Embraer Legacy

Brazil's big-cabin entry to business aviation — at a price south of $20 million

By Fred George
Photography by Màrcio Jumpei

For the residents of Sao Jose dos Campos, Carnival may start in late December, which is a few weeks early for the ultimate Brazilian party. You see, Sao Jose dos Campos is the home of Empresa Braziliera de Aeronautica S.A.— Embraer — and by year's end, folks there expect to celebrate certification of the Legacy business jet.

The $19.8 million Legacy doesn't offer cutting-edge technology. And Embraer officials unabashedly admit that this, the first business jet in its 32-year history, is a derivative of the well-proven EMB-135 jetliner that entered service in 1999 as part of the EMB-145 family. Still, the Legacy marks a significant milestone for Embraer, a formerly state-owned organization that had been a government employment project for its first 25 years. Little more than a decade ago, Embraer was in deep trouble because sales of its turboprop commuter EMB-120 had slowed even as the country's inflation was rocketing skyward.

That all began to change in 1995 when Brazil sold Embraer to a group of private investors. The timing was perfect. Flush with a fresh cash infusion, Embraer's strong leaders seized the opportunity to jump into the newly emerging 50-passenger regional jet market with the EMB-145, first certified in mid-1996.

Regional airline operators soon crowed about the aircraft's simplicity, dispatch reliability and operating economy. The EMB-145 became known as a money maker. Several variants followed, including the EMB-135, certified in 1999. Sales soared and production climbed to 18 units per month. Embraer recovered from its economic tailspin and has become Brazil's leading exporter and the world's fourth-largest aircraft manufacturer.

That caught the attention of business aircraft operators, such as Swift Air, a Phoenix-based charter company that plans to begin a fractional ownership program with Legacies. The EMB-135, built to cram in 37 commuters, could coddle 10 to 13 business travelers in its 43-foot-long, 1,400-plus-cubic-foot cabin. It actually offered 92 percent of the cabin volume of a Gulfstream IVSP.

Eager to expand production, Embraer proposed the Legacy, an EMB-135 fitted with winglets and auxiliary fuel tanks that could carry 10 passengers 3,200 nm, an increase of 1,200 miles over the standard aircraft.

But extra fuel and extra weight result in higher wing- and power-loading ratios compared to most other $20 million business aircraft. As a result, its takeoff runway performance is more regional-jet-like than business-jet-like. (See accompanying Range/Payload Profile chart.)

That makes the Legacy a niche aircraft, as shown in B/CA's trio of performance charts, along with the Comparison Profile. However, there's much more to the Legacy than the graphs convey. In order to understand the Legacy's full capabilities, it's essential to delve into the details.

Certification Basis, Structure and Systems

The Legacy is a derivative of the EMB-145, which was type certified in December 1996 in accordance with FAR Part 25 through Amendment 84, plus certain subsequent provisions up through Amendment 97. However, the new business jet, including auxiliary fuel, winglets (also used on the new EMB-145XR), interior modifications and cabin completion, plus all factory options, will receive its own type certificate. Embraer won't use the STC process for any standard or optional equipment on the aircraft.

The airframe is conventional semi-monocoque construction — stressed skins, hoop frames and longitudinal stringers. Composites are used for fairings, primary and secondary control surfaces, and main landing gear doors. The airframe's design economic life is 55,000 hours or 20,000 cycles.

The Legacy's airfoil is an original Embraer design, one with a relatively flat, "roof top" upper surface and mildly, reflexed (S-curve shaped) lower surface contours for long-chord lift distribution and low-drag rise up to MMO. For the business aircraft market, Embraer is raising the Legacy's MMO to 0.80 Mach from the EMB-135's 0.78 Mach redline. It has added aft body strakes to dampen the EMB-135's natural low amplitude wing rock that was aggravated by the addition of the winglets.

The leading edges on all EMB-145-series aircraft have four vortilons — "poor man's slats," is how Embraer engineers describe them. These devices energize the boundary layer at high angles of attack, thereby decreasing stall speed as much as 3.5 percent.

Inside the aircraft, the EMB-135's dropped aisle, which is offset to the left to accommodate one by two airline seating, and the airliner's side wall-mounted seat rails have been replaced with a specially braced floor to support business aircraft passenger chairs and other furniture. A central, dropped aisle increases headroom by two inches. A flat floor is available to accommodate asymmetric seating layouts.

The main cabin door is an airstair, Type I design and measures 30-inches wide by 67-inches tall. On the Legacy, the EMB-135's right, forward service door has been eliminated, freeing space for a full length, forward galley. There is a right-side, 20-by-36-inch Type III overwing emergency exit. The 40-by-45-inch baggage compartment door is located below the left engine.

The Legacy's systems are simple and heavily redundant, permitting dispatch with one inoperative component in virtually any system. For example, the aircraft can be dispatched with four of five 28 VDC generators, three of four hydraulic pumps, and one inoperative air cycle machine, or one inoperative wheel brake and/or fuel pump on either side.

The basic wing fuel capacity of 11,321 pounds is enough to fly 10 passengers about 2,000 miles. That total, however, has been increased 6,382 pounds by adding twin, forward belly and twin aft fuselage auxiliary fuel tanks, upping range by 1,200 miles. Notably, the forward belly fuel tank is high enough to clear the ground in the event of a gear-up landing.

A single-point pressure refueling port, with refuel quantity pre-select, is located on the right side of the forward wing fairing.

The dual hydraulic systems provide power for ailerons, rudder and flight spoilers, along with the landing gear, wheel brakes, nosewheel steering, thrust reversers and entry door closing system.

The aileron and rudder controls are powered but have a manual reversion mode. The electrically controlled and hydraulically actuated speed brakes provide flight spoiler and automatic ground spoiler functions. The double slotted, trailing edge Fowler flaps are actuated by dual DC electric motors. The elevators are manually actuated, assisted by servo and spring tabs that reduce effort. Stall protection is provided by a dual angle-of-attack, stick shaker and stick pusher system.

The Legacy has trailing link main landing gear fitted with carbon brakes, controlled by a dual channel, brake-by-wire system. Brake temperature is displayed on the EICAS. Nosewheel steering employs a

The main entry door, with integral airstair, measures 30 inches wide by 67 inches tall.

Aft body strakes were added to improve directional stability.

All walk-around preflight tasks can be done with feet on the ground, including refueling.

digital steer-by-wire system, with five degrees of authority available through the rudder pedals and an additional 71 degrees available through the tiller.

An 8.1-psi, digital-control cabin pressurization system maintains a maximum 8,000-foot cabin altitude at the aircraft's 39,000-foot certified operating ceiling.

Bleed air is used for cabin pressurization, engine inlet, wing and horizontal stabilizer leading edge anti-ice, and engine starting. The APU, which is fitted with a full authority electronic control, can be used for cabin pressurization in flight. Airframe anti-ice systems are automatically actuated by an ice detection system. Embraer chose to heat the leading edge of the horizontal stabilizer to prevent performance degradation caused by ice contamination. Electrical heat protects the angle-of-attack probes, ice detection probe, pitot tubes, static ports and windshields.

Embraer Legacy

B/CA Equipped Price $19,800,000

Characteristics

Wing Loading	88.8
Power Loading	3.30
Noise (EPNdB) (est.)	79.5/84.9/92.5
Seating	2+12/15

Dimensions (ft/m)

External	See three-views
Internal	
Length	39.0/11.9
Height	6.0/1.8
Width	6.8/2.1

Thrust

Engine	2 RR AE3007 A1P
Output/Flat Rating	
OAT°C	7,426 lb ea/ISA+30°C
Inspection Interval	OC

Weights (lb/kg)

Max Ramp	49,096/22,270
Max Takeoff	48,943/22,200
Max Landing	40,785/18,500
Zero Fuel	35,273/16,000c
BOW	29,233/13,260
Max Payload	6,040/2,740
Useful Load	19,863/9,010
Executive Payload	2,400/1,089
Max Fuel	17,703/8,030
Payload With Max Fuel	2,160/980
Fuel With Max Payload	13,823/6,270
Fuel With Executive Payload	17,463/7,921

Limits

MMO	0.800
FL/VMO	FL 276/320
PSI	8.1

Climb

Time to FL 370	37 min.
FAR 25 OEI Rate (fpm)	TBD
FAR 25 OEI Gradient (ft/nm)	TBD

Ceilings (ft/m)

Certificated	39,000/11,887
All-Engine Service	39,000/11,887
Engine-Out Service	16,500/5,029
Sea Level Cabin	20,550/6,264

Certification . . . . . FAR/JAR/CTA 25 pending

Flying Impressions

Few aircraft we've flown have better crew ergonomics than the Legacy. This first becomes evident during preflight inspection. During our walk-around at the Sao Jose dos Campos airport, Embraer senior test pilot Luiz Carlos Rodrigues and I checked every item on the preflight list in less than five minutes. The subject of our scrutiny was EMB 135 Serial Number 363, the second of four Legacy flight-test aircraft. This would be its 19th flight.

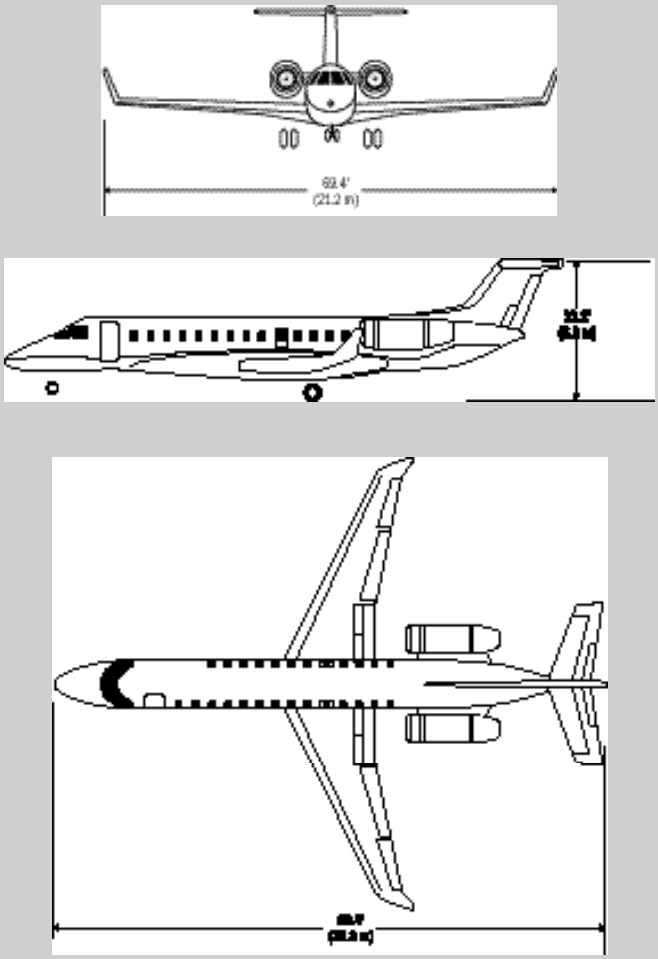
"This is a walk-around inspection done with your feet on the ground," Rodrigues remarked. All inspection points are within ready view or arm's reach, or they can be checked remotely on EICAS pages in the cockpit. There is no need to climb rickety ladders or squeeze into greasy equipment bays. A white glove, starched shirt kind of walk-around.

Once that was complete, Rodrigues and I strapped into the right and left seats of the Legacy, with Silvio Olenscki jumpseating as safety pilot and Roberto Herbert staffing the flight-test engineer's station.

/ manuals.

Legacy has loads of hand-eye coordination features that expedite "flow" completion of checks, backed up by checklist verification. The normal operating position of all knobs, for example, is the 12 o'clock position, easily verified with eyes and finger tips. The absence of aural warnings combined with a dark EICAS message screen means you're ready for takeoff.

Embraer Legacy



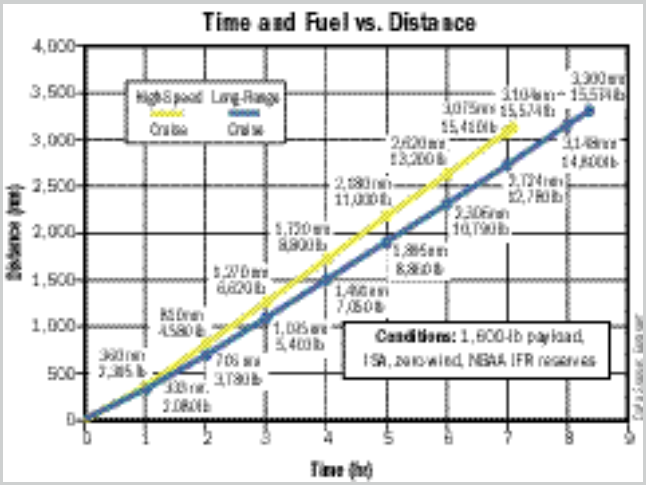
Embraer Legacy

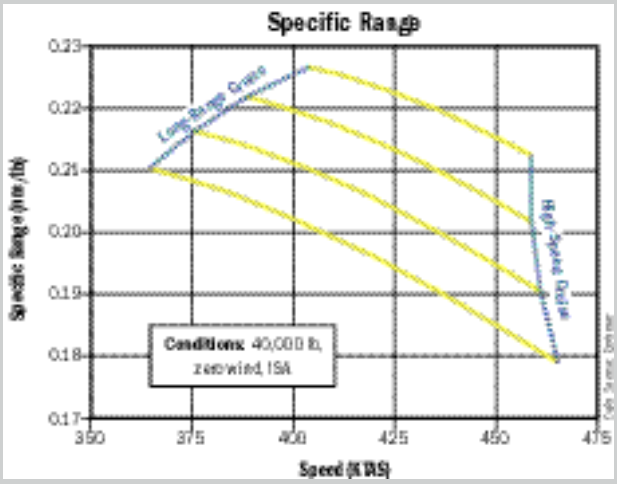
These three graphs are designed to be used together to provide a broad preliminary view of the Legacy's performance. Do not use these data for flight planning. For a complete operational analysis, use the Approved Aircraft Flight Manual, Operational Planning Manual and other flight planning data supplied by Embraer.

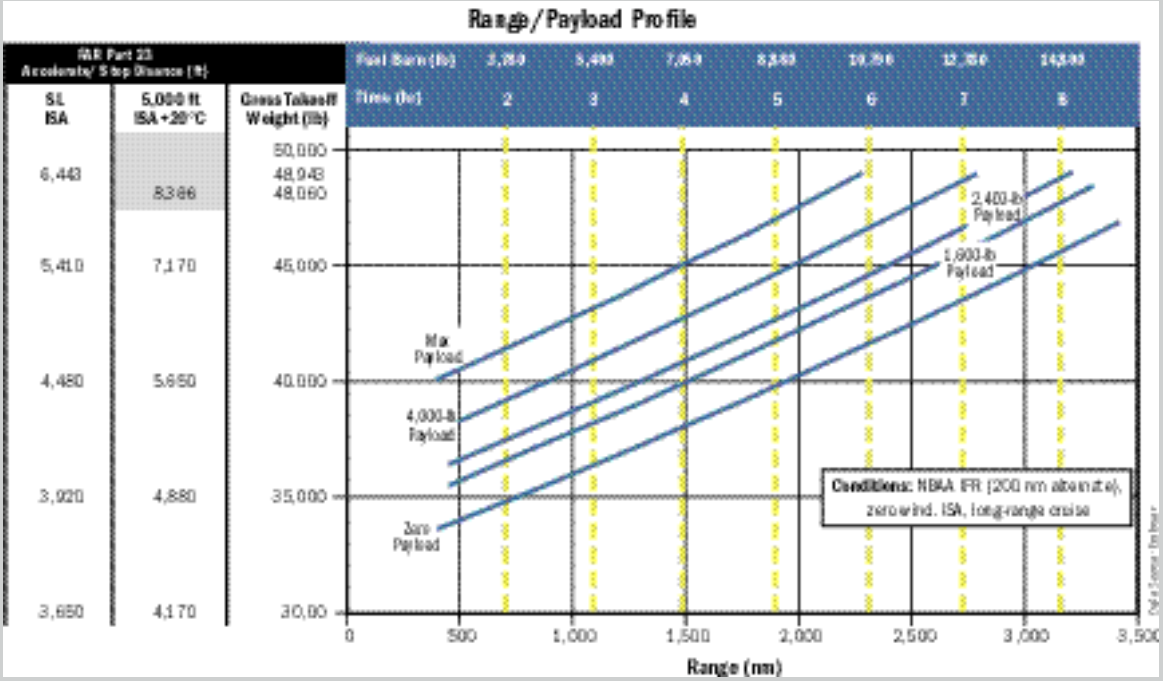
Time and Fuel vs. Distance — This graph shows the performance of the Legacy at 0.68 Mach long-range cruise and 0.78 Mach high-speed cruise. The numbers at the hour lines indicate the miles flown and the fuel burned for each of the two cruise profiles. Each of the hour points is based upon specific mission data supplied by Embraer. While flying the Legacy for this report, we found actual aircraft performance to fall slightly short of Embraer's projections, but this was in a flight-test aircraft, not a production model.

Specific Range — The specific range of the Legacy, the ratio of miles flown to pounds of fuel burned (nm/lb), is a measure of fuel efficiency. The lines are relatively flat, suggesting a rather linear increase in drag up to the aircraft's 0.80 Mach redline. Quite unlike most other turbofan business aircraft, the spread between the Legacy's long-range and high-speed cruise specific range decreases only moderately at maximum cruise altitude, suggesting the aircraft could cruise more efficiently if its service ceiling were higher.

Range/P ayload Profile — The purpose of this graph is to provide simulations of various trips under a variety of payload and airport density altitude conditions, with the goal of flying the longest distance at high-speed cruise. The five payload lines are plotted from individual mission profiles with five data points, ending at the maximum range for each payload. The time and fuel burn dashed lines are based upon the long-range cruise profile shown on the Time and Fuel vs. Distance chart. The runway distances are computed using either flaps nine degrees or 18 degrees configuration, depending upon density altitude.







Our green test aircraft had a full complement of orange test gear, bringing its BOW to 26,742 pounds, or about 8.5-percent lighter than a production Legacy with a corporate interior. Loaded with 8,800 pounds of wing fuel, plus a 1,606-pound payload, the ramp weight was 37,148 pounds, about three-fourths of the Legacy's 49,097-pound maximum ramp weight.

Rodrigues started the APU to supply bleed air for air conditioning and main engine start. The APU is not required for dispatch. Starting the Rolls-Royce AE3007 turbofans is easy and virtually automatic. Switch on the fuel pumps, turn the engine run knobs to start and the FADECs handle all the start monitoring and safety chores.

Once start was complete, the engine run knob audibly clicked back to the normal 12 o'clock "run" position, signifying successful completion of the process. The dual DC generators automatically came on line and the APU bleed air was redirected to the ACMs, keeping the passengers comfortable.

The FADECs are not integrated with the FMS. So in preparation for takeoff, the crew must manually dial in the ambient temperature and desired takeoff thrust mode — normal for full thrust or flex for reduced engine wear. This enables the FADECs to set thrust properly when the throttles are advanced to a pre-select detent in the quadrant. Regardless of mode, pushing the throttles beyond the pre-set detent overrides the flex mode and boosts thrust to maximum available.

Docile slow-speed handling characteristics and low V_{REF} speeds make Legacy easy to fly in the pattern.

Five minutes after engine start, we taxied to Runway 15, elevation 2,119 feet. For the aircraft's 37,000-pound takeoff weight, flaps 15 configuration and 81°F (27°C) airport temperature, Herbert computed V speeds of 124 knots for V_1 and V_R along with 126 knots for V_2. The approximate computed takeoff field length was 4,522 feet.

With the aircraft's comparatively light weight, starting the taxi roll required little thrust increase beyond idle. Turning sharply out of the chocks to avoid the open flight-test hangar, we noted a slight over-control tendency of the nosewheel steering (NWS) near full throw of the tiller. Up to half travel, though, the tiller provided very smooth steering during taxi. NWS through the rudder pedals is quite smooth, though limited to five degrees.

The Legacy has Embraer's unique array of four engine mode control buttons just aft of the throttles: takeoff, max continuous, climb and cruise. For takeoff, we pressed the T/O button and then advanced the thrust levers to the pre-set detent, thereby commanding the FADECs to set the dialed-in thrust.

Initial acceleration was moderate, even at our comparatively light weight. Initial pitch force to 14 degrees rotation was substantial, but not excessive, considering the main landing gear's position well aft of the c.g. With weight off the main landing gear, the pitch forces were well proportioned to airspeed — light when slow and moderate when fast.

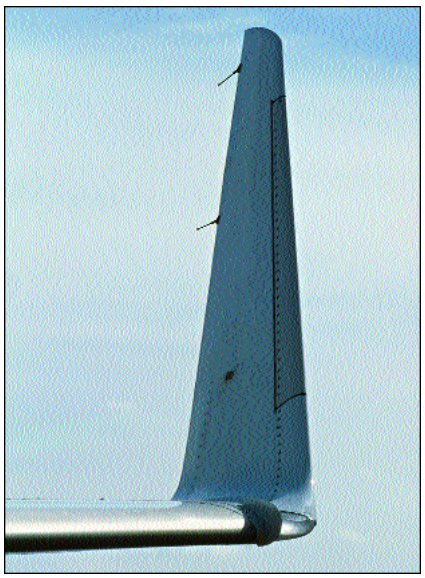
The Legacy's roll control forces vary from light to heavy, depending on wheel displacement. As speed increases, there is a natural, light wing rock that must be actively countered with wheel inputs. This is an aircraft better flown by the autopilot as speed increases above 200 KIAS, in our opinion.

We filed for FL 390, but local airspace constraints limited the climb to 8,000 feet until we were 50 miles from Sao Jose dos Campos. This skewed our fuel burn and time-to-climb measurements during the

Honeywell Primus 1000 Avionics

The Legacy comes loaded with a Primus 1000 avionics package, featuring five large-format CRTs. The base system includes dual LASEREF IV, dual FMS with approach-certified GPS, dual Primus II C/N/S radio systems, dual DADCs, dual GPS-synched chronometers, CVR, FDR, TCAS and TAWS, Primus 880 Doppler turbulence detection weather radar, HF with SELCAL, single-channel CAT II autopilot and Smiths Industries Integrated Standby Instrument System.

Options include a Flight Dynamics HUD, CAT IIIa certification, ACARS printer and third VHF comm, along with LSZ-860 lightning sensor, communications management unit and a cockpit monitor for the Airshow 400.



Winglets and auxiliary fuel tanks boost range to 3,200 nm.

250 KIAS/0.65 IMN climb to cruise altitude. Aircraft weight at level off was 35,580 pounds.

At a long-range cruise speed of 0.68 Mach, 386 KTAS in ISA-5°C conditions, the total fuel flow was 1,764 pph, yielding a specific range of 0.219 nm/lb. In contrast, the Embraer's preliminary predictions for long-range cruise were 425 KTAS on 1,886 pph in ISA conditions, producing an estimated specific range of 0.226 nm/lb.

Accelerating to a high cruise speed of 0.76 Mach, or 432 KTAS under those conditions, the Legacy burned 2,094 pph, yielding a specific range of 0.206 nm/lb. Early Embraer predictions were 459 KTAS on 2,117 pph at high-speed cruise in ISA conditions, resulting in 0.217 nm/lb. It's worth noting that production Legacies will be able to climb directly to FL 390 at MTOW and cruise at 0.767 Mach, or 440 KTAS. We soon discovered that the Embraer's wing design has large high-speed buffet margins. At 0.76 Mach and at 4,000 pounds below mid cruise weight, the aircraft exhibited no buffet at a sustained bank angle of 60 degrees at FL 390.

Short- and long-period pitch stability also were excellent. The 89-second, long-period pitch cycle damped in one and one-half cycles.

The speed brakes have one extension position and that causes a very slight rumble. Extension produces less than a three-degree nose-down pitch change because of a speed brake/stab trim interconnect.

Flap and landing gear configuration changes produce pitch changes of only one to two degrees. Changes in thrust have almost no effect on pitch.

Steep turns bring out the aircraft's well-harmonized pitch and roll forces. These same qualities were noted during formation flying for the aerial photography in this report.

Approach-to-stall behavior in all configurations is well mannered. The PFD provides a plethora of visual approach-to-stall and stall recovery cues. A stick shaker warns of the approaching stall. A stick pusher moves the nose down five degrees

Legacy Cabin Comfort

The Legacy's 1,410-cubic-foot cabin has twice the volume of most midsize business jets and 60-percent more volume than most other $20 million class, super midsize aircraft.

The challenge inherent in all that cabin volume and floor space is keeping to completion weight limits and schedules. Embraer plans to eliminate the completion problem by moving the process in-house and putting most popular options on to the standard equipment list. These two steps relegate "completion weight allowance" to the fine print part of the contract, rather than becoming a buyer's nightmare.

The interior includes an average 54 dBa acoustical insulation package by Flight Environments, 16-g-rated passenger seats by BE Aerospace (a.k.a. AMP), cabinets by Bomhoff, and interior panels by Nordham. The 240-cubic-foot baggage compartment has full Class C fire protection and is accessible through a door in the full width lav at the rear of the cabin.

Four seating configurations are offered and Embraer will fine-tune any of them to customer request. For major changes,however, the green aircraft must be taken to an outside completion center.

Standard equipment includes galley with oven, coffee maker and ice drawer; AC power outlets; single-channel satcom; Aircell; Airshow 400 with DVD, CD and VCR players, forward 20-inch, flat-panel monitor, individual passenger service units and headsets. All of that is included in the 3,589-pound completion allowance, resulting in a 29,233-pound BOW.

Options include multi-channel satcom and MagnaStar, a wide variety of airborne office equipment, individual passenger video monitors, microwave oven and refrigerator drawer for the galley, high-gloss cabinets and various extra closets.

Weight penalties for the options will be as low as possible, Embraer officials say. They expect to retain a 10-passenger, tanks-full capability even when the aircraft is loaded with virtually every popular option.

The 240-cubic-foot external baggage compartment, with Class C fire protection, also is accessible through a door in the aft cabin.

The radome accommodates a 10-inch weather radar antenna.

just prior to the stall, making hands-off recoveries possible with little or no wing roll off.

Handling manners in the landing pattern are another strong suit for the Legacy. Approach and landing speeds are similar to those of a light jet. At our initial landing weight of 32,165 pounds, for example, VREF was 114 KIAS at flaps 45 degrees.

Rodrigues coached me on landing technique. Similar to an MD-80 or B-727, the key is to flare the Legacy just high enough to arrest the rate of descent, but then just prior to main landing gear touchdown, roll down the nose slightly to prevent a kerplunk. The first few landings took practice to avoid squandering a large length of Sao Jose dos Campos' 9,843-foot runway.

On roll out, stability was excellent, braking action was smooth and powerful. Brake pedal forces were quite heavy, but that prevented jerky deceleration.

Simulated one-engine-inoperative takeoffs were easy in the Legacy. Required pedal pressure to counteract asymmetric thrust was light and pleasant. We flew the entire takeoff and landing pattern circuit with one throttle retarded, using 22-degrees flaps and adding 10 knots to VREF.

Conclusions? The Legacy's slow-speed handling manners are superb, its high-speed, high-altitude cruise performance is modest yet comfortable, and the autopilot can do a better job flying the aircraft in cruise than even the most exacting human pilots.

Cost vs. Value

The accompanying Comparison Profile provides a thumbnail sketch of the Legacy, revealing its airliner traits. It's big on cabin volume and it can tote a ton of payload with full tanks. Takeoff, climb and cruise performance are not its strong points. The longest missions will take one-half longer than those noted in the comparison profile business jets.

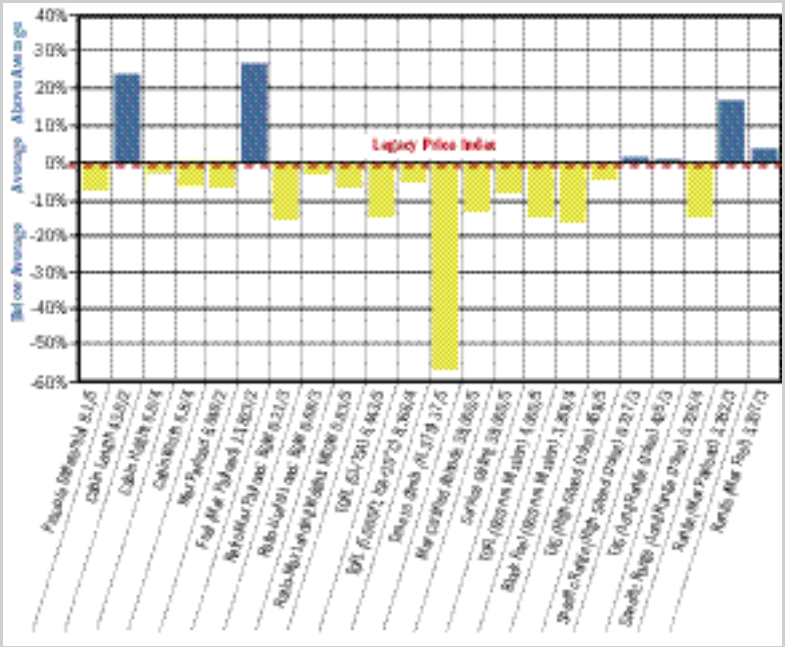
But that time won't necessarily be lost. Ten to 13 passengers can work productively or relax in a substantially more spacious cabin than in other $20 million business aircraft. On the longest overnight missions, such as eastbound over the North Atlantic, operators might choose to slow down to economy cruise so that six or seven passengers can sleep for seven and one-half hours in the fully berthable chairs.

Embraer had announced 34 orders and 31 options for the Legacy as of late July. Swift Air, the launch customer, accounts for 25 orders and 25 options. United Biz Jet reportedly will operate several 19-passenger, Legacy executive shuttles without the auxiliary fuel tanks. Two more aircraft have been ordered by an unnamed Brazilian firm. Embraer plans to deliver five Legacy aircraft this year, 18 in 2002 and 24 in 2003. Not all those slots are taken. Positions still are available for late next year.

The Legacy's regional airliner heritage, large-cabin comfort and back-to-basics practicality seem to have launched it well on the flight path to success. Business travelers increasingly favor big-cabin aircraft for long trips. The Legacy's prospects, therefore, depend upon customers opting for cabin comfort and systems redundancy over traditional high cruise speed and nimble runway performance. **B/CA**

Comparison Profile

(Percent Relative to Average)



Tradeoffs are a reality of aircraft design, although engineers attempt to optimize the blend of capabilities, performance and passenger comfort.

In order to portray graphically the strengths and compromises of specific aircraft, *B/CA* compares the subject aircraft to the composite characteristics of other aircraft in its class, computing the percentage differences for the various parameters. We also include the absolute value of each parameter, along with the relative ranking, for the subject aircraft within the composite group.

For this Comparison Profile, *B/CA* included the Bombardier Corporate Jetliner, Dassault Falcon 50EX, Dassault Falcon 2000 and Gulfstream G200 (a.k.a. Galaxy) because they are the closest competitors in price. The Legacy's retail price is within one percent of the composite average. The Comparison Profile illustrates the Legacy's advantage in cabin size, range with max payload and range with max fuel. It also shows that the Legacy's competitors have runway, climb and cruise performance advantages.

Rolls-Royce AE3007 Turbofans

The Legacy's A1P engines, rated at 7,426 pounds of thrust for normal takeoff (ISA+30°C), have an 8,169-pound-thrust rating for one-engine-inoperative conditions (ISA+19°C). For operators, that translates into full rated thrust up to 113°F (45°C) at sea level. The A1E engines' high-altitude thrust output is robust — 2,053 pounds at 40,000 feet (ISA) uninstalled.

The A1E, the newest version rated at 7,953 pounds of thrust for takeoff with 8,716 pounds for OEI operations, has been developed for the EMB-145XR. Embraer has not announced plans to fit the A1E to the Legacy.

Legacy Shop Talk

By Dave Benoff

The good news for Legacy maintainers is that the ERJ-135LR is an MSG-3 (Maintenance Steering Group 3) airplane. And as with all aircraft manufactured under MSG-3 requirements, operator input and field response helped mold its design to accommodate economic and functional issues. By building on its engineering experience with the ERJ-135 and ERJ-145, Embraer can enhance the Legacy's reliability and maintainability, just as Boeing did when it developed the BBJ.

Heavy duty carbon brakes provide excellent stopping power and long life.

James Rankin, president of Skyways Airlines, said his carrier chose the ERJ-135 and -145 because of their "high reliability" and "state-of-the-art-technology" — both products of the MSG-3 process.

The commercial aircraft maintenance is performed "on-condition" with tasks arranged in calendar/time intervals. By operating on condition, maintenance tasks are covered over a longer period and a non-intrusive method of reliability management is used to decrease operational costs and risk.

The Legacy maintenance program is a derivative of the airline program. Under Embraer's MSG-3 for FAR Part 91, components and systems are broken down into six-month/400-hour events. Corrosion and zonal inspections are required every 12 months, structural inspections every two years, and these inspections do not have a flight hour requirement. To keep the Legacy on this type of program there are no additional inspection requirements.

"Our customer profile differs from that of the traditional corporate customer," said Ricardo Lucas, Embraer customer support manager, Brazil. "In short, we have modified our program to incorporate the very low utilization operator — less than 500 hours per year — but also provide a maintenance program for the 'High Utilization Biz jet Operator.'"

On the powerplant side, the Legacy takes advantage of lessons learned from the ERJ-145 and Citation X (and Global Hawk unmanned aerial vehicle) by using two Rolls-Royce AE3007A1 engines. This high-bypass (5:1), two-spool, axial flow engine is flat rated at 7,580 pounds of thrust. It features a wide-chord single-stage direct drive fan with a 14-stage compressor. In addition, the engine uses dual mounted, fully redundant FADECs, which improve engine performance and reliability.

Maintained under an on-condition program, the engines have no specific time limit, but can average 3,000 hours between hot section inspections and 6,000 hours for overhauls. A power-by-the-hour program is available for the AE3007A1s under a baseline configuration or with two options.

The baseline coverage includes scheduled and unscheduled maintenance, shop and line activity costs, required Service Bulletins and an optional Engine Trending program. In addition, the baseline covers an operator for spare engine assets without incurring access fees. Optional coverage for the engines include freight and logistics costs and life-limited component coverage beyond normal guarantees.

If you ask the maintenance personnel at Embraer what they pride themselves on more than any other, they cite their responsive and accurate technical support.

Under the MSG-3 requirements, the Legacy is required to have a maintenance feedback loop, which ensures a constant product improvement process. Embraer fulfills its requirement by providing field, logistic, material and service center support.

"We are currently establishing a family of maintenance providers who are authorized to perform warranty work and provide an AOG team," said Bob Davis, Embraer's U.S. customer support manager.

Field and technical support for the Legacy is primarily coordinated through Embraer's account managers. They provide 24-hour global support designed to resolve short in-service problems. In addition, they provide a fleet monitoring program designed to close the loop for the MSG-3 process, which reduces maintenance costs while improving dispatch reliability.

The customer account managers have at their command technical representatives who are strategically located around the world. "Some of our tech rep teams are located at the airlines," Davis said, "so Legacy operators can reap the knowledge from someone who has already encountered a similar problem."

There is excellent access to system components, making short work of most maintenance tasks.

To aid in troubleshooting Embraer provides CD-ROM versions of its paper-based maintenance manuals, including illustrated parts and wiring manuals. This, along with an Internet version, allows operators to search all of the publications through a single line command. In addition, the publications are updated frequently and posting of change pages is not required.

There are currently more than 10 factory-approved Legacy service centers in the United States, which offer complete warranty service and inspections. In addition, Embraer is considering other potential centers based on geographical needs.

"Each service center will have a defined stock level they will maintain based on location," said Davis. Operators also have the ability to go directly to the third party OEM and go online with Embraer's Customer Integration System. Davis also said that Embraer was developing its own maintenance service plan that should be available when the Legacy is delivered.

Overall, the estimated cost to maintain the Legacy is $512 per flight hour. The following table is an example of typical costs.

		Time/Cycle	HSI/Core Costs	Cost per Flight Hour	Quantity per Aircraft
Engines	HSI	3,000 Flight Hours *No Time Limit*	$230,000	$116.67	2
	Overhaul	6,000 Flight Hours *No Time Limit*	$470,000 (including HSI)		
Windshield		19,000 Flight Hours *No Time Limit*	$37,000 each	$1.95	2
Tires	Nose	400 Flight Cycles *No Time Limit*	$210 each	$0.53	2
	Main	400 Flight Cycles *No Time Limit*	$200 (retread, each) $460 (new, each	$0.72	4
Brakes		1,350 Flight Cycles	$5,100 Each	$3.78	4
Landing Gear		20,000 Flight Cycles 12 years	$95,000 Main Landing Gear $40,000 Nose Landing Gear	$6.75	
C Check		4,000 Flight Hours 48 months	$77,010	$19.25	