give aircraft exceptional capabilities in all areas—including price—but the laws of physics do not allow one aircraft to do all missions with equal efficiency. Tradeoffs are a reality of aircraft design.

In order to obtain a feeling for the strengths and compromises of a particular aircraft, B/CA compares the subject aircraft's performance to the composite characteristics of aircraft in its class. We average parameters of interest for the aircraft that are most likely to be considered as competitive with the subject of our analysis, and then we compute the percentage differences between the parameters of the subject aircraft and the composite numbers for the competitive group as a whole. Those differences are presented in bar-graph form, and the absolute value of the parameter under consideration, along with its rank with respect to the composite, are given.

For this Comparison Profile®, we present selected parameters of the Pilatus PC-12 in relation to a competitive group consisting of the Beech King Air C90SE, the Beech Super King Air B200, the Cessna Grand Caravan and the TBM 700. It should be understood that this Comparison Profile® is meant to illustrate relative strengths and compromises of the subject aircraft; it is not a means of comparing specific aircraft to each other.

*Cessna Grand Caravan is not pressurized.
**1,000-nm mission not possible in Cessna Grand Caravan.

shaker and stick-pusher system. During aircraft development, Pilatus determined that under certain conditions of aft c.g. and full power, the PC-12 could be flown at very high angles of attack—a flight regime in which control response was marginal and wing drop at stall was excessive. As a result, the company elected to fit the PC-12 with a stick shaker/pusher to ease the certification process. The artificial stall-warning device defines the stall at a lower angle of attack, resulting in crisper control response (especially aileron effectiveness) and, thus, more docile stall recovery characteristics. Even so, the PC-12's stick shaker/pusher fires below the FAA's regulatory maximum 61-knot stall speed for singles over 6,000 pounds MTOW, thereby allowing a boost in the certified MTOW to 9,020 pounds—a 200-pound increase—that is slated for this month.

The aircraft teems with workload-reducing features, especially on the instrument panel. (See avionics sidebar.) Among these are automatic fuel-level balancing, automatic torque limiting, single power control lever, an active, synoptic diagram on the electrical panel and logically arranged circuit breakers in full view of the pilot.

Pilatus also put plenty of emphasis on maintainability features. The interior can be quickly removed for maintenance inspections, and the floor panels, as well as other access plates, are designed for speedy removal. In addition, the avionics and engine instrument system have built-in test modes to help identify problems.

RANGE, PAYLOAD AND LOADING CONSIDERATIONS

Making the most of the one-and-one-half-ton useful load of the aircraft requires careful preflight planning—which at the present time is not an easy chore. Pilatus has yet to publish flight planning and cruise data for the aircraft. That is due sometime this year and it explains the lack of our performance charts. The weight specifications, however, show that the PC-12 can carry a heavy payload or full fuel—but not both. Top the fuel tanks, and less than 100 pounds in payload is available, except for crew and supplies. However, with full fuel, the aircraft has a 1,950-nm range with IFR reserves.

Conversely, the aircraft's basic empty weight of 5,858 pounds—even when the 238-pound executive interior is removed—allows just over 700 pounds of fuel to be carried with the maximum payload. The actual range with a specific fuel load is tough to call. The aircraft flight manual doesn't have a flight-planning section and contains no cruise speed and fuel-consumption tables. That supplementary section of the manual, which incidentally is not required for aircraft certification, is slated for publication sometime this year.

Calculating weight and balance requires use of a sharp pencil. Although the aircraft has a generous c.g. envelope, it's not difficult to exceed the aft c.g.-limit if heavy cargo is loaded in the aft section of the cabin. (And that's a real possibility if the forward passenger chairs are not occupied.) It's advisable to load the aircraft from front to rear, or at least put bulky freight in the cabin's mid-section. Notably, the floor doesn't have balls or rollers for loading. The cargo container or pallet must have its own wheels or rollers for ease of positioning inside the cabin.

FLYING IMPRESSIONS

The PC-12 has military ancestors in its lineage. The preflight inspection is short and straightforward. Starting the engine consists of pushing the start switch, moving the condition lever to the ground idle notch at the appropriate gas generator turbine rpm and then waiting for the engine to accelerate to idle speed.

Our awareness of the length and span of the aircraft was heightened as soon as we began to taxi. There are no recognition lights on the wing tips, so some caution would be in order when taxiing the aircraft in close quarters after dark. The landing and taxi lights on the landing gear, however, provide excellent forward illumination of the ramp and runway.

With two people on board, 1,548 pounds of fuel and spare equipment, our taxi weight was 8,106 pounds.

The PC-12 has fewer pre-takeoff checks than other PT6A turboprops we've flown. For example, no prop governor and overspeed checks are necessary. We checked the stall-warning system and trim, positioned the wing flaps to 15 degrees and set the cabin pressure controller for cruise altitude. Just prior to taking the runway, we moved the condition lever to flight idle—1,700 rpm. Our takeoff weight was 8,068 pounds, 752 pounds less than MTOW, resulting in a computed takeoff distance of 2,050 feet.

Having 1,200 shp on tap might lead one to conclude that the PC-12 would be tricky to handle when the power control lever is pushed forward on the takeoff roll. That's simply not so. The takeoff roll is smooth and stable in yaw, requiring less rudder input than some singles with one fourth the power.

Fine tuning the power during the takeoff roll isn't necessary. If the torque exceeds the takeoff setting due to ram effect, the automatic torque-limiting feature keeps the engine and gearbox within safe limits, thereby minimizing pilot workload.

The initial pitch forces at a rotation speed of 75 KIAS are light, with the aircraft lifting off at 80 KIAS and quickly accelerating to an initial climb speed of 95 KIAS. For greater yaw stability, we switched on the yaw damper, but it is not required for dispatch.

High Marks For Human Engineering

Single-pilot flying chores are seldom as easy as they are in the Pilatus PC-12. The standard instrument panel configuration features a two-tube AlliedSignal EFIS 40 in front of the pilot, flanked by conventional air-data instruments.

The PC-12's engine instrument system (EIS), however, steals the show from the EFIS. The EIS is a digital system that is closely related to engine instrument/crew alerting systems, known as EICAS in high-end turbine business aircraft. In contrast to EICAS, the EIS uses liquid crystal displays (LCD) with both analog and digital readouts instead of a CRT.

The EIS isn't just another way of displaying engine instrumentation. It's a smart system that has dual-data acquisition units that digest information from engine and system sensors. The data are then forwarded to a computer that, in turn, monitors all of the systems for anomalies. In addition, the computer displays engine and system status in analog form to catch the pilot's eye as changes occur, and in digital form for precision.

The PC-12 EIS was adapted from a similar system in the Pilatus PC-9 trainer. Should an anomaly occur, the EIS rapidly flashes the instrument indication and, when appropriate, also triggers the caution and warning annunciators located above the EFIS attitude deviation indicator (ADI).

False warnings are extremely rare because the EIS has two channels, and it automatically switches data paths if it detects a fault in the system. Switching is accomplished without any disruption of system performance other than the display of a fault code. The EIS is somewhat like having an electronic flight engineer on board the aircraft. If, for example, the pilot forgets to turn on the pitot heat, the EIS flashes the OAT display when the temperature nears freezing.

Other highlights of the panel design include a KFC 325 three-axis autopilot, dual KX 155 navcom transceivers, a KN 62A DME, KR 87 ADF, a single KT 71 transponder (the KT 70 Mode S transponder is offered to U.S. customers), a KEA 130A encoding altimeter and a KAS 297C altitude pre-select/altitude alerter system.

An RDS 82 VP weather radar with a 10-inch antenna is a $23,925 option. The relatively small antenna results in a usable range of 75 miles and a relatively broad, 12-degree beam width. The antenna pod, however, is so slippery that is doesn't noticeably alter aircraft performance.

Other options include a KLN 90A GPS receiver ($7,500), a multifunction display that includes the weather radar sensor ($86,770), a copilot's EFIS ($59,295) and an HF transceiver ($17,630). A second encoding altimeter and a second transponder are not offered as factory options.

Notably, the landing and taxi lights are mounted on the gear struts. As soon as the gears come up, there are no lights—other than the navigation and strobe lights—to warn others of your proximity.

Rolling the aircraft into a 30-degree turn for a right downwind departure, we discovered gentle roll-control forces and adequate (though not exceptional) aileron authority. Retracting the flaps at the minimum 100 KIAS, we noted very little pitch change, accelerated to a climb speed of 120 KIAS and reduced power to 1,000 shp.

Our climb to FL 290 eastbound was punctuated by numerous level-offs to accommodate other traffic, thus delaying our time to climb and performance measurements. However, the single power control lever minimizes the workload of power changes. Passing through 15,500 feet, we reached the maximum ITT for climb/cruise and gradually adjusted the power setting to stay within engine limits during the rest of the ascent.

The PC-12 has good stability and control characteristics. With the yaw damper off, aerodynamic yaw damping—largely due to the recent addition of ventral fins on the aft fuselage—was fine, with full damping after four cycles. Similarly, short-period and long-period pitch stability are fine. Initial roll stability is good, with very slow divergence in spiral stability beyond 10 degrees of roll.

Our cruise speed at FL 290 was 254 KTAS while burning 348 pph. This was at a weight of 7,800 pounds and ISA+8°C. Pilatus, however, claims an average block speed of 260 KTAS on a theoretical 1,200-mile trip using a cruise altitude of FL 300. Our performance measurements, however, were not consistent with that claim. B/CA believes that the actual block speeds for the PC-12 will approach those of a Beech Super King Air 200.

As we descended for landing at V_{MO}, predictably we found the control forces to be more substantial, but subjectively somewhat lighter than those of some other single-engine turboprops at the same speed. Slowing for landing, extending the flaps beyond 15 degrees—particularly from 30 degrees to 40 degrees—results in some ballooning and a noticeable pitch-trim change.

We used an 85-KIAS reference speed for our first landings, resulting in good control response. For minimum distance landings, the aircraft flight manual recommends 78 KIAS, which provides for excellent pitch and yaw controllability, but somewhat mushy aileron feel. Our computed landing distance was 2,420 feet, but liberal use of reverse thrust shaved 1,000 feet off the landing rollout.

Lower landing speeds and shorter landing distances are possible at lighter weights by using the angle of indication as a reference instead of the airspeed indicator. By doing so, the stall margin would be maintained, but control response would be reduced.

Preliminary Specifications - Pilatus PC-12

B/CA Equipped Price	$2,040,720
Seating	1+7/10
Dimensions (ft/m)	
Length	46.8/14.3
Height	13.9/4.2
Span	52.8/16.1
Power	
Engine	P&WC PT6A-67B
Output	1,200
TBO	3,500
Weights (lbs/kgs)	
Max Ramp	8,885/4,021
Max Takeoff	8,820/4,001
Max Landing	8,820/4,001
Zero Fuel	8,160/3,701
EOW*	5,858/2,657
Max Payload*	2,302/1,044
Useful Load*	3,007/1,364
Executive Payload*	1,400/635
Max Fuel	2,727/1,237
Payload—Max Fuel*	280/127
Fuel—Max Payload	705/320
Fuel—Executive Payload*	1,607/720
Limits	
V_{MO}	238 KIAS
V_A	145 KIAS
PSI	5.75
Airport Performance	
TO (SL, ISA) (ft/m)	2,360/719
TO (5,000 ft, ISA+20°C) (ft/m)	3,375/1,029
V_{SO}	50 KIAS
V_X	112 KIAS
V_Y	121 KIAS
Climb	
Rate (fpm/mpm)	2,040/622
Gradient (ft/nm m/km)	1,012/196
Ceilings (ft/m)	
Certificated	30,000/9,144
Service	35,000/10,666
Sea-level Cabin	13,200/4,023
Cruise	
Long Range	
TAS	222
Fuel Flow	245
Altitude	FL 300
Specific Range	0.902
High Speed	
TAS	267
Fuel Flow	391
Altitude	FL 250
Specific Range	0.683
NBAA IFR Ranges (100-nm alternate)	
Executive Payload	
Nautical Miles	1,221
Average Speed	250
Trip Fuel	1,980
Specific Range/Altitude	0.615/FL 300
Max Fuel**	
Nautical Miles	1,950
Average Speed	222
Trip Fuel	2,423
Specific Range/Altitude	0.805/FL 300
Ferry	
Nautical Miles	1,950
Average Speed	222
Trip Fuel	2,423
Specific Range/Altitude	0.805/FL 300
Missions (4 pax)	
300 nm	
Runway	1,510
Flight Time	1+18
Trip Fuel	599
PSR/Altitude	2.003/FL 300
600 nm	
Runway	1,655
Flight Time	2+26
Trip Fuel	990
PSR/Altitude	2.424/FL 300
1,000 nm	
Runway	1,652
Flight Time	3+58
Trip Fuel	1,206
PSR/Altitude	3.320/FL 300

*Does not include flightcrew **Max fuel with available payload

GROWING PAINS

The PC-12 is coping with aviation adolescence on its way to full maturity. For example, to improve wing performance and enhance directional stability respectively, the production- configuration aircraft sprouted winglets and twin ventral strakes as it grew out of the proof-of-concept phase.

Icing certification is scheduled for this year. Also this year, the flight planning and cruise-performance section of the flight manual, as previously mentioned, is due for publication, thereby providing operators with much-needed range/payload performance information.

In the future, Pilatus plans to petition certification authorities for a waiver of the FAR Part 61 KCAS stall-speed restriction. The firm believes that a three-knot increase, to 64 KCAS, would make possible eventual certification of a 10,000-pound MTOW—the maximum weight for which the PC-12 was designed.

The 61-knot waiver request largely would be based on the crashworthiness protection provided by the aircraft's 25-g crew seats and 16-g passenger seats—unprecedented in this class of aircraft.

The seats are supplied by Mata/Golan Industries of Israel.

Raising the MTOW to 10,000 pounds would allow the aircraft to carry a 1,000-plus-pound payload with full fuel and, in our calculations, result in range with maximum payload of 1,800 nm to 1,900 nm. The PC-12's sprightly airport and climb performance during our demonstration flight suggests it can otherwise handle a 10,000-pound takeoff weight.

With an increased takeoff weight, the PC-12 also would have the potential to rival the well-established twin- turboprop aircraft in range/payload capabilities while offering much better runway performance and substantially lower operating costs. B/CA estimates that with a 10,000-pound takeoff weight, the PC-12 could carry crewmembers and six passengers between Danbury, Connecticut and Davis, California, for example, with one fuel stop in either direction. In our estimation, it also would be able to tote more than a ton of cargo from Wausau, Wisconsin to Worland, Wyoming.

In the interim, however, the PC-12's strong suit will be transporting large payloads very short distances or modest payloads 1,200-plus miles. From what we've experienced, the PC-12 has the potential to grow into a hard-working business tool. **B/CA**