

ARCHIVED REPORT

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Embraer ERJ 135/140/145

Outlook

- Except for the Legacy 600/650 business jets, no further production of ERJ 145 series aircraft is forecast
- Future demand could be met by used aircraft

Orientation

Description. Short-range, twin-turbofan-powered regional transport aircraft.

Sponsor. The ERJ 135, ERJ 140, and ERJ 145 are sponsored privately by Embraer.

Status. Production ended in 2013.

Total Produced. Through 2013, one ERJ 145 prototype, three pre-series production ERJ 145s, and 730 production ERJ 145s were produced. In addition, two ERJ 135 prototypes (both converted from existing ERJ 145s) and 121 production ERJ 135s were built. One ERJ 140 prototype (converted from one of the

ERJ 135 prototypes) and 74 production ERJ 140s were also built.

These totals do not include Embraer's Legacy 600 and Legacy 650 business jets, which are derivatives of the ERJ 135. The 600 and 650 are covered in a separate Forecast International report titled "Embraer Legacy 600/650."

Application. Short-range scheduled and non-scheduled regional passenger transportation.

Price Range. ERJ 145, \$19.6-\$26.5 million in 2009 U.S. dollars.



ERJ 145

Source: Embraer

Embraer ERJ 135/140/145

Contractors

Prime

Embraer - Empresa Brasileira de Aeronáutica SA	http://www.embraer.com , Av Brigadeiro Faria Lima, 2170, São José dos Campos, 12227-901 São Paulo, Brazil, Tel: + 55 12 3927 1000, Fax: + 55 12 3927 6600, Prime
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Subcontractor

Hispano-Suiza	http://www.hispano-suiza-sa.com , 18, Blvd Louis-Seguín, Colombes, 92707 France, Tel: + 33 1 41 30 50 10, Fax: + 33 1 41 30 54 12 (Composite Fan Duct)
Liebherr-Aerospace Toulouse SAS	http://www.liebherr.com , 408, Ave des Etats-Unis, Toulouse, 31016 France, Tel: + 33 5 61 35 28 28, Fax: + 33 5 61 35 28 00 (Pressurization System)
Parker Aerospace Stratoflex Products Division	http://www.parker.com , 700 4th St, Mansfield, TX 76063 United States, Email: spdmarketing@parker.com (Hydraulic Hose)
Parker Hannifin Corp	http://www.parker.com , 6035 Parkland Blvd, Cleveland, OH 44124-4141 United States, Tel: + 1 (216) 896-3000, Fax: + 1 (216) 896-4000 (Flight Controls; Hydraulic Components; Fuel System; Steering System)
Rolls-Royce Corp	http://www.rolls-royce.com/northamerica/na/ , PO Box 420, 2001 S Tibbs Ave, Indianapolis, IN 46206-0420 United States, Tel: + 1 (317) 230-2000, Fax: + 1 (317) 230-4020 (AE 3007 Turbofan Engine)
Sierracin Corp	http://www.sierracin.com , 12780 San Fernando Rd, Sylmar, CA 91342-3796 United States, Tel: + 1 (818) 362-6711, Fax: + 1 (818) 362-0603 (Heated Windshield; Laminated Side Panel)
Technofan	http://www.technofan.com , 10 place Marcel Dassault, ZAC du Grand-Noble - BP 30053, Blagnac, 31702 France, Tel: + 33 61 30 92 00, Fax: + 33 61 30 02 04 (Ventilation System)
UTC Aerospace Systems	http://utcaerospace.com , One Hamilton Rd, Windsor Locks, CT 06095 United States, Tel: + 1 (860) 654-6000, Fax: + 1 (860) 654-2621 (Air Conditioning)
Woodward HRT	http://woodwardhrt.woodward.com , 25200 W Rye Canyon Rd, Santa Clarita, CA 91355 United States, Tel: + 1 (661) 294-6000 (Aileron Damper Components)

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Technical Data

(ERJ 145LR)

Design Features. Cantilever low-swept-wing monoplane with fuselage-mounted high-bypass-ratio turbofan engines. Semi-monocoque fuselage with swept T-tail. Tricycle type landing gear. A design review conducted in 1991 resulted in a clean, three-section wing with ground and flight spoilers, no leading edge control surfaces, and no winglets. The wing aspect ratio was set at 7.86. The wing is swept 22.7 degrees at 25 percent mean aerodynamic chord. The wing leading edge is metallic. The main landing gear are twin-wheeled and retract inward. The nose gear is twin-wheeled and retracts forward.

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	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Overall length	29.87 m	98.0 ft
Height	6.76 m	22.17 ft
Wingspan	20.04 m	65.75 ft
Cabin width	2.10 m	6.91 ft
Cabin height	1.83 m	6.00 ft
Weight		
Basic operating weight	12,114 kg	26,706 lb
Maximum takeoff weight	22,000 kg	48,501 lb
Maximum landing weight	19,300 kg	42,549 lb
Maximum payload	5,786 kg	12,755 lb
Performance		
Maximum cruise speed	Mach 0.78	Mach 0.78
Takeoff field length (SL, ISA, MTOW)	2,270 m	7,448 ft
Range (SL, ISA, MLW)	2,873 km	1,550 nm

Propulsion

ERJ 145LR (2) Rolls-Royce AE 3007A1 turbofan engines rated 33.0 kN (7,426 lbst) each, or
(2) Rolls-Royce AE 3007A1P turbofan engines rated 33.0 kN (7,426 lbst) each.

Seating

Standard 50-seat, three-abreast configuration with 31-inch seat pitch. Crew of two or three.

Variants/Upgrades

ERJ 145LR. The ERJ 145LR is a long-range version of the ERJ 145, and features a range of 2,873 kilometers (1,550 nm). Maximum takeoff weight is 22,000 kilograms (48,501 lb). The ERJ 145LR has 20 percent greater fuel capacity.

ERJ 145LR customers had a choice of powering their aircraft with either the AE 3007A1 or the AE 3007A1P, which are uprated versions of the Rolls-Royce AE 3007 engine. The A1 was optional on the baseline ERJ 145ER.

ERJ 145MP. The ERJ 145MP became available in 1999. It combined various features of the ERJ 145LR and the ERJ 145ER. Maximum takeoff weight is 20,990 kilograms (46,275 lb). Range is the same as that of the ER model (1,060 nm with 50 passengers).

ERJ 145 XR. In July 2000, Embraer launched a new, extra-long-range version of the ERJ 145 called the ERJ 145 XR. The launch customer was Continental Express (now known as ExpressJet Airlines), which ordered 75 of the new version. In addition, Continental Express took options for 100 additional aircraft in the ERJ 135/145 series.

The ERJ 145 XR has 7,950-lbst AE 3007A1E engines, winglets, a reinforced fuselage, and increased fuel capacity. The initial flight of the ERJ 145 XR

prototype, which was modified from one of the pre-series ERJ 145s, took place in June 2001. The first flight of the initial production ERJ 145 XR occurred in April 2002. Certification by the Brazilian CTA was granted in September 2002, and was followed by U.S. FAA certification in November 2002. Deliveries began in November 2002, to ExpressJet.

The XR has a range of 3,706 kilometers (2,000 nm). It provides improved hot-and-high operation capabilities, a higher single-engine ceiling, and reduced specific fuel consumption.

ERJ 135. In September 1997, Embraer launched a 37-passenger version of the ERJ 145 called the ERJ 135. The ERJ 135 had over 95 percent commonality with the ERJ 145. The wing was identical. The fuselage was 3.6 meters (11.7 ft) shorter. Maximum landing weight was 18,500 kilograms (40,785 lb). Maximum takeoff weight was 19,000 kilograms (41,887 lb). Range was 2,409 kilometers (1,300 nm). Customers had a choice of two engines, either the 7,075-lbst AE 3007A3 or the 7,705-lbst AE 3007A1/3.

The first prototype, which was converted from the ERJ 145 prototype, made its initial flight in July 1998. A second prototype, converted from one of the ERJ 145

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pre-series aircraft, made its first flight in September 1998. U.S. FAA certification was awarded in July 1999. Initial delivery, to launch customer Continental Express, occurred later that month.

A long-range version of the ERJ 135 was called the ERJ 135LR. It had a range of 3,243 kilometers (1,750 nm). Maximum takeoff weight of this version was 20,000 kilograms (44,092 lb). The LR model was powered by Rolls-Royce AE 3007A1/3 engines.

ERJ 140. In September 1999, Embraer launched a 44-passenger jet called the ERJ 140. It was a 2.3-meter (7.5-ft) stretch of the ERJ 135. The aircraft had 98 percent commonality of structure, parts, and systems with the ERJ 135/145. Maximum takeoff weight was

20,100 kilograms (44,312 lb). The engines are 7,705-lb AE 3007A1/3 turbofans. Range is 2,317 kilometers (1,250 nm).

A long-range version of the ERJ 140 was also developed. Range was 3,058 kilometers (1,650 nm).

First flight of the ERJ 140 prototype, which was converted from one of the ERJ 135 prototypes, occurred in June 2000. In mid-2001, FAA certification was granted and initial deliveries were made.

In September 2000, American Eagle became the launch customer for the ERJ 140, ordering 130 of the aircraft. The carrier later ordered nine additional ERJ 140s. However, in 2003, American Eagle converted 80 of its ERJ 140 orders into orders for ERJ 145s.

Program Review

Background. Embraer launched the 50-passenger ERJ 145 regional jet (then called the EMB 145) at the 1989 Paris Air Show.

Original Design Specifications. To reduce EMB 145 development costs, Embraer had intended to maintain about 75 percent component commonality with the EMB 120 Brasilia, though with several significant modifications. High-bypass turbofan engines were mounted in the same location as the EMB 120's turboprops, but above the EMB 120-derived wing. This was done to avoid a lengthening of the landing gear. Various modifications were incorporated in the wing. In addition, fuselage plugs of 3.35 meters (11.0 ft) fore and aft of the wing were added.

Design Changes

In late 1990, Embraer conducted wind tunnel tests of a scale-model EMB 145 at Boeing facilities. Results showed that higher-than-expected drag caused a reduction in range, and the manufacturer subsequently redesigned the wing and powerplant installations. In a further redesign a few months later, the Allison (now Rolls-Royce) engines were repositioned on the aft fuselage. At the 1992 Farnborough Air Show, Embraer announced that recently completed transonic wind tunnel tests, once again conducted at Boeing's facilities, had confirmed that the performance, stability, and control characteristics of the reworked design met or exceeded design specifications.

In October 1993, Embraer announced that it had produced the first dedicated ERJ 145 part, a nose landing gear attachment fitting, for use on the prototype aircraft. The company had begun cutting metal for the program the previous June and initially concentrated on manufacturing ERJ 145 parts that were common to the Brasilia and the CBA-123. In late 1993, wind tunnel

testing revealed significant improvements in the runway performance of the ERJ 145.

In early 1994, Embraer announced the initial order for the ERJ 145. Australian carrier Flight West Airlines placed an order for two ERJ 145s, plus options for an additional two.

The initial flight of the ERJ 145 prototype occurred in August 1995. Certification by the Brazilian CTA was granted in November 1996, followed by FAA certification in December 1996. Later that month, the initial production ERJ 145 was delivered to U.S. carrier Continental Express.

ER Variant Announced

Extended-Range Version. In 1993, Embraer announced the development of an extended-range (ER) variant. This version was called the EMB 145ER. With 50 passengers, it has a range of 1,963 kilometers (1,060 nm). Its maximum takeoff weight is 20,600 kilograms (45,414 lb).

The extended-range version was eventually regarded as the baseline version of the ERJ 145.

Joint Venture

In December 2002, Embraer signed an agreement to build a production unit in the People's Republic of China (PRC) through a joint venture with Harbin Aircraft Industry Group and Hafei Aviation Industry Company, both of which are subsidiaries of Aviation Industry Corp of China (AVIC).

The joint venture company, called Harbin Embraer Aircraft Industry Company Ltd, is located in Harbin, the capital of Heilongjiang Province in the PRC. Embraer owns 51 percent of the company.

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Originally, Harbin Embraer built ERJ 145s. The initial ERJ 145 built by Harbin Embraer was rolled out, and made its first flight, in December 2003. At that time, the company did not have a launch order. This changed in February 2004 when China Southern Airlines ordered six ERJ 145s.

By the summer of 2006, Harbin Embraer was struggling and was facing the possibility of closure of the assembly line. By August, it had delivered only 11 ERJ 145s: six to China Southern Airlines and five to China Eastern Airlines Jianguo. Its backlog consisted of five ERJ 145s

for China Eastern Airlines Wuhan, which were scheduled to be delivered by June 2007.

In August 2006, however, Hainan Airline Company Ltd ordered 50 Harbin Embraer ERJ 145s (and 50 Embraer 190s). Deliveries of the ERJ 145s began in September 2007. Hainan later reduced its ERJ 145 order to 25 aircraft, the last of which was delivered in April 2011.

In June 2012, Embraer signed an agreement with AVIC to transition the Harbin Embraer line to the Legacy 600 and Legacy 650 business jets.

Funding

Embraer estimated the development cost of the ERJ 145 at \$300 million, including construction of one prototype and three pre-series aircraft. Approximately \$100 million was underwritten by ERJ 145 program partners.

Embraer estimated the ERJ 135 development cost at \$100 million. This cost was to be covered by Embraer resources, risk-sharing suppliers, and industrial development institutions such as the Brazilian BNDES social and economic development bank.

Embraer estimated the development cost of the ERJ 140 at \$45 million.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Jun	1989	EMB 145 regional jet launched
Dec	1989	Allison AE 3007 engine selected
Late	1990	EMB 145 development temporarily suspended
Mar	1991	Completion of first major redesign
Late	1991	Second major redesign
Aug	1995	First flight of prototype
Nov	1995	First flight of initial pre-series aircraft
Feb	1996	First flight of second pre-series aircraft
Apr	1996	First flight of third pre-series aircraft
Nov	1996	Brazilian CTA certification
Dec	1996	U.S. FAA certification; initial delivery
Sep	1997	Embraer launches ERJ 135
Jul	1998	First flight of initial ERJ 135 prototype (a converted ERJ 145)
Sep	1998	First flight of second ERJ 135 prototype (a converted ERJ 145)
Jun	1999	Brazilian CTA certification of ERJ 135
Jul	1999	U.S. FAA certification of ERJ 135; initial delivery of ERJ 135
Jun	2000	First flight of ERJ 140 prototype (a converted ERJ 135)
Jun	2001	Brazilian CTA certification of ERJ 140
Jul	2001	U.S. FAA certification of ERJ 140; initial delivery of ERJ 140

Embraer ERJ 135/140/145

Worldwide Distribution/Inventories

(as of April 2014)

Operator	Designation	Quantity
Aero Dynamics Inc	ERJ 145	2
Aeromexico Connect (Aerolitoral)	ERJ 145	7
Aeromexico Connect (Aerolitoral)	ERJ 145ER	1
Aeromexico Connect (Aerolitoral)	ERJ 145LR	20
Air Caraibes	ERJ 145LR	1
Air Namibia	ERJ 135ER	4
Airlink Swaziland Ltd	ERJ 135LR	1
American Eagle Airlines	ERJ 135ER	1
American Eagle Airlines	ERJ 140	59
American Eagle Airlines	ERJ 145	6
American Eagle Airlines	ERJ 145LR	109
American Eagle Airlines	ERJ 145 XR	1
Athens Airways	ERJ 145	1
Belgium Air Component	ERJ 135	2
Belgium Air Component	ERJ 145	2
bmi regional	ERJ 135ER	4
bmi regional	ERJ 145	14
Brazil Air Force	EMB 145	8
Brazil Air Force	ERJ 145ER	7
Brazil Air Force	ERJ 145LR	1
Champion Air LLC	ERJ 145	1
Chautauqua Airlines	ERJ 135LR	1
Chautauqua Airlines	ERJ 140	15
Chautauqua Airlines	ERJ 145	3
Chautauqua Airlines	ERJ 145LR	54
China Eastern Airlines	ERJ 145	10
China Southern Airlines	ERJ 145	6
Colombia Air Force	ERJ 145ER	1
Colombia Air Force	ERJ 145LR	1
Conoco-Phillips Company	ERJ 135LR	1
Dniproavia	ERJ 145	7
Dniproavia	ERJ 145LR	4
Eastern Airways	ERJ 135ER	2
Eastern Airways	ERJ 145	2
Eastern Airways	ERJ 145LR	1

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Operator	Designation	Quantity
Equaflight	ERJ 135ER	1
Equaflight	ERJ 135LR	1
Equatorial Guinea Government	ERJ 145	1
Executive Jet Management Inc	ERJ 135ER	5
ExpressJet Airlines Inc	ERJ 135LR	8
ExpressJet Airlines Inc	ERJ 145ER	24
ExpressJet Airlines Inc	ERJ 145LR	113
ExpressJet Airlines Inc	ERJ 145 XR	104
Gestair Private Jets	ERJ 135	1
Greece Air Force	EMB 145 AEW&C	4
Greece Air Force	ERJ 135ER	1
Hainan Airlines	ERJ 145	2
Hebei Airlines	ERJ 145LR	5
HOP!	ERJ 135ER	2
HOP!	ERJ 145	19
IBC Airways	ERJ 145ER	2
India Air Force	EMB 145 AEW&C	2
LAM-Linhas Aereas de Mocambique	ERJ 145	1
LOT Polish Airlines-Polskie Linie Lotnicze	ERJ 145LR	1
Luxair	ERJ 135LR	1
Luxair	ERJ 145	2
Luxair	ERJ 145LR	4
Mexico Air Force	EMB 145	2
Mexico Air Force	EMB 145 AEW&C	1
National Airways Corp	ERJ 145	1
Pan Europeenne Air Service	ERJ 135LR	1
Pan Europeenne Air Service	ERJ 145LR	1
Passaredo Linhas Aereas	ERJ 145	4
Privilege Style	ERJ 145	1
Servicos Executivos Aereos de Angola (SEAA)	ERJ-135LR	1
Servicos Executivos Aereos de Angola (SEAA)	ERJ-145LR	1
SiAvia	ERJ 145	1
SiAvia	ERJ 145LR	1
Solenta Aviation Pty Ltd	ERJ 145	1
Solenta Aviation Pty Ltd	ERJ 145LR	2
South African Airlink Pty Ltd	ERJ 135ER	1
South African Airlink Pty Ltd	ERJ 135LR	9
South African Airlink Pty Ltd	ERJ 145	1
TAP Portugal	ERJ 145	7

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Operator	Designation	Quantity
TAP Portugal	ERJ 145LR	1
Thailand Army	ERJ 135	2
Thailand Navy	ERJ 135	2
Tianjin Airlines	ERJ 145	23
Trans States Airlines	ERJ 145	5
Trans States Airlines	ERJ 145ER	8
Trans States Airlines	ERJ 145LR	13

Forecast Rationale

Embraer is scheduled to deliver a third EMB 145 airborne early warning and control (AEW&C) aircraft for the Indian Air Force in 2014. Delivery of this aircraft, which has already been built, will fulfill a deal for three EMB 145 AEW&C aircraft for the service. The first two aircraft were delivered in 2012.

Production of the ERJ 145 as a commercial airliner ended in 2011. Market demand for 50-seat regional jets has evaporated, having been impacted by a combination of factors. These include scope clause relaxation, air traffic growth, and problematic operating economics. Residual demand for 50-seat jets will be filled by used aircraft.

Meanwhile, any future production of ERJ/EMB 145 airframes would likely be for specialized markets

outside the commercial airline sector. For instance, the Indian Air Force has indicated interest in acquiring four ERJ 145s for use as VIP transports. The Argentinean Air Force has displayed interest in acquiring an ERJ 145 for use in the airborne early warning role.

It should be noted that selection of the ERJ 145 for such military procurements would not necessarily mean a continuation of new ERJ 145 production. Used aircraft could be utilized instead. Over the next several years, airlines will be retiring hundreds of ERJ 145s, either for operating efficiency reasons or because they are being replaced by larger-capacity aircraft. Many of these ERJ 145s will become available on the used market.

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