Raytheon Premier I

LITTLE BIG JET

A single-pilot, swept-wing hot rod

BY THOMAS A. HORNE

Say hello to Raytheon Aircraft Company's first homegrown business jet, the Premier I. First announced in 1995, the Premier I was certified under the latest provisions of FAR Part 23 in March 2001. Single-pilot and known-icing approval followed in May, and the first owner flew away from Raytheon's Beech Field one month later. At this writing, 18 Premier Is have been delivered, and 300 more are on the order books. And while the program is off and running, there were times in its development when certification issues plagued the airplane with delays.

One problem involved rudder self-centering after full deflection. Another issue was the amount of aileron control force required to keep the airplane level with one wing fuel tank full and the other empty. Potential engine rotor-burst and tire-burst concerns were also on the list. All these problems were addressed (the rudder has a centering spring;

PHOTOGRAPHY BY MIKE FIZER

there's an auxiliary roll-trim function; and structural beef-ups protect areas susceptible to bursting engines and tires), and the result is an airplane with safety margins that meet or exceed those of any other airplane in its class.

The Premier I is a breakthrough in what can be called the three Cs of airplane design and manufacturing: construction, cabin, and cockpit.

The Premier I airframe is a hybrid. Its swept aluminum wings and horizontal and vertical stabilizers are of conventional construction, but its fuselage is made of a carbon-fiber/epoxy honeycomb composite. Raytheon bought five computer-controlled tape-placement machines—robots, actually—to automatically build up Premier fuselages. Dubbed Vipers for the tape-placement heads' snakelike articulation, these machines strategically place epoxy-impregnated carbon-fiber tape—thousands of miles of it—on a mandrel that's shaped like the Premier fuselage. After the tape placement is done, the fuselage is essentially baked under pressure in an autoclave. Then the door and window openings are cut out and the fuselage is mated to the wings. The fuselage is mounted high off the wing, using forged aluminum "dog bones"—wing attach links.

The Premier I's large cabin comes as a result of mounting the composite fuselage atop the wing assembly. No fluid lines run through the pressure vessel, another benefit of keeping the cabin away from the wing center section.

With carbon-fiber construction, Raytheon says, you get a fuselage that is 20 percent lighter than comparable aluminum versions, yet three times stronger. The weight savings allows a larger cross section because the fuselage walls are thinner than those of aluminum and don't need the stringers and longerons of conventional aluminum structures.

This brings us to the cabin. For a light jet, it's big. Compared to its closest competitors—the Cessna CitationJet series—it's 11 inches wider, eight inches higher, and at 315 cubic feet has a cabin volume that beats the CJs, CJIs, and CJ2s. The factory-installed standard leather interior is a six-seat, single-club setup, with fully articulating and berthable seats, a choice of five refreshment center options, and an aft lavatory with electric flushing potty and sliding wood partitions. Together with the Premier's tall ramp stance and airstair entry door, the overall impression is one of a very substantial airplane. For the 20 percent of customers who intend to sit in back and impress their peers, there will be no need for apologies. The Premier I cabin looks and feels like it belongs in a mid-size business jet.

For the vast majority—80 percent of customers to date—who intend to use the Premier I as owner-flown transportation, the ambiance and capability up front is truly impressive.

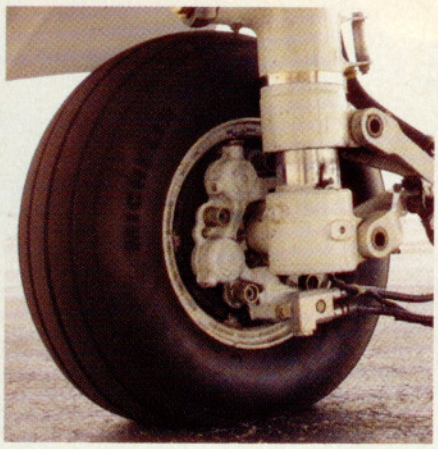
The cockpit's most prominent aspect is its Collins Pro Line 21 avionics suite. Two huge 8-by-10-inch color liquid crystal displays are standard equipment. One's a primary flight display (PFD) that's situated in front of the captain's station. The other's a multifunction display (MFD) that lives just to the left of the panel's center. A copilot PFD is a $109,000 option that takes the place of the right side's standard-equipment, round-gauge cluster of flight instruments.

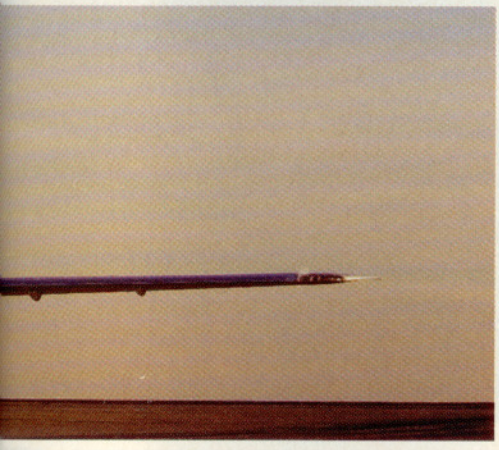
The PFDs make use of vertical-tape symbology for airspeed, altitude, and vertical speed information. The airspeed tapes incorporate purple trend vector lines that predict the airspeed you'll reach in 10 seconds—an extremely useful tool for setting power and pitch in climbs and descents. And for making sure you don't blow through the 250-knots-below-10,000-feet rule.

The PFD can be configured to show a huge amount of information—V-speeds, altimeter settings, altitude targets, navigation sources, transponder codes, com radio frequencies, power settings, radar imagery, TCAS symbology, autopilot modes, and much more. PFD data is called up on the screen by means of a display control panel and the PFD's line select keys.

For example, let's say you want your takeoff reference speeds to appear on the airspeed tape so you can see when V_1 (takeoff decision speed), V_R (rotation speed), V_2 (takeoff safety speed), and V_T (target initial climb speed, which is the best single-engine climb speed) occur. Push the Refs button on the display control panel. Now, along the left edge of the PFD, you see each V-speed highlighted. Push the line select key opposite the highlighted speeds, then use the control unit's Menu Set knob to dial in the proper speed (these are obtained from a quick-reference table in the

COURTESY OF RAYTHEON AIRCRAFT COMPANY





Large-airplane amenities and proportions dominate the Premier I. Though the airplane has a mid-size jet feel to it, single-pilot certification is available.

Collins' Pro Line 21 avionics adorn the Premier I's front office. Master them, and you've mastered the airplane.

pilot checklist book), and then hit the line select key to both enter the speed and move on to the next.

Similarly, the Nav/Brg key can be used to enable the PFD line select keys to display navigation sources—be they flight management system (FMS, which incorporates GPS navigation), VOR, localizer, ILS, or ADF. The Radar key superimposes the airplane's weather radar imagery on the PFD's navigation display.

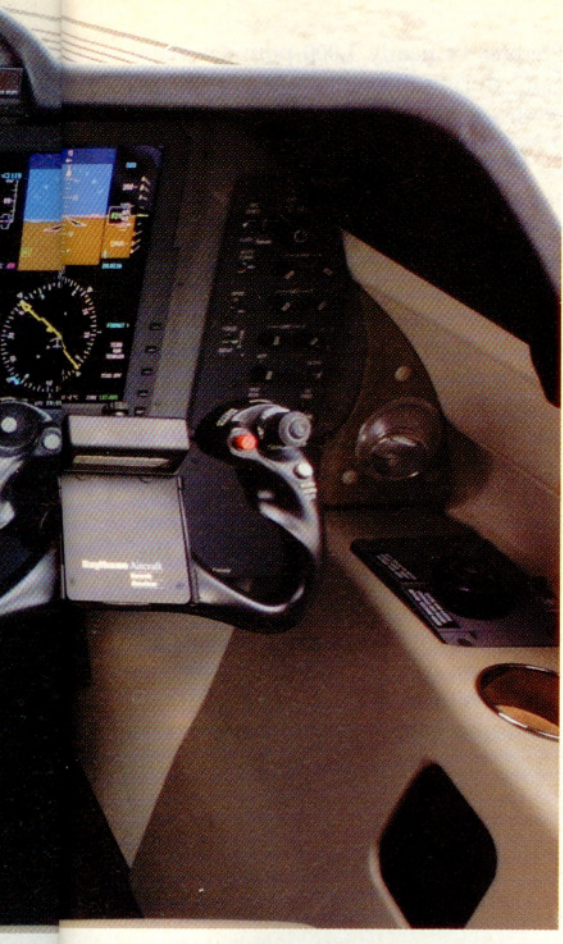
The MFD is typically set to show both engine information and the flight-planned route, but it can also be configured to show TCAS (traffic alert and collision avoidance system) and EGPWS (enhanced ground proximity warning system) symbology.

Should a PFD or MFD tube give up the ghost, reversionary functions let you stack the information from both displays on the remaining functioning tube.

Like the rest of the cockpit, the subpanels are models of simplicity. Controls and indicators for the oxygen, hydraulic, ice protection, landing gear, electrical, fuel, and environmental systems spread from left to right—each one grouped in orderly clusters.

If those monster displays are the face of the Pro Line 21 suite, the dual FMSs and glareshield-mounted flight guidance system are its heart and soul. Flying a Premier I most efficiently, like most every modern jet, means knowing how to make these two systems sing. And if setting up the displays sounds complicated to you, wait until you first try to work the FMS.

FlightSafety International—the firm that offers free Premier I pilot initial and mechanic training as part of the Premier I's standard-equipped $5,258,015 price tag—reports that the first three days of the two-week-long pilot initial training course are spent in classroom sessions and focus mainly on operating the FMS.



The goal is to let the FMS and flight guidance system do most of the flying, so in normal operations the pilot usually hand-flies only takeoffs and landings. In a single-pilot operation there's a lot of button-pushing to keep the head down and distracted. Two-pilot operations would obviously lighten the load, letting one pilot fly and the other be the avionics manager. Most of the 120 Premier Is sold so far to foreign customers will be flown as two-pilot airplanes.

Thanks to the flight guidance system's autopilot and flight director, flying the Premier I is a breeze. Electrically powered engine control units (ECUs)

also help. The thrust levers have two detents for takeoff power—labeled Takeoff (maximum power) and Norm Takeoff (maximum continuous)—so all you have to do is advance the power until you feel a detent, and off you go. There's no need for the pilot to run through charts to calculate power settings based on temperature and airport elevation. The ECUs do it for you.

Not that hand-flying is a chore, mind you. Roll control, for example, is enhanced by outboard wing spoilers that deploy once there's a 10-degree deflection of the ailerons. For prompt descents or speed reductions, both the outboard and inboard wing spoiler panels deploy when you move the speed brake to the Extend position.

The Premier I flown for this evaluation weighed 8,143 pounds, empty. That's a fairly typical weight and includes some popular options: the second PFD; the $152,000 Collins TCAS-4000 TCAS II; the $77,000 Honeywell Mark V EGPWS; and aft baggage compartment heat. That package represents 63 pounds and, together with the weight tacked on by the rotor- and tire-burst protection, accounts for much of the Premier I's nearly 1,000-pound weight gain during development. Add two pilots, a passenger, and a full load of fuel, and our ramp weight turned out to be 12,310 pounds, allowing for nearly 190 lb of additional passengers or baggage. Pretakeoff checks include tests of the airplane's stall protection (dual stick-shakers and -pushers), flaps, and spoilers. Successfully completing the tests assures that the latter two items deploy symmetrically.

Our V-speeds that day were 106 knots (V_1), 110 kt (V_R), 122 kt (V_2), and 140 kt (V_T). With flaps set at 10 degrees, our required takeoff field length at Wichita's Beech Factory field would be some 3,700 feet—no problem because the field has an 8,000-foot-long runway.

Hold the brakes when in position, run the thrust levers up two detents for maximum power, and the 2,300-lb-thrust Williams FJ22-2A engines kick in

SPECSHEET

Raytheon Premier I

Standard-equipped price: $5,258,015

Specifications

Powerplants	Two Williams FJ22-2A turbofans/2,300-lb thrust ea
Recommended TBO (provisional)	2,500 hr
Length	46 ft
Height	15 ft 4 in
Wingspan	44 ft 6 in
Wing area	247 sq ft
Wing loading	51 lb/sq ft
Power loading	2.7 lb/lbst
Seats	2 + 6
Cabin length (excluding cockpit)	12 ft 10 in
Cabin width	5 ft 6 in
Cabin height	5 ft 5 in
Basic operating weight	8,240 lb
Max ramp weight	12,591 lb
Max takeoff weight	12,500 lb
Max fuel weight	10,000 lb
Max useful load	4,350 lb
Payload w/full fuel	738 lb
Max landing weight	11,600 lb
Fuel capacity, std	553 gal (539 gal usable)
	3,704 lb (3,611 lb usable)
Baggage capacity, external, forward	150 lb, 10 cu ft
Baggage capacity, external, aft	400 lb, 77 cu ft

Performance

Takeoff field length, SL @ 15 deg C, flaps 20	3,792 ft
Takeoff field length, 5,000 ft @ 30 deg C, flaps 10	7,785 ft
Two-engine rate of climb, sea level	3,700 fpm
One-engine rate of climb, sea level	948 fpm
Cruise speed/range w/NBAA fuel rsv w/100-nm diversion (fuel consumption) @ High-speed power setting/11,000 lb/31,000 ft	454 kt/900 nm
	(1,292 pph/191 gph)

and send you on your way. Shortly after takeoff the autopilot and yaw damper are engaged, and you can follow your clearance altitude, heading, or route using the glareshield controls.

Normal climb speed is 220 kt initially, and at that airspeed our Premier I climbed at 3,600 fpm. A little more than 27 minutes later, and we were at Flight Level 410. We could have done better, but ATC gave us step climbs and altitude restrictions on the way up.

A cold front was about to move through, so it was a cloudy day in Kansas. Between 27,000 and 31,000 feet we ran into icing conditions. How did we know? The Premier I has an ice detection probe that vibrates at a set frequency. If the probe ices up, the vibrations decrease and an Icing annunciator light comes on. When that happens you can turn on one of the Premier's more exotic features—an electromagnetic expulsive deice system, or EMEDS for short. The wings use engine bleed air to prevent ice from forming there, but the tailplane is another matter. The EMEDS stores electrical energy in a series of capacitors just beneath the tailplane's aluminum leading edges, then releases it in a sequence of discharges that literally blasts ice away. The discharges sound like a rhythmic metallic rapping, and can be heard on the ground during the preflight—if you're outside the airplane. Inside, you can't hear it running. For extra protection against the dangers of tailplane stalls in icing conditions, the expulsive discharges run at a faster rate when flaps are deployed past 20 degrees.

Our cruise speed at high-speed power settings turned out to be 425 kt at FL410 and 448 kt at FL310. The numbers would have been a few knots higher, Raytheon demonstration pilot Mark Loyacano said, but temperatures were slightly higher than standard and this extracted a small thrust penalty. Originally, Raytheon promised a 461-kt maximum cruise speed, but in fact the airplane is about 10 kt slower. The company also promised a 1,500-nm maximum range with IFR fuel reserves, but

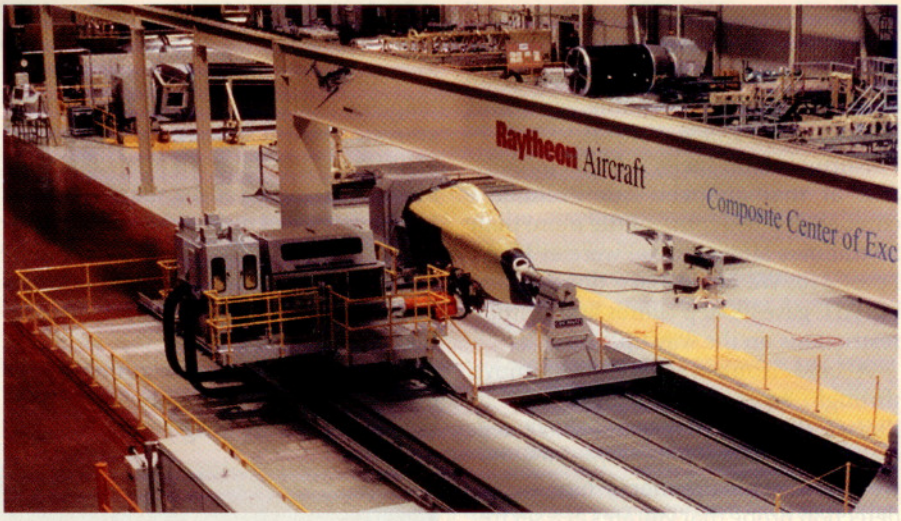
@ Long-range power setting/10,000 lb/41,000 ft .....355 kt/1,385 nm .....(605 pph/90 gph)
Max operating altitude .....41,000 ft
Engine-out service ceiling .....25,700 ft
Sea-level cabin .....21,400 ft
Landing distance.....3,170 ft

Limiting and Recommended Airspeeds

V_{MCA} (min control w/one engine inoperative, air)
Flaps 0 .....102 KIAS
Flaps 10 .....97 KIAS
Flaps 20 .....93 KIAS
V_1 (takeoff decision speed), flaps 10 .....107 KIAS
V_R (rotation speed), flaps 10.....111 KIAS
V_2 (takeoff safety speed) .....123 KIAS
V_{FE} (max flap extended) .....200 KIAS
V_{LE} (max gear extended).....200 KIAS
V_{LO} (max gear operating)
Extend .....200 KIAS
Retract .....180 KIAS
V_{REF} (reference speed, final approach) .....119 KIAS
V_{MO} (max operating speed) .....320 KIAS
V_{MMO} (max Mach number) .....Mach 0.80
V_{S1} (stall, clean) .....108 KCAS
V_{SO} (stall, in landing configuration) .....95 KCAS

For more information, contact Raytheon Aircraft Company, Post Office Box 85, Wichita, Kansas 67201; telephone 316/676-7111; fax 316/676-4819; Web site www.raytheonaircraft.com

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, sea level, maximum weight conditions unless otherwise noted.



Raytheon has led the way in automated processes for composite assemblies. For the Premier I, an automated tape placement machine builds the fuselage.

production airplanes are falling short by 70 nm. Still, the airplane's speed and range fall within the tolerances of the perfomance guarantees made back in 1995.

For the return to Beech field, we entered a crossing altitude for an intermediate approach fix. Punch in the appropriate numbers—3,000 feet, in this case—opposite the fix name on one of the FMS's flight plan pages, select VNAV on the glareshield panel, and a glideslope-like vertical path display appears to the right of the attitude indicator. Hand-fly the command bars (or let the autopilot do it) and your FMS-calculated descent profile will have you reaching your target fix and altitude at the same time. For healthy descents without incurring the aural overspeed warning's wrath, power reductions and spoilers can be used to both slow down and go down. Spoilers deploy without creating any of the aerodynamic rumbling or pitch excursions that are so common in many other business jets.

On approach, the magic power setting is 63 percent N_1, or engine fan speed. With full flaps and gear down, the V_{REF} for our landing weight (10,700 pounds) worked out to be 115 kt. After touchown, speed brake extension causes a separate set of spoilers—ground spoilers—to deploy along with the flight spoilers. The Premier I has no reverse thrust, so this lift-dumping function—along with the antiskid brakes—is essential to achieve shorter landing distances.

The Premier program is off to a great start with, at last count, the fifty-seventh fuselage coming off the Viper, and reduced vertical separation minimums (RVSM) approval on the way. But the airplane continues to evolve. By modifying the positions of the fuel line pickups in the fuel tanks Raytheon hopes to reduce the airplane's unusable fuel by 67 pounds. This ought to increase the airplane's range by 25 to 30 nm, and boost payload as well. Beginning with the sixty-seventh Premier I, the factory will make this change. Airplanes in the current fleet can have a retrofit kit installed.

Another effort is under way to reduce the airplane's field length requirements. As an FAR Part 23 airplane, the Premier I's takeoff and approach speeds are keyed to 1.3 times V_{SO}, with stall speed defined as the point when the stick pusher fires. This represents a fully stalled wing. Raytheon is petitioning the FAA to use FAR Part 25 methods of determining stall reference speed. These define a stall as the speed at which a wing first starts to lose lift. Under this scheme, the Premier I could use 1.2 V_{SO} as a reference multiplier, and thus provide lower V_R, V_2, and V_{REF} speeds. These lower speeds translate into reduced runway requirements.

With systems and a cabin worthy of an airplane costing at least twice as much, the Premier I is redefining the term entry-level jet. It's proof that composite construction is here to stay, and that plush interiors will never go out of style. AOPA

i Links to additional information about light business jets may be found on AOPA Online (www.aopa.org/pilot/links.shtml)

E-mail the author at tom.horne@aopa.org