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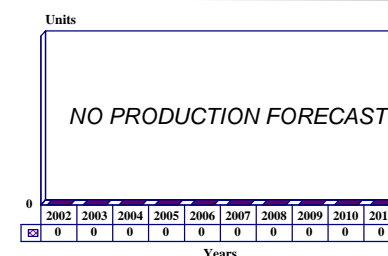
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Boeing MD-80/90 Series - Archived 5/2003

Outlook

- Boeing is marketing an MD-82 freighter conversion
- MD-90 production was completed in 2000
- MD-80 production ended 1999

10 Year Unit Production Forecast
2002 - 2011



Orientation

Description. Twin-engine, short/medium-range, narrowbody commercial transport aircraft family.

Sponsor. Privately sponsored by Boeing Company.

Contractors. Boeing Company; Long Beach, California, USA. The MD-80/90 series was developed and initially produced by McDonnell Douglas Corp which, in 1997, merged with Boeing.

Licensees. Shanghai Aviation Industrial Corp (SAIC), Shanghai Aircraft Manufacturing Factory; Shanghai, People's Republic of China (PRC).

Status. Production of the MD-80 series was completed in late 1999. Production of the MD-90 was completed in October 2000.

Total Produced. A total of 1,191 MD-80 series aircraft (including 30 MD-82 kits for China) was produced. In addition, a total of 117 MD-90s were produced, including the initial prototype.

Application. Short/medium-range, low/medium density, scheduled passenger transportation.

Price Range. MD-80 series, \$42.0 to \$49.0 million; MD-90, \$49.0 to \$56.5 million (both in 1999 US dollars).

Technical Data

(MD-81/82/83/87/88)

Design Features. Cantilever low-wing monoplane with a 24-degree, 30-minute leading edge sweep at quarter chord, employing fiberglass trailing edges, ailerons and flaps. Moving surfaces for each wing are a single manually controlled aileron, speed brakes, full span leading edge slat, double-slotted trailing edge flap, and

three spoilers (two outboard sections acting as flight and ground spoilers with inboard section for ground use only). The tail unit is a T-design with all-moving horizontal surfaces. Single rudder with trim tab. Tricycle-type retractable landing gear with twin wheels on each unit.

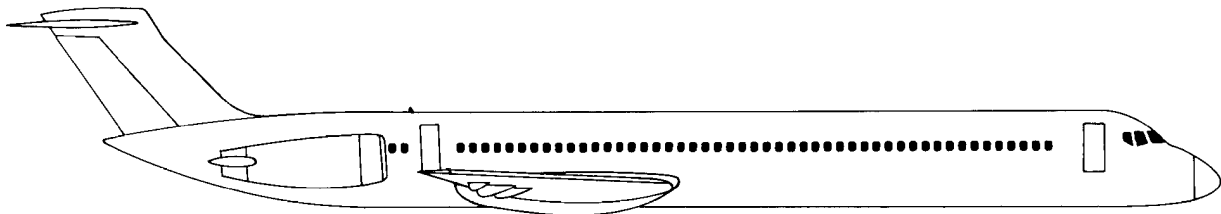
	<u>Metric</u>	<u>US</u>
Dimensions		
Length overall	45.05/45.05/45.05/39.70/45.05 m	147.83/147.83/147.83/130.50/147.83 ft
Height	9.02/9.02/9.02/9.30/9.02 m	29.60/29.60/29.60/30.50/29.60 ft
Wingspan	32.86 m	107.83 ft
Cabin ^(a)		
length	30.78 m	101.0 ft
max width	3.13 m	10.27 ft
Weight		
Operating weight empty	35,329/35,369/36,145/33,237/ 35,369 kg	77,888/77,976/79,686/73,274/ 77,976 lb
Max take-off weight	63,500/67,800/72,570/63,500/ 67,800 kg	140,000/149,500/160,000/140,000/ 149,500 lb
Capacities		
Max structural payload	18,194/19,969/19,193/17,566/ 19,969 kg	40,112/44,024/42,314/38,726/ 44,024 lb
Standard fuel	22,107/22,107/26,498/22,107/ 22,107 liters	5,840/5,840/7,000/5,840/ 5,840 US gal
Performance		
Maximum ranges, depending on variant	2,897-4,635 km	1,562-2,499 nm
Propulsion		
MD-81	(2)	UTC Pratt & Whitney JT8D-209 twin-spool, axial flow, medium bypass turbofan engines rated 85.6 kN (19,250 lbst) each.
MD-82	(2)	Pratt & Whitney JT8D-217/217A turbofans rated 92.75 kN (20,850 lbst) each.
MD-83	(2)	Pratt & Whitney JT8D-219 turbofans rated 96.5 kN (21,700 lbst) each.
MD-87	(2)	Pratt & Whitney JT8D-217C turbofans rated 92.75 kN (20,850 lbst) each. Other - 200 engines are optional.
MD-88	(2)	Pratt & Whitney JT8D-219 turbofans rated 96.5 kN (21,700 lbst) each.
MD-90-30	(2)	International Aero Engines V2525-D5 turbofans rated 111.2 kN (25,000 lbst) each.

Seating

MD-81/82/83/88 generally seat 137-172 passengers at five abreast. Typical mixed-class seating is 148 with single all-tourist seating for up to 172. MD-87 seats a maximum of 139 passengers. Additional MD-80 seating configurations are discussed in the **Variants/Upgrades** section below.

MD-90-30 seats 153 passengers in a mixed-class configuration.

^(a)Not including flight deck.



BOEING MD-83

Source: Forecast International



BOEING MD-80

Source: Boeing

Variants/Upgrades

MD-81. The first of the series, originally known as the DC-9 Super 80, is powered by a pair of JT8D-209s. It entered airline service in October 1980. The aircraft seats up to 172 passengers. As are all MD-80 series transports, the MD-81 is equipped and approved for two-pilot operation.

MD-82. Announced in April 1979, this was the hot/high version powered by JT8D-217 engines. The aircraft entered airline service in August 1981 at a certificated weight of 66,680 kilograms (147,000 lb). A second version, fitted with -217A powerplants and certificated at a higher maximum gross weight (67,800 kg/149,500 lb), became available in the fall of 1982. The MD-82T was the basic MD-82 fitted with a new CATIC-designed and -produced austere field landing gear. However, no MD-82Ts were ever produced.

MD-83. Launched in January 1983, this was the long-range (4,747 km/2,562 nm) version powered by JT8D-219 engines. Alaska Airlines received the first MD-83 in February 1985. Two 2,195 liter (580 US gal) fuel tanks were incorporated into the aircraft's cargo compartment; other modifications included a strengthened landing gear and some refinements to the

wing structure and skin. The higher thrust engines are 2 percent more fuel efficient than the -217As.

MD-87. Essentially a replacement for the DC-9-30, the MD-87 features a fuselage shortened by over 5 meters and seats 130-139 passengers. Power is provided by JT8D-217C engines, which provide 2 percent lower fuel consumption than -217A turbofans. The aircraft takes off at 63,500 kilograms. Following its first flight in 1986, the MD-87 entered airline service in November 1987.

MD-87-105. In 1991, Douglas proposed this shortened version of the existing MD-87 with a fuselage length some eight feet less than its predecessor, a maximum take-off weight of 118,200 pounds (versus 140,000 pounds for the MD-87), an operating empty weight of 70,300 pounds (versus 73,274 pounds for the MD-87), and 833 cubic feet of cargo volume. The aircraft was designed to carry up to 105 passengers in a single class to ranges of approximately 1,750 nautical miles. It was obviously being sized to pre-empt the next-generation of 80-130 passenger regional jets planned by various companies and partnerships. No MD-87-105s were ever produced.

MD-88. This is basically an MD-82 fitted with updated JT8D-219 engines, which also power the MD-83, and

incorporating more advanced avionics and cockpit instrumentation. Delta placed orders and options for 30 and 50, respectively, in January 1986 and took initial deliveries in late 1987.

MD-90-30. At 46.51 meters (152.6 ft), this 153-passenger aircraft is slightly longer than the MD-82. It possesses a range of 2,085 nautical miles (with 153 passengers and international reserves), has a maximum take-off weight of 70,760 kilograms (156,000 lb), and has an operating empty weight of 39,916 kilograms (88,000 lb). Fuel consumption is 12-18 percent better compared with the MD-82. Noise performance is outstanding at 20 decibels below the current Stage 3/Chapter III standard and 12 decibels lower than that of the Airbus A321-100. Delta launched the aircraft on firm orders and options of 50 and 110, respectively.

First flight was originally expected in 1992, with deliveries to begin a year later. However, changes in the MD series manufacturing and assembly processes caused schedule changes. Roll-out occurred on February 13, 1993, with first flight soon after. The aircraft was selected in 1992 for the People's Republic of China (PRC) Trunkliner program. The PRC version equipped with the CATIC-built austere field landing-gear system was known as the MD-90-30T; however, Chinese MD-90s were ultimately not equipped with the new landing gear.

An extended-range version of the -30 is called the MD-90-30ER. This version has a greater maximum take-off weight and increased range. Range with 153 passengers and international reserves is 2,172 nautical miles.

McDonnell Douglas had also proposed a number of other MD-90 versions. None of these ever entered production. They are as follows:

MD-90-10. One of three new MD-90 versions announced in November 1989, the MD-90-10 would have been the smallest of the three. It was to be powered by International Aero Engines V2500-D5 advanced technology turbofan engines. It was designed to seat 114 in a mixed-class configuration, had the same fuselage as the MD-87, and had the wing of the MD-83. Its vertical stabilizer, rudder, and engine pylons were modified to fit the new engines. The aircraft had an operating weight empty of 80,887 pounds, a maximum take-off weight of 139,000 pounds, and a range (fully loaded) of 2,386 nautical miles.

MD-90-40. A prospective further addition to the IAE-powered family, the MD-90-40, was to seat between 170 and 180 in a dual class configuration and was to weigh over 163,000 pounds at maximum take-off weight. Fuselage length was to be 172 feet, plus or minus a few inches. First flight was expected in 1994, with customer deliveries a year later. This aircraft was canceled by McDonnell Douglas when Swissair and Austrian decided to purchase A321 transports.

MD-90-50. To be powered by V2528 engines rated at 28,000 lbt each, this aircraft was externally similar to the -30 but would have been fitted with two additional belly-mounted auxiliary fuel tanks. Range with 153 passengers and international reserves was an estimated 3,022 nautical miles. The -50 would have had a 78,245 kilogram (172,500 pound) maximum take-off weight.

MD-90-55. The -55 would have featured a new set of passenger doors in the forward fuselage and seating for 187 in an all-economy layout.

Program Review

Background. The MD-80 became the largest commercial jetliner program for McDonnell Douglas and the one responsible for keeping the company in the marketplace during the 1981/1982 economic downturn. In the development of the MD-80, Douglas was able to exploit as much of the DC-9 as possible while adding

significant improvements in fuel efficiency, capacity, flight controls and avionics, and cabin amenities. The MD-90 is a further extension of the old DC-9 line with even more advanced propulsion, flight controls, avionics, and structure.

Preliminary design work on the MD-80's oldest DC-9 ancestor, model 2086, was begun in 1962, and construction of the first DC-9 airframe began in March 1964. A prototype flew in February 1965, with certification and initial deliveries of the DC-9-10 taking place in November and December 1965, respectively. The popular short-range DC-9 twin was produced in five major variants prior to launch and redesignation of the stretched medium-range MD-80 series. Production of the DC-9 series was as follows:

<u>Model</u>	<u>Total</u>	<u>Engine Model</u>
DC-9-10	137	JT8D-5/-1
DC-9-20	10	JT8D-9
DC-9-30	638	JT8D-7 (-9/-11/-15/-17 available as options)

<u>Model</u>	<u>Total</u>	<u>Engine Model</u>
DC-9-40	74	JT8D-15/-17
DC-9-50	77	JT8D-15/-17
C-9A ^(a)	21	JT8D-9
C-9B ^(a)	19	JT8D-9
VC-9C ^(a)	3	JT8D-9
Total	979	

^(a)See Military Variants below.

Military Variants. Douglas produced three military versions of the DC-9. They are as follows:

C-9A Nightingale. An off-the-shelf DC-9-30 with JT8D-9 engines converted for an aeromedical role, the Nightingale carries 30 to 40 litters and five attendants. The USAF MAC (Military Airlift Command) ordered 21, all of which were delivered by 1973.

VC-9C. A special configuration DC-9-30 ordered in late 1973 by USAF for the Special Air Missions Wing at Andrews AFB. Three were delivered in 1975.

C-9B Skytrain. The US Navy ordered and received 17 C-9Bs, and another two aircraft went to Kuwait. This is a DC-9-30 configured for a convertible passenger/cargo fleet logistic mission. In mid-1983, the Navy announced plans to seek funds for 14 more C-9Bs; although the service received procurement funding of \$33.9 million in FY85, no quantities were noted, and the Navy has since purchased ex-commercial DC-9s for this role.

PRC Program. McDonnell Douglas and the People's Republic of China (PRC) opened discussions in 1979 regarding the latter's purchase of the MD-80 and licensed production of MD-80s in the PRC. In February 1981, the Chinese delivered the first of 100 DC-9 landing gear door shipsets to the US manufacturer under terms of a \$1.0 million contract signed the previous year. In April 1985, the two principals announced that Shanghai Aviation Industrial Corp in the PRC would assemble 25 MD-82s from kits shipped from the US. The first shipset of components arrived in China in January 1986. The first Chinese-assembled aircraft flew in July 1987, with all 25 units in service by October 1991. The program was extended with orders for an additional five MD-82s (plus five MD-83s). Subsequent to the first delivery of Chinese-built MD-82s, Douglas and the PRC government expanded the agreement to include production of all MD-80 series nose cones and tail sections. The June 1988 accord called for the cones to be produced by Chengdu Aircraft Corp, and the tail sections by Shanghai Aviation.

PRC Trunkliner. In June 1992, the PRC approved the purchase of 20 MD-80 kits and 20 MD-90-30 kits. This buy was part of the MD-90-30 Trunkliner program.

The Chinese identified a need for up to 170 aircraft in the Trunkliner program. For the PRC requirement, the MD-82 and the MD-90-30 were to be fitted with a new dual-tandem main landing gear to operate on that country's light duty runways; however, this landing gear was not fitted.

In November 1994, McDonnell Douglas and the PRC signed an amendment to the original Trunkliner agreement. The new agreement called for the purchase of 40 aircraft, including 20 MD-90s to be built in the PRC and another 20 produced in Long Beach, California.

MD-90 production in the PRC began in 1995. In mid-1998, the PRC decided that production would stop after completion of the first three Chinese-produced MD-90s. Final assembly of the initial aircraft had not yet started. But plans changed again – production would stop after only two were completed. The first was completed in mid-1999, and the second was completed in early 2000. Both aircraft were delivered to China Northern Airlines in September 2000.

MD-80 Propfan Demonstrator. In mid-1985, McDonnell Douglas and General Electric agreed to flight-test an MD-80 testbed fitted with a GE UnDucted Fan™ (UDF™) engine. Flight tests began in mid-1987. The flight-test program proved the fuel efficiency of the concept and also dispelled criticism of the aircraft/engine combination's potential noise problems. The testbed aircraft has also flown with an Allison 578-DX propfan.

MD-90. Active marketing of the MD-90 began in late 1989. Within 45 days, Douglas secured a huge order: 50 firm orders and 110 options from Delta. The orders were actually conversions of some MD-88 options. Soon after, Alaska Airlines and ILFC followed suit with significant orders.

The MD-90 achieved FAA certification in November 1994, and initial delivery occurred in February 1995. The first MD-90 version in service was the 153 passenger -30. It was to be followed by the 170-180 passenger MD-90-40, but this version was shelved when Austrian and Swissair placed large orders for Airbus A321 transports. McDonnell Douglas later

proposed the -50/-55 versions of the MD-90 (see **Variants/Upgrades**, above).

P-9D LRAACA Proposal. In one of the most hotly contested military aircraft programs in recent times, McDonnell Douglas proposed a GE36 propfan-powered variant of either the MD-87 or the planned MD-91 for the US Navy's Long Range Air ASW Capable Aircraft (LRAACA) requirement. Approximately 120 aircraft would be needed as replacements for current Lockheed P-3Cs. Lockheed proposed a turboprop-powered P-3 variant, while Boeing proposed a version of its 757. The Navy selected Lockheed's improved P-3, powered by General Electric GE38 advanced turboprop engines. This project was canceled by the Navy in December 1989.

End of MD-80 Production. In November 1997, Boeing unveiled a strategy regarding the airliners formerly produced by McDonnell Douglas Corp. The company decided to produce the MD-80 and the MD-90 until approximately mid-1999 when then-current production commitments ended. Beyond mid-1999, the possibility was left open for additional MD-90 production in the PRC beyond the 20 that were already planned to be produced there. However, as mentioned above, the PRC decided in 1998 that not even the initial 20 would be produced and that production would stop after completion of only three.

In April 1998, TWA ordered 24 MD-83s. This order extended MD-80 series production until December 1999, when the final MD-83 was delivered to TWA.

Funding

MD-90 development cost was estimated at \$750 million to \$1.0 billion (1993 US dollars).

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1962	Preliminary design began
Feb	1965	Prototype first flight
Nov	1965	DC-9-10 certified
Dec	1965	Initial DC-9-10 deliveries
Jan	1967	Initial DC-9-30 deliveries
Feb	1968	Initial DC-9-40 deliveries
Aug	1975	DC-9-50 entered airline service (Swissair)
Oct	1979	DC-9-80 first flight
Sep	1980	Initial delivery of DC-9-81 (Swissair)
Jan	1981	DC-9-82 first flight
Late	1982	Initial MD-82 deliveries
Jan	1983	MD-83 launched
Feb	1985	Initial MD-83 deliveries
Early	1985	MD-87 launched
May	1985	MD-80 Propfan demonstrator program announced
Dec	1986	MD-87 first flight
Oct	1987	MD-87 certification and first deliveries
Jun	1987	First Chinese-assembled MD-82 flown
Aug	1987	MD-88 first flight
Dec	1987	MD-88 certified
Nov	1989	Douglas launched MD-90
Dec	1989	Delta ordered 50 MD-90-30s and options 110
Early	1991	McDonnell Douglas proposed shortened MD-87-105
Jun	1992	Douglas won PRC Trunkliner award
Feb	1993	First flight of MD-90-30
Feb	1995	Initial delivery of MD-90-30
Dec	1999	Final MD-80 delivered
Oct	2000	Final MD-90 delivered

Worldwide Distribution

See the Airline Inventories appendix.

Forecast Rationale

Boeing began marketing a passenger-to-freighter conversion program for the MD-82 in late 1999. The MD-82SF freighter, as the aircraft would be called after conversion, can carry 12 88-inch x 108-inch pallets on its main deck. Total cargo volume of the freighter is 161 cubic meters (5,684 cubic feet), including 126 cubic meters (4,440 cubic feet) on the main deck and 35 cubic meters (1,244 cubic feet) in the lower cargo hold.

Overall, the market for an MD-80 series freighter conversion could be somewhat limited. Some operators might consider the aircraft's fuselage cross-section to be too narrow.

Boeing and Rolls-Royce have been studying the market potential of a program to re-engine the MD-80 with the Rolls-Royce BR715 engine. For the MD-80, the

BR715 would be rated at its full 93.5 kN (21,000 lbst) rating. This would make it suitable for most MD-80 versions, though not the high gross weight MD-83. Rolls-Royce considers the MD-82 to be the most viable candidate for the program.

The modification would provide a cumulative noise decrease of 10 decibels, and up to 20 percent reduction in fuel consumption depending on the mission. It would also make the MD-80 compliant with the new Chapter 4 noise regulations.

Pratt & Whitney is developing a hushkit package that would enable the MD-80 to meet the Chapter 4 noise standards. The company is also considering an MD-80 re-engining program using the PW6000 engine.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

Aircraft	(Engine)	thru 01	High Confidence Level				Good Confidence Level				Speculative			Total 02-11
			02	03	04	05	06	07	08	09	10	11		
BOEING														
MD-81	JT8D-209	132	0	0	0	0	0	0	0	0	0	0	0	0
MD-82	JT8D-217	532	0	0	0	0	0	0	0	0	0	0	0	0
MD-83	JT8D-219	264	0	0	0	0	0	0	0	0	0	0	0	0
MD-87	JT8D-217	75	0	0	0	0	0	0	0	0	0	0	0	0
MD-88	JT8D-219	158	0	0	0	0	0	0	0	0	0	0	0	0
MD-90-30	V2525-D5	115	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal - BOEING		1276	0	0	0	0	0	0	0	0	0	0	0	0
SHANGHAI AVIATION IND. CORP. (Licensee)														
MD-82(a)	JT8D-217	30	0	0	0	0	0	0	0	0	0	0	0	0
MD-90-30	V2525-D5	2	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal - SHANGHAI AVIATION IND. CORP. (Licensee)		32	0	0	0	0	0	0	0	0	0	0	0	0
Total Production		1308	0	0	0	0	0	0	0	0	0	0	0	0

(a) Figures represent kits received by Shanghai Aviation. Delivery approximately 6 months later.