



Embraer Phenom 300

Its price, cabin, performance and fuel efficiency, plus airliner-inspired and maintenance-friendly design make this light jet a serious contender.

By Fred George

Embraer loves disruptive change. When the \$7.6 million Phenom 300 enters service late this year, it could shatter traditional price vs. value expectations in the super light jet market segment, just as Embraer's Phenom 100 did in the entry level jet sector in 2008. While Embraer is positioning the Phenom 300 as a light jet, it's clearly in the next class up from any aircraft within a million dollars of its price tag. Compared to most other light jets, it's bigger and faster, it has a lower cabin altitude and it has more advanced aerodynamics, potentially delivering better fuel efficiency.

The cabin dimensions and volume of Embraer's newest business jet almost mirror those of the \$9.3 million Learjet 40XR. And while the Phenom 300 doesn't cruise as fast or as high as the Learjet, it can fly four passengers 240-plus miles farther,

it gets better fuel economy and can operate from shorter runways.

Similar to the Learjet 40XR, the Phenom has brake-by-wire, single-point pressure refueling and an externally serviced toilet. Unlike the Learjet, it also has optional synthetic vision, 3-D traffic, electronic charts and XM radio weather.

Such advanced design features are bound to win praise from pilots, but Embraer's first priority for the Phenom 300 was accommodating the needs of passengers. This started with the aircraft's signature "Oval Lite" fuselage cross section, a shape that bellies out at the bottom to increase leg and foot room. The Oval Lite cross section also allows the cabin seats to be mounted lower, thereby increasing shoulder and headroom.

BMW Group DesignworksUSA created the interior layout, as it did for the Phenom 100. Early in the program, the main cabin was stretched 14 inches, thus providing greater legroom and more space to recline

the seats. Passengers will peer out of the largest cabin windows in the light jet/super light jet class, all of which are mounted to provide passengers with the best viewing angle while seated. The aircraft has five 12-inch-wide by 14-inch-high transparencies on the right side of the main cabin vs. four on the left because of the cabin door. There are two more windows in the lavatory that provide plenty of ambient light, a feature not offered by other light or super light jets.

The aircraft has improved acoustical insulation, compared to the Phenom 100, along with better muffling of the outflow from the air distribution and pressurization systems. Embraer claims the cabin will have a 74.5 dB sound level, but speed and altitude conditions were not specified.

The Phenom 300 is the only business aircraft priced under \$12.5 million to have a single-piece air-stair door for easy entry and exit. It's sturdy, measuring 28.5 inches wide and 58.3 inches tall. It's counter-

balanced with a torsion bar spring for easy closing and is supported by cables when open. Buyers can opt for telescoping rails that replace the air-stair support cables.

Embraer will offer three basic cabin layouts. The standard interior configuration has six chairs arranged as a forward four-seat club section with tandem forward-facing seats in the aft cabin. It also has a forward, right-side galley across from the entry door and the aft lav enclosed by solid doors. In 2010, Embraer plans to certify seven- and eight-seat cabin configurations that will swap out the forward galley for a single aft-facing chair or a two-place, side-facing divan. A belted potty seat also will be available next year.

Unlike the Phenom 100, there will be no pre-set interior decor groups. Customers will be given a full choice of fabrics, carpets and seat coverings to customize their aircraft. There will be numerous cabin upgrades including inflight entertainment systems.

As with the four-seat Phenom 100, the six-seat Phenom 300's aft external compartment is sized to accommodate a golf bag or snow ski bag, plus a garment bag, a roll-on bag and a carry-on bag for each passenger. Inside the cabin, there's more storage room for carry-on and laptop bags in a lavatory compartment, plus there's an optional forward hanging bag locker in place of the right-side galley in the cabin.

The flight crew can stow their gear, along with engine duct covers and the tow-bar adapter, in a five-cubic-foot nose baggage compartment.

Advanced, Yet Proven Technology Design Features

The Phenom 300 evolved from the Phenom 100, so it's structurally efficient because it shares the same cross section and it's nine feet longer. But Embraer maintains it's not just a stretched version of the Phenom 100 because it has a different internal fuselage structure and wing, different engines and systems, and different performance characteristics.

Similar to the Phenom 100, most of the Phenom 300's primary airframe structure is aluminum monocoque with chemically milled sheet metal, extruded and machined parts. Fuselage frames are more closely spaced than in the Phenom 100 to accommodate the higher pressurization differential. However, the skin is thinner between the frames to save weight.

Aluminum forgings are used for the window frames. The vertical fin and horizontal stabilizer, along with all control surfaces, gear doors and fairings, are



Phenom's forward right-side galley behind the copilot's seat is available with a variety of options. Alternatively, it may be exchanged for an optional seventh, aft-facing seat plus a storage closet or a two-place, side-facing divan.

fabricated from carbon epoxy composites. The radome is fiberglass. The windshields are glass over acrylic for durability and they are treated with rain-repellant coating.

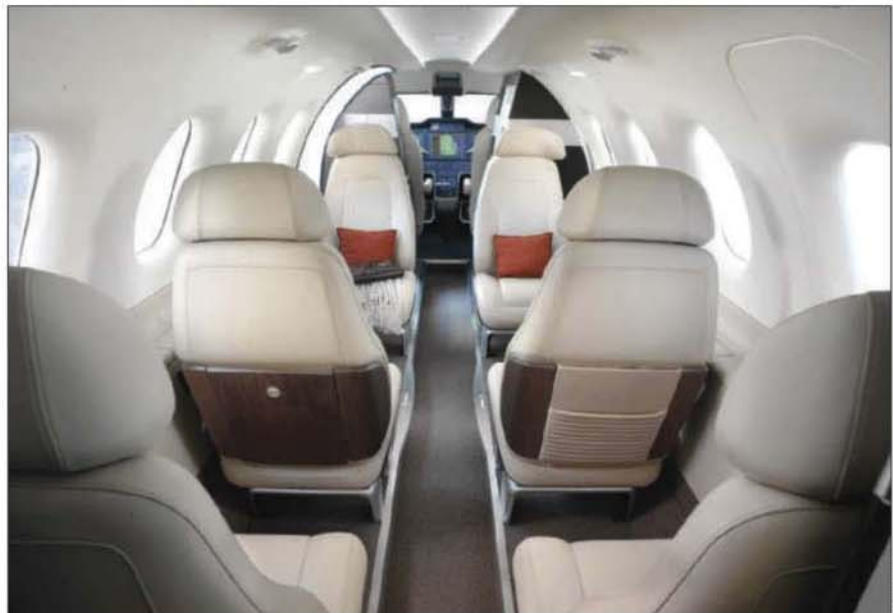
The wing boxes are classic ladder structures comprising forward and aft spars, chord-wise ribs and sheet metal skins. Each main landing gear is supported by the inboard section of the rear spar and a third, sub-spar. The winglets are made of cast aluminum. The wing passes under the fuselage and attaches to it at eight points.

Embraer designed a clean-sheet super-critical airfoil for the Phenom 300.

Transonic flow is achieved in the low to mid 0.70 Mach numbers, depending upon lift coefficient. The drag divergence Mach number, the speed at which a significant rise in Mach-induced drag occurs, is well above the aircraft's 0.78 Mmo redline, so the aircraft can efficiently cruise at high speed.

The Phenom 300's design life is 28,000 cycles or 35,000 hours, assuring it will have a 30- to 40-year economic life even with heavy commercial use.

The primary flight controls are manually actuated and there is three-axis electric



The Phenom 300 has the largest cabin windows in its class, and a 6,600-foot cabin altitude at FL 450. The main cabin features a four-seat club section, plus two forward-facing seats in the aft cabin.

trim. Embraer fitted the Phenom 300 with a trimmable horizontal stabilizer to provide greater pitch control authority and to accommodate a Mach trim system, if needed to meet speed stability requirements for type certification. At this point in the development program, though, it doesn't appear that such a trim system will be required.

The left aileron and rudder are fitted with conventional trim tabs for roll and yaw trim. Notably, the Phenom 300 is the first Embraer business jet to be fitted with fly-by-wire multifunction spoilers. These panels provide pilot-commanded inflight speed brake, automatic ground spoiler and automatic differential roll spoiler actuation to augment roll control authority.

The Phenom 300 also has a unique spring-loaded rudder boost system that automatically is actuated above 60 knots in the event of an inflight engine failure. In less than one second, the FADECs send a signal to a hydraulic actuator that tensions two powerful servo springs that assist the pilot in moving the rudder pedals to counter thrust asymmetry.

The aircraft has dual yaw dampers, one of which is controlled by an on/off switch and connected to the aircraft's rudder. The secondary yaw damper is connected to a small auxiliary rudder behind the tail-mounted ventral fin. It's automatically activated any time the primary yaw damper is not operational and it is actuated by an autopilot servo.

The wing is fitted with four-position, four-panel trailing-edge Fowler flaps that are mechanically actuated by jack screws, which, in turn, are powered by a DC electric motor.

Similar to all previous Embraer aircraft with T-tails, the Phenom 300 has a stall-barrier stick pusher. It's set to push the yoke forward with 120 pounds of force just before the aircraft reaches aerodynamic stall. Embraer engineers claim the aircraft isn't prone to deep stall and it retains positive pitch stability in all configurations and at all c.g.'s in the flight envelope. However, it is prone to wing roll-off at aerodynamic stall. The stick pusher prevents uncommanded wing roll-off at high angles of attack.

The split-bus 28 VDC electrical system is powered by left and right starter-generators. It features automatic, nonessential load shedding during start and in case of abnormal operations. To assure "quiet start," uninterrupted power transfer to avionics and airframe systems, the electrical system is configured with dual batteries, much the same as the Phenom 100. The aft battery is used for engine start and the forward battery is dedicated to power systems and avionics. Both batteries are positioned for easy access. The aft battery is housed in the right rear wing root and a door on the right side of the nose provides access to the forward battery. The batteries also provide 45 minutes of emergency power to essential systems, including the left PFD, left integrated avionics computer, integrated standby instrument system, wet compass and cockpit dome light.

All fuel is contained in left and right wet wing tanks, which combined have a total capacity of about 5,340 pounds. Jet pumps, powered by high-pressure motive flow from the engine fuel pumps, scavenge fuel from the feeder and wing tanks and

supply it to the engines. DC-powered fuel boost pumps provide fuel supply for engine start and crossfeed, or in the event of a jet pump failure. In contrast to the Phenom 100, which has a tank-to-tank cross-transfer valve, the Phenom 300 uses tank-to-engine crossfeed to balance asymmetric fuel loads.

A single-point pressure refueling receptacle in the fuselage fairing, ahead of the right wing root, enables the aircraft to be refueled in 12 minutes or less. Over-the-wing refueling ports alternately may be used to replenish the tanks. Anti-icing additives are not required.

Unlike the Phenom 100's electrically powered, on-demand hydraulic system, the Phenom 300 has a full-time 3,000-psi hydraulic system powered by left- and right-side engine-driven pumps. Embraer doesn't believe in using Skydrol. The system is filled with MIL-PRF-87257 hydraulic fluid, the successor to MIL-H-5606 red oil. Client systems include rudder boost, multifunction spoilers, stall-barrier stick pusher, landing gear actuators and wheel brakes.

The landing gear also has a backup free-fall extension function should the hydraulic system fail. Trailing link main landing gear provide smooth touchdowns on landing. A brake-by-wire system actuates lightweight carbon brakes designed for 2,000 landings between overhauls. Acting through bungee linkages, the rudder pedals command up to 20 degrees of steering authority with another 23 degrees available through differential braking and thrust. Overall, the 43 degrees of nosewheel steering authority doesn't make for a tight turning radius.

For towing the aircraft, the nose landing gear torque link must be detached and a tow-bar adapter, furnished with the aircraft, attached. In addition, all three landing gear must be pinned if the aircraft is towed.

The Phenom 300's environment system features 9.2 pressurization to provide a maximum 6,600-foot cabin altitude at FL 450. The vapor cycle air-conditioning system is sized for Brazilian summers, so it has the capacity needed to chill the cabin quickly in extreme heat. Dual zone temperature control is standard and cabin altitude control is completely automatic, with the landing field elevation supplied by the FMS.

Operators have told Embraer that the aft part of the Phenom 100 cabin is too noisy, so it's likely that the Phenom 300 will get improved soundproofing to reduce noise coming from the cabin air distribution



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Capt. Eduardo Menini opens the single-point pressure refueling access door ahead of the right wing. The SPPR panel has LED illumination for night operations and a selectable refill quantity feature.

system and outflow valves.

The oxygen system incorporates the latest diluter demand functionality. Even though a crewmember may be wearing a mask, no oxygen flows unless cabin altitude exceeds 10,000 feet. Cabin air only is supplied to the mask. This prevents oxygen tank depletion during normal operations.

Engine bleed air is used for anti-ice heating of the wing and horizontal stabilizer, along with the engine nacelle inlets. Electrical heat prevents ice accretion on the glass windshields and air data probes. A vibrating ice detector is standard equipment.

With the exception of the incandescent wing inspection light and the four HID landing/taxi lights, all lights on the aircraft are LEDs. These illuminate the baggage compartment and SPPR bay, the optional air-stair tread lights, cabin and cockpit lights.

Flying the Phenom 300

Eduardo Menini, a senior test pilot with Embraer, walked us around EMB 505-101, the first production-conforming aircraft to enter the flight test program, during the preflight inspection. He pointed out some of the Phenom 300's high-utilization and operator-friendly design features.

Basic maintenance intervals, for instance, are 12 months or 600 flight hours. The aircraft's MSG 3 maintenance-friendly design makes it possible to replace windshields in two hours. The third-generation L-3 SmartProbes eliminate tubes and pipes between probes and ADC boxes. All antennas and other external sensors, including the SmartProbes, can be changed from outside the airplane. Gel gaskets eliminate the need to use liquid sealants that must cure before flight.

All flight control cables and linkages are designed so that they cannot be reversed during installation. The front and rear batteries slide out on trays for easy access and replacement. The aircraft uses only one type of grease. The fuel boost pumps have brushless motors for long life and they are mounted in dry canisters so they may be changed without defueling the aircraft. The winglets are mounted with screws, making them easy to remove and replace.

All main electronic and avionics components, including the engine FADECs, are located inside the pressure vessel where they are protected from pressure and temperature extremes. A central maintenance computer (CMC) simplifies fault identification. The CMC can even check autopilot servo torque, thereby eliminating the need to remove



The Phenom 300 is designed for easy access to systems and high-frequency utilization, similar to Embraer's jetliners. The design expedites the crew's preflight inspections.

them for bench tests.

Most line service tasks are easy. If needed, the oxygen bottle may be refilled through a port in the nose baggage compartment. The single-point pressure refueling panel has a utility light for nighttime operations and it has a selectable refill quantity feature. Engine oil quantity can be checked with sight glasses visible through doors in the nacelles. The toilet is externally serviced. The baggage compartment has a large, counter-balanced swing-up door and the sill is waist high for easy loading.

Menini, though, didn't show us how to install and remove the landing gear pins without getting dirty. The gear must be

pinned if the aircraft is towed and unpinned prior to flight. One must go on hands and knees to get access to the pins in the main landing gear wheel wells. The nose gear pin is mounted high in its wheel well, so it's almost necessary to lie down on the ramp to reach it.

In addition, while the toilet is externally serviced, fresh water reservoirs in the galley and lavatory must be replenished internally. Those systems weren't installed in the flight test aircraft we flew, so we could not assess the associated workload issues.

Still, because of all the flight test equipment and a ballast tank, 505-001

Pratt & Whitney Canada PW535E Turbofans



The Phenom 300 is fitted with two 3,360-pound-thrust, FADEC-equipped PW535E engines that provide competitive takeoff field performance and the capability to climb directly to FL 450 at MTOW. The engine is a close relative of the PW535 fitted to the Citation Encore/Encore+, so it has been well proven in line service.

The low-pressure section of the engine features a single-piece, wide-chord, swept-blade fan with a single-stage low-pressure booster powered by two turbine stages. The high-pressure section includes two axial flow and one centrifugal flow compressor stages, a compact reverse flow combustor and a single-stage high-pressure turbine. A deep-fluted mixer nozzle combines bypass and core exhaust gases to reduce the noise signature and improve high-altitude thrust output.

had an empty weight of 11,900 pounds, or about 450 pounds heavier than a completed production aircraft with standard equipment.

With my strapping into the left seat and Menini in the right, flight test engineer Leandro Bigarella at the console and Daniel Bachman at the videocam, the aircraft's zero fuel weight was 13,000

pounds, including forward water ballast to keep it in the c.g. envelope. Loaded with 4,400 pounds of fuel, ramp weight was 17,400 pounds.

Bigarella computed takeoff V speeds for Flaps 1 (eight degrees) and a 17,300-pound takeoff weight or 96 percent of MTOW. He called out 107 KIAS for the V_1 decision speed, 110 KIAS for rotation and 120 KIAS

for the V_2 OEI takeoff safety speed, based upon São José dos Campos' 2,119-foot field elevation, 29.94 inch Hg barometer setting and 20°C OAT. Computed takeoff distance was 3,050 feet. Estimated OEI takeoff field length over a 35-foot obstacle was not available.

We plugged in ground power to save the batteries and to allow all the onboard test equipment to warm up before engine start. During cold weather operations, the batteries must be warmed to at least 0°C before engine start, even if external power is available. This assures adequate battery performance to meet the 45-minute emergency power requirement.

Menini pointed out that the aircraft's automated electrical system requires only one button push to connect external power. All other system switches can be left in the "on" or "automatic" positions.

After electrical power is turned on, pre-start checks are quick, consisting of fire protection, baggage compartment smoke detector, annunciator light, stall protection and ice protection checks performed with a rotary test switch. Embraer also requires that the crew manually set in OAT as a reference for the FADECs, a procedure that dates back to the EMB-145. This provides a backup reference for the FADEC's temperature sensor in the engine inlet. We also checked individual battery voltages to assure ample power reserves.

Once the cabin door was closed, we turned first the right, then the left, engine operating switch from Off to Run to Start. The vapor-cycle air conditioner automatically turned off during start to conserve electrical power. The FADECs handled all the starting tasks as we monitored the engine and systems indications on the MFD.

After engine start, the air-conditioning automatically came online and we disconnected external power. We checked battery reserve power, free control movement and proper takeoff trim and flap setting. We verified that the FMS had programmed in the landing field elevation of São José dos Campos for proper cabin depressurization upon our return and set Flaps 1, verifying the flap movement on the MFD.

Getting the aircraft to roll out of the chocks required very little thrust increase. Wheel brake action was smooth with the cold carbon brakes, but the aircraft required heavy pedal pressure, typical for Embraer aircraft. Nosewheel steering authority through the rudder pedals was adequate for most taxi maneuvering, but differential braking and thrust was required for tight maneuvering. Since the aircraft doesn't have a tight turning radius, care must be

Prodigy Cockpit

The Phenom 300's flight deck continues Embraer's philosophy of reducing workload by automating systems and slashing the size of checklists. Much the same as does the Phenom 100, the Phenom 300 reflects Embraer's experience in designing airliners for a broad range of pilot experience levels.

Less is more in this cockpit. Dedicated controls are installed for frequently operated systems, such as engines and airframe systems. Occasionally operated systems, such as weather radar and TCAS, have software-driven interfaces accessible through the MFD.

There is minimal need to touch switches, knobs and buttons. Systems switches may be left in the automatic positions, knobs are positioned to 12 o'clock and most annunciator light buttons are dark for normal operations.

The Garmin G1000 provides the foundation for the Phenom 300's Prodigy avionics system. Similar to the Phenom 100, the Phenom 300 has three identical 12.4-inch LCD screens for easy reversion capabilities and simplified spares support.

Embraer's choice of display colors is highly intuitive and consistent. No digital finger paint here. Color only is used as necessary to convey information effectively. Magenta signifies FMS- and computer-driven data, green is used for active modes and short-range nav, white denotes standby or pre-selected mode, yellow means the data are coming from cross cockpit and cyan is for manually entered data.

Standard equipment includes dual AHRS, dual L-3 SmartProbe solid-state pitot/static/angle-of-attack sensors, dual VHF comm and nav radios, dual WAAS GPS, dual marker beacons, dual audio control panels and a full-featured FMS, having airways, multiple-waypoint VNAV, complete ARINC 424 procedure guidance and automatic FMS to ILS switching.

The system also includes cruise speed control, an XM radio weather receiver, Garmin GWX 68 weather radar, Mode S transponder with TIS-B function, TAWS-B, CVR, three-axis autopilot and Thales integrated standby instrument system.

Factory standard options include a second Garmin Mode S transponder, ADF radio, Synthetic Vision System for the PFDs, ACSS TCAS II, Honeywell DME, L-3 FDR, Honeywell HF with SELCAL, radio altimeter, ELT, TAWS-A, Iridium satcom and electronic Jeppesen charts.



taken when taxiing on crowded ramps.

We also checked the emergency brakes. Pulling up partially on the parking brake T handle actuates the emergency brakes smoothly and progressively through a secondary hydraulic circuit, but no differential braking or anti-skid is available.

Prior to takeoff, Menini pressed the takeoff configuration check button and we heard the integrated Prodigy avionics system say, "Takeoff OK," verifying that flaps, spoilers, pitch trim and parking brake were in the proper position for departure. Having 10,200 feet of pavement available on Runway 15, we were not concerned by accelerate-stop distance. Using the Flaps 1 configuration results in lower drag than Flaps 2, thereby improving second-segment OEI climb performance.

On the runway centerline, we pushed up the throttles to the takeoff and go-around (TOGA) position, the third detent in the quadrant. There's also a maximum thrust position, forward of the TOGA detent, but how much extra thrust it will command, and under what conditions, has yet to be determined.

Acceleration was smooth, but not sporty. Rotation forces were moderate, if not hefty, another trait of Embraer jets. We rotated to 12 degrees nose up and retracted the gear with a positive rate of climb. In the process, we had to increase pitch attitude to 25 degrees to prevent exceeding the 140 KIAS V_{LO} limit speed imposed on the test aircraft. Production aircraft will have more-robust landing gear doors and thus a considerably higher landing gear operating speed.

At 400 feet agl, we accelerated to 136 KIAS and retracted the flaps. We continued the climb, leveling off at 5,000 feet for air traffic control while we exited the local traffic area to the northeast. We noted that while the aircraft has a heavy stick force per g, it's not particularly sensitive in pitch to speed or configuration changes. Pitch and roll control forces were moderate, well harmonized and more in line with what we'd expect from a midsize jet than a light jet.

Winter storm clouds created a choppy ride up to 10,000 feet, but the flexible wing structure seemed to soak up most of the bumps. At that point, we noted an anomaly in the weather radar display. Garmin has yet to develop the capability of overlaying the flight plan route on the onboard radar display. That makes it difficult to determine if the programmed flight plan track will steer clear of storm clouds. However, the flight plan track is displayed together with XM radio weather graphics, if one is operating in the continental U.S. coverage area.



Embraer

Climb performance is impressive. The aircraft can depart at MTOW, climb directly to FL 450 and then cruise at 370-plus KTAS while burning 840 pph.

When stabilized at 10,000 feet, we recorded a weight of 16,975 pounds, started the clock and began a direct climb to FL 450. Menini said best climb performance would be obtained using a 225 KIAS/0.60 IMN climb schedule.

During the climb we checked roll control response, noting heavy control forces at maximum yoke deflection, but achieving 60-degree-per-second roll response, according to Bigarella's instruments. The effect of the roll spoilers on roll rate and roll control effort seemed negligible.

Later, we checked short-period stability, noting that the aircraft is well damped. We also noted that the current version of SmartProbe software has very little dampening, thus the VSI readout often jumped ± 50 feet with no change in aircraft attitude or speed.

Eight- to 10-degree warmer-than-standard outside air temperatures during

most of the climb didn't help climb performance. OAT didn't cool off to ISA until we crossed FL 400. But OAT dropped to ISA-6.5°C by the time we leveled at FL 450, stopping the clock at 22 minutes and recording a 550-pound fuel burn for the climb.

We accelerated to 0.66 Mach long-range cruise at FL 450. We attempted to use the aircraft's cruise speed control (CSC) function, a feature that provides limited authority thrust adjustment, with the trim range of the FADECs, when altitude hold is engaged. But CSC wouldn't hold speed without uncoupling, so it appeared to need more development work before it's ready for service.

Once stable, we recorded 372 KTAS while burning 840 pph at a weight of 16,340 pounds (91 percent of MTOW) in ISA-6.5°C conditions. We also noted that the aircraft's pitch trim seemed a touch



Embraer

Phenom 300's climb performance is impressive. The aircraft can depart at MTOW, climb directly to FL 450 and then cruise at 370-plus KTAS while burning 840 pph.



Embraer

Capt. Menini demonstrated the operation of the counter-sprung airstair door.

sensitive, providing plenty of pitch trim change with very little movement of the trim switch.

We then evaluated high-speed buffet margins. We rolled into an increasing angle of bank, holding altitude. Flight test restrictions limited us to using a maximum 45-degree angle of bank. But we still recorded 1.5 g of load at 16,200 pounds with no evidence of buffet.

We also checked spiral stability. When we rolled into bank angles up to 30 degrees, the aircraft gradually returned to wings level. At bank angles greater than 30 degrees, the aircraft slowly would roll off.

Long-period pitch (phugoid) stability proved to be a strong point for the aircraft. We trimmed for cruise at 180 KIAS at FL 435, pulled up until the speed decreased to 156 KIAS and let go of the yoke. After five up-and-down cycles, averaging 74-second periods, aerodynamic damping almost had eliminated the porpoising.

The Phenom 300 also exhibits strong Dutch roll damping, a product of its having primary and secondary rudder dual yaw dampers. While the primary rudder yaw damper can be shut off, the secondary dorsal fin rudder is activated automatically anytime the primary yaw damper is inoperative and it cannot be shut off.

After our checks at high altitude, we descended to FL 300 for a high-speed cruise check. On the way down, we evaluated the performance of the two-position air brakes. When extended, the air brakes produce moderate buffet and mild pitch-up. Retracting them produces the opposite effect. A software interlock prevents air brake extension with the flaps extended.

Setting the throttles at max cruise at FL

300, the aircraft stabilized at 448 KTAS at a weight of 16,000 pounds (89 percent of MTOW) while burning 1,586 pph in ISA+6.5°C conditions. The final static source error correction curves have yet to be programmed into the SmartProbes, so the aircraft actually was cruising at 453 KTAS, according to the onboard flight test instrumentation. Book cruise performance predicted 451 KTAS under those conditions, Bigarella said. Both numbers back up Embraer's claim that the aircraft will cruise at 450 KTAS at 90 percent of MTOW.

Descending to 15,000 feet, we put the aircraft through some basic air work maneuvers. A couple of near 60-degree bank angle turns revealed that the aircraft had the heavy stick force per g pitch control feel that's characteristic of most Embraer aircraft with conventional flight controls.

Make a note: Trim into the turn or be prepared to use both hands on the yoke for your checkride.

Stall behavior was docile and predictable. At a weight of 15,870 pounds, we trimmed the aircraft to 122 KIAS in the clean configuration, equivalent to 1.3 V_{SI}. The stick pusher fired at 90 KIAS (94 KCAS) or 24.4 degrees AOA. Repeating the maneuver at a weight of 15,760 pounds with gear and flaps down, we trimmed to 111 KIAS or 1.3 V_{SO}. Descending 500 feet and leveling off, the stick pusher fired at 82 KIAS (86 KCAS) or 22.7 degrees AOA. There was no tendency to roll off or yaw in either configuration during the maneuvers, but altitude loss was considerable because of the stick pusher. These are not conditions one would want to encounter at pattern altitudes.

Returning to São José dos Campos for

pattern work, we coupled the autopilot and let the Prodigy system fly an FMS to ILS approach to Runway 15. Lateral and vertical navigation were very smooth throughout the procedure, with the multiple waypoint VNAV feature reducing much of the workload. However, both vertical and lateral navigation modes seemed a little soft in response, favoring smoothness over precision guidance.

Once the aircraft eventually stabilized on the 155-degree magnetic inbound course, a change in HSI course deviation needle from magenta to green signified the transition from FMS to ILS guidance. We clicked off the autopilot to get a feel for the aircraft during the approach. We again observed that the aircraft seemed to have somewhat overly sensitive pitch trim, yet was comparatively numb in speed stability. Thus, airspeed excursions of 10 knots or more didn't result in much pitch force change.

Extending the landing gear and flaps produced very little pitch change. We bugged 110 KIAS for V_{REF} for the Flaps 3 (26 degrees) configuration at a weight of 15,500 pounds. Final flight tests evaluating the use of full flaps on landing performance were not yet complete, so we couldn't use that configuration.

Over the threshold, we reduced power to idle and started to let the aircraft decelerate for the landing touchdown. In retrospect, we should have chopped the power sooner. The aircraft had excess airspeed in the flare, resulting in a long float to touchdown.

Menini reconfigured the aircraft to Flaps 1 (eight degrees) and set the pitch trim into the takeoff position. We followed through with a touch-and-go, turning left downwind into the VFR pattern. This was followed by a normal touch-and-go.

The next pattern was designed to evaluate the aircraft's OEI performance, especially its balked landing performance characteristics. Menini pulled back the right throttle on downwind, we simulated calling for the engine failure check and configured the aircraft for a simulated single-engine landing. Again we used Flaps 3 (26 degrees), but flew the approach at V_{REF}+10. There were ample power reserves on approach.

When we neared 200 feet agl, we executed a balked landing. As we advanced the thrust lever to TOGA, Bigarella recorded a maximum 110 pounds of pedal force, indicating that the spring-loaded rudder boost system was helping to reduce pedal effort. As we rotated, we moved the flap lever to Flaps 2 and retracted the gear with a positive rate of climb. Changing



Embraer

The Phenom 300 features brake-by-wire with high-capacity carbon heat packs. Pedal pressure, similar the Embraer's jetliners, is heavy but braking action is very smooth.

to the Flaps 2 position, though, strictly was a procedural step. It didn't change flap deflection from 26 degrees, so the aircraft climbed very poorly until we moved the lever to the Flaps 1 (eight degrees) position. We concluded that most pilots will want to use Flaps 1 for routine takeoffs because of better OEI climb performance. Flaps 2 will be better suited to light takeoff weights and very short runway operations.

Once we climbed to flap retraction altitude, we cleaned up the aircraft and we matched the throttle positions in preparation for a normal landing, which followed. We then taxied back to Runway 15 in preparation for a simulated OEI takeoff. At a weight of 15,200 pounds and based upon using Flaps 1, Bigarella computed V speeds of 98 KIAS for V_L , 103 KIAS for rotation, 115 KIAS for V_2 and 127 KIAS for flap retraction.

Menini pulled back the right throttle at 93 KIAS, resulting in noticeable yaw as the aircraft reached V_L . We countered with opposite rudder to maintain directional control. Bigarella recorded a rudder force of 100 pounds.

We initially rotated to 12 degrees and retracted the landing gear with a positive rate of climb. At this comparatively mid weight, the aircraft had strong OEI climb performance. We climbed to flap retraction altitude, cleaned up the aircraft and returned for a normal, albeit maximum effort landing.

Based upon a 15,000-pound landing weight and using Flaps 2, Bigarella computed a 110 KIAS V_{REF} speed. Rolling to final, we delayed reducing thrust until reaching the threshold. Again, this resulted in excess airspeed in the flare and delayed touchdown. The aircraft

decelerated smartly, with little tendency to engage the anti-skid function above 60 knots. The maneuver reminded us that Embraer aircraft require comparatively heavy pedal force to achieve maximum braking performance.

After the maximum effort landing, the carbon brakes were quite warm and they exhibited some jerkiness as we taxied back to Embraer's delivery center. Menini said that was expected and that braking action is smooth when they are cool. Total fuel burn for the two-hour, 24-minute mission was 2,500 pounds.

Final Steps Toward Certification and Entry Into Service

Embraer now has four production-conforming aircraft in the flight test program, racing toward final Brazilian ANAC and FAA type certification late this year. All flight test data collected up to September 2009 indicate that the aircraft will meet or beat Embraer's projections. Speed, range and sea-level runway performance numbers are on target. Hot-and-high takeoff performance appears to exceed the original estimates by a wide margin.

Embraer has been working closely with training services partner CAE to develop an FAR Part 142 training system. The first full-flight simulators will be installed at CAE locations in Dallas and Burgess Hill, United Kingdom this year. CAE and Embraer plan to open a second U.S. training center in Florida or the Northeast United States in 2010. But it's not clear if the simulator will earn full FAA approval by the end of this year. Much the same as with the Phenom 100, the first Phenom 300 operators may have to train their pilots

in their aircraft until the simulators are certified.

Officials concede that the Phenom 300 development program is about two weeks behind schedule, but are confident they will earn TC and start initial customer deliveries in the fourth quarter of the year.

That's good news for Phenom 300 customers, including Flight Options, which has ordered 100, Executive Airshare with four orders and four options, Falcon Aviation Services of Abu Dhabi with six orders and four options, Eagle Creek Aviation Services with four positions and Dusseldorf-based Vibroair with two orders. Embraer won't release the total number of orders it has for the aircraft, but the large block from fractional operator Flight Options could be spread out over several years because of softness in the business jet market.

Long term, though, the Phenom 300 should be a strong contender in the light jet market because of its price, cabin, performance and fuel efficiency, plus its airliner-inspired, maintenance-friendly design. In addition, Embraer's after-market product support is earning high marks from Phenom 100 and Legacy 600 customers, so that reputation should help bolster Phenom 300 sales. Two levels of Embraer Executive Care will be offered, with the standard service providing just parts and freight and the enhanced service providing parts, freight, both scheduled and unscheduled labor, and emergency field service. Pratt & Whitney Canada will offer its Eagle Service Plan power-by-the-hour program to cover the engines.

Quite clearly, Embraer is making a major investment in the business aircraft market, making bold moves to unseat long established firms such as Bombardier, Cessna and Hawker Beechcraft from their positions of dominance. The design of the Phenom 300 demonstrates Embraer's engineering muscle. The Phenom 300's airliner toughness and 28,000-hour design life also could make some other light jets seem like spoiled prom queens in comparison. And should something break, Embraer's growing commitment to product support is second to none. That all bodes well for the Phenom 300.

The business jet industry, particularly the light jet sector, is forecast to rebound slowly as the economy recovers. And with its Phenoms and other executive aircraft models, in production or in development, Embraer is becoming well positioned to seize a significant share of this sector over the next several years. ■