Wing aspect ratio, excl nacelles 5.5
Distance between proprotor centres 14.20 m (46 ft 7 in)
Length: fuselage, excl probe 17.47 m (57 ft 4 in)
overall, wings stowed/blades folded 19.20 m (63 ft 0 in)
Height: over tailfins 5.46 m (17 ft 11 in)
wings stowed/blades folded 5.56 m (18 ft 3 in)
overall, nacelles vertical 6.73 m (22 ft 1 in)
Tail span, over fins 5.61 m (18 ft 5 in)
Wheel track (c/l of outer mainwheels) 4.62 m (15 ft 2 in)
Wheelbase 7.62 m (25 ft 0 in)
Nacelle ground clearance, nacelles vertical 1.32 m (4 ft 4 in)
Proprotor ground clearance, nacelles vertical 6.35 m (20 ft 10 in)
Dorsal escape hatch: Length 1.02 m (3 ft 4 in)
Width 0.74 m (2 ft 5 in)

DIMENSIONS, INTERNAL:
Cabin: Length 7.37 m (24 ft 2 in)
Max width 1.80 m (5 ft 11 in)
Max height 1.83 m (6 ft 0 in)
Usable volume 24.3 m³ (858 cu ft)

AREAS:
Rotor discs, each 105.36 m² (1,134.1 sq ft)
Rotor blades: each 4.05 m² (43.58 sq ft)
total 24.30 m² (261.5 sq ft)
Wing, total incl flaperons and fuselage centre-section 35.49 m² (382.0 sq ft)
Flaperons, total 8.25 m² (88.80 sq ft)
Fins, total 21.63 m² (232.80 sq ft)
Rudders, total 3.27 m² (35.20 sq ft)
Tailplane 8.22 m² (88.50 sq ft)
Elevators, total 4.79 m² (51.54 sq ft)

WEIGHTS AND LOADINGS:
Weight empty 15,032 kg (33,140 lb)
Max fuel weight: MV-22 baseline 3,493 kg (7,700 lb)
MV-22 option 4,468 kg (9,850 lb)
CV-22 baseline 6,282 kg (13,850 lb)
CV-22 with cabin tanks 11,970 kg (26,390 lb)
Max internal payload (cargo) 9,072 kg (20,000 lb)
Cargo hook capacity: single 4,536 kg (10,000 lb)
two hooks (combined weight) 6,804 kg (15,000 lb)
Rescue hoist capacity 272 kg (600 lb)
Normal mission T-O weight: VTO 21,545 kg (47,500 lb)
STO 24,947 kg (55,000 lb)
Max VTO weight 23,446 kg (51,690 lb)
Max STO weight for self-ferry 27,442 kg (60,500 lb)
Max floor loading (cargo) 1,464 kg/m² (300 lb/sq ft)
Max disc loading: VTO 111.3 kg/m² (22.79 lb/sq ft)
STO 130.2 kg/m² (26.67 lb/sq ft)
Transmission loading at max T-O weight and power 4.03 kg/kW (6.62 lb/shp)

PERFORMANCE:
Max level speed at S/L 275 kt (509 km/h; 316 mph)
Max cruising speed: at S/L, helicopter mode 100 kt (185 km/h; 115 mph)
Max forward speed with max slung load 214 kt (396 km/h; 246 mph)
Max rate of climb at S/L: vertical 332 m (1,090 ft)/min
inclined 707 m (2,320 ft)/min
Service ceiling 7,925 m (26,000 ft)
Service ceiling, OEI 3,441 m (11,300 ft)
Hovering ceiling OGE 4,331 m (14,200 ft)
T-O run at normal mission STO weight less than 152 m (500 ft)
Range:
amphibious assault 515 n miles (953 km; 592 miles)
VTO with 4,536 kg (10,000 lb) payload 350+ n miles (648+ km; 403+ miles)
VTO with 2,721 kg (6,000 lb) payload 700+ n miles (1,296+ km; 806+ miles)
STO with 4,536 kg (10,000 lb) payload 950+ n miles (1,759+ km; 1,093+ miles)
STO at 27,442 kg (60,500 lb) self-ferry gross weight, no payload 2,100 n miles (3,892 km; 2,418 miles)
g limits +4/−1

UPDATED

BLENNTEC

BLENNTEC (formerly UPship Corporation)

5198 Highway 84, Elba, Alabama 36323
Tel/Fax: (+1 334) 897 61 32
e-mail: airship@alaweb.com
Web: http://www.airship.us
PRESIDENT AND TECHNICAL DIRECTOR: Jesse Blenn

Company renamed BlennTEC in 2003, although UPship retained as airship trademark type name. First to be built will be a two-seat, 32 m (105 ft) example, planned to be marketed under new FAA Light Sport Aircraft standards for approximately US$75,000. Will have all main features of eight-seat, 50 m UPship described below, including bow thruster, semi-rigid construction and ground handling systems; will also be used for pilot training and to test cargo handling systems for Brazilian cargo market. This will allow further development and verification of 50- and 90-tonne payload cargo designs currently in progress (lengths 180 and 216 m; 590.6 and 708.7 ft respectively.

Additional efforts in 2003 included co-operative agreement in Brazil, and design work on a six-seat, 45 m (147.6 ft) UPship planned for construction by a Malaysian company for Far East market.

NEW ENTRY

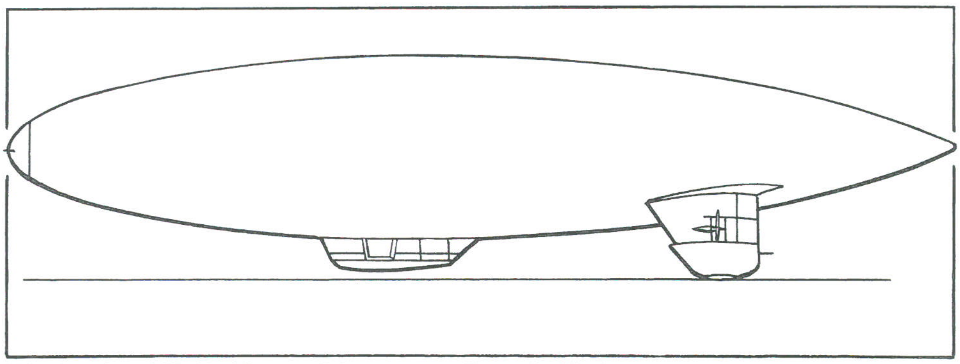
BLENNTEC UPSHIP 50 METRE

TYPE: Helium semi-rigid.

PROGRAMME: UPship design started 1989, original 750-001 later being enlarged as two-seat, 32 m proof-of-concept vehicle; further enlarged in 1999 with lower-drag envelope profile and three seats (or two occupants and heavier commercial or scientific payload) for planned US Type Certification. Now focusing again on initial improved 32 m (105 ft) version to market under expected FAA Light Sport Aircraft rules from 2004. First version planned later for full (Argentinian) Type Certificate will be 50 m eight-seater.

CURRENT VERSIONS: **50 m UPship:** *Following description applies to this version except where indicated.*

CUSTOMERS: To be built and operated as aerial platforms for customer's specific applications; FAA-certified 50 m version targeted at advertising, tourism, surveillance and scientific markets; other sizes planned to meet sport aviation, cargo and passenger markets.



Side elevation of UPship 32 m small demonstrator *(James Goulding)* ***NEW***/0567291

COSTS (estimated): 32 m US$75,000; 50 m between US$600,000 and US$1 million. Commercial operating costs (50 m) less than US$100,000 per month and expected leasing cost US$175,000 per month. (All 2003.)

DESIGN FEATURES: Study of strengths and weaknesses of past and present airships, focusing on aerodynamic and structural efficiency, including features not seen or proposed since 1930s. Listed features include better distribution of loads; lower internal pressures; better maintenance access; multiple helium compartments; and hardpoints for ground handling. Basic design scaleable to larger sizes than present airships, with almost all the advantages of rigid construction yet less costly or complex. Mechanical landing system permits greatly reduced ground handling crew (four for advertising, six for passenger operations).

Envelope shaped for minimum air resistance; propulsion engines mounted in inverted-V tailfins; nose-mounted thruster engine for all-speed control.

STRUCTURE: Framework of aluminium and steel tubing, with some carbon composites; envelope of proprietary rip-stop construction, with internal divisions and five helium cells. US-patented tailfins deflect under excessive ground or air loads.

POWER PLANT: Three 59.7 kW (80 hp) Jabiru piston engines, with electric starting and fixed-pitch propellers; one (pusher) in each tailfin and one operating bow thruster. Fuel capacity 270 litres (71.3 US gallons; 59.4 Imp gallons).

ACCOMMODATION: Pilot and seven passengers in ventral gondola, with rear entry stair; quiet and vibration-free due to distance from engines. Eletrically heated cabin, with space provision for lavatory and/or rescue or other equipment.

DIMENSIONS, EXTERNAL:
Envelope: Length 50.0 m (164 ft 0½ in)
Max diameter 10.0 m (32 ft 9¾ in)

DIMENSIONS, INTERNAL:
Envelope volume 2,400 m³ (84,755 cu ft)
Helium volume 2,100 m³ (74,160 cu ft)

WEIGHTS AND LOADINGS (approx):
Weight empty 1,260 kg (2,778 lb)
Useful lift 840 kg (1,852 lb)
Thruster lift 200 kg (441 lb)
Total lift 2,100 kg (4,630 lb)

PERFORMANCE (estimated):
Max level speed 59 kt (110 km/h; 68 mph)
Cruising speed: at 75% power 54 kt (100 km/h; 62 mph)
at 50% power 47 kt (87 km/h; 54 mph)
at 25% power 37 kt (69 km/h; 43 mph)
Range: at 75% power 326 n miles (605 km; 375 miles)
at 50% power 399 n miles (740 km; 459 miles)
at 25% power 615 n miles (1,139 km; 707 miles)
Endurance, 20% fuel reserves:
at 75% power 5 h 30 min
at 50% power 8 h 15 min
at 25% power 16 h 30 min

NEW ENTRY

BOEING

THE BOEING COMPANY

100 North Riverside Plaza, Chicago, Illinois 60606
Tel: (+1 312) 544 20 00
Web: http://www.boeing.com
PRESIDENT AND CEO: Harry Stonecipher
NON-EXECUTIVE CHAIRMAN: Lewis Platt
SENIOR VICE-PRESIDENT AND CHIEF TECHNOLOGY OFFICER: David Swain
SENIOR VICE-PRESIDENT AND CHIEF FINANCIAL OFFICER: TBA
VICE-PRESIDENT, COMMUNICATIONS: Judith Muhlberg

Company founded July 1916. Currently organised into major business segments as detailed below, plus several smaller elements. Revenues for 2001 were US$58.2 billion.

Boeing and McDonnell Douglas merger under the Boeing name was completed on 4 August 1997, elevating Boeing to status of largest aerospace company in the world. Headquarters remained in Seattle, Washington, until September 2001, when moved to Chicago, Illinois. Expansion of global interests occurred in 1997, with Boeing entering into alliances with AVIC and Taikoo Aircraft Engineering Co of China; with CSA Czech Airlines to establish joint venture company and acquire stake in Aero Vodochody; and with Instytut Lotnictwa of Poland for potential future collaboration on advanced technologies. In 1998, similar agreements and arrangements concluded with Israel Military Industries concerning military and civil programmes and with Hellenic Aerospace Industry to promote F-15H as new fighter for Greek Air Force, though latter failed to secure order. In January 1999, Boeing reached agreement with Netherlands-owned company MD Helicopters (which see in US section) on previously announced disposal of light civil helicopter range. In January 2003, Boeing had 166,800 employees.

Following further reorganisation in latter half of 2002, operating components of The Boeing Company comprise:

Integrated Defense Systems
Follows this entry
Boeing Commercial Airplanes
Follows Integrated Defense Systems
Phantom Works
Follows Boeing Commercial Airplanes
Shared Services Group
Follows Phantom Works

UPDATED

INTEGRATED DEFENSE SYSTEMS

PO Box 516, St Louis, Missouri 63166-0516
Tel: (+1 314) 232 02 32
Fax: (+1 314) 234 82 96
PRESIDENT AND CEO: Jim Albaugh
MEDIA CONTACTS:
GENERAL MANAGER: Doug Kennett, *Tel:* (+1 314) 234 35 00
DIRECTOR, MEDIA RELATIONS:
Jo Anne Davis, *Tel:* (+1 314) 233 89 57
MANAGER MEDIA/INTERNATIONAL PROGRAMMES:
Mary Ann Brett, *Tel:* (+1 314) 234 71 11
INTERNATIONAL PROGRAMMES:
Jim Schlueter, *Tel:* (+1 314) 234 21 49

Created in latter half of 2002 through merger of Military Aircraft and Missile Systems with Space and Communications, Integrated Defense Systems has overall responsibility for military business activities. Management of aircraft and helicopter programmes as detailed below reflects the military customer base, but several subordinate organisations exist to oversee other key areas.

Other elements include **Aerospace Support** (service and logistics support, plus modifications).

Sales in 2001 were US$22.9 billion; workforce in January 2003 numbered 76,600.

Major business units of Integrated Defense Systems are as follows:

Navy Systems
VICE-PRESIDENT AND GENERAL MANAGER: John Lockard (St Louis, Missouri)

Air Force Systems
VICE-PRESIDENT AND GENERAL MANAGER: George Muellner (Long Beach, California)

Army Systems
VICE-PRESIDENT AND GENERAL MANAGER: Roger Krone (Delaware County, Pennsylvania)

Human Space Flight
VICE-PRESIDENT AND GENERAL MANAGER: Mike Mott (Houston, Texas)

Missile Defense Systems
VICE-PRESIDENT AND GENERAL MANAGER: Jim Evatt (Washington, DC)

Homeland Defense
VICE-PRESIDENT AND GENERAL MANAGER: Rick Stephens (Seal Beach, California)

Space and Intelligence Systems
VICE-PRESIDENT AND GENERAL MANAGER: Roger Roberts (Seal Beach, California)

Commercial Space Systems
VICE-PRESIDENT AND GENERAL MANAGER: Bill Collopy (Seal Beach, California)

Aerospace Support
VICE-PRESIDENT AND GENERAL MANAGER: David Spong (St Louis, Missouri)

UPDATED

BOEING F-15E EAGLE

Israel Defence Force name: Ra'am (Thunder)

TYPE: Multirole fighter.

PROGRAMME: F-15 initially employed as air superiority fighter, having first flown on 27 July 1972. Demonstration of industry-funded Strike Eagle prototype (71-0291) modified from F-15B, including accurate blind weapons delivery, completed at Edwards AFB and Eglin AFB in 1982; product improvements for the F-15E were tested on four Eagles, among which were the Strike Eagle prototype, an F-15C and an F-15D, between November 1982 and April 1983, including first take-off at 34,019 kg (75,000 lb), 3,175 kg (7,000 lb) more than F-15C with conformal tanks; new weight included conformal tanks, three other external tanks and eight 500 lb Mk 82 bombs; 16 different stores configurations tested, including 2,000 lb Mk 84 bombs, and BDU-38 and CBU-58 weapons delivered visually and by radar.

Full programme go-ahead announced 24 February 1984; first flight of first production F-15E (86-0183) 11 December 1986; first delivery to Luke AFB, Arizona, 12 April 1988; first delivery 29 December 1988 to 4th Wing at Seymour Johnson AFB, North Carolina.

In mid-2001, USAF and Boeing examining various options for mid-life upgrade of F-15E known as Block 6; among the possibilities are adoption of active electronically scanned array (AESA) radar, update of radar warning receiver equipment, re-engining with version of General Electric F110 turbofan, installation of new wing structure incorporating carbon fibre skin that would provide increased take-off weight and accommodate two extra hardpoints.

CURRENT VERSIONS: **F-15E:** Basic version, *as detailed*.

F-15F: Proposed single-seat version, optimised for air combat; not built.

Boeing F-15I Ra'am of 69 Squadron, Israel Defence Force *(Paul Jackson)* ***NEW***/0546853

F-15H: Proposed export version, lacking specialised air-to-ground capability; supplanted by F-15S. Designation subsequently allocated to version for Greece, which eventually selected F-16 Fighting Falcon.

F-15I Ra'am: Israeli export version of F-15E; selected November 1993; confirmed 27 January 1994; 21 ordered 12 May 1994; option on four more converted to firm order in November 1995. First flight of initial (unpainted) aircraft on 12 September 1997; this was subject of formal roll-out and handover ceremony at St Louis on 6 November 1997, with first pair of aircraft to be delivered leaving St Louis on 16 January 1998 and arriving in Israel three days later; total of 16 delivered during 1998, with final nine aircraft following in 1999. Operating unit No. 69 Squadron. Tactical electronic warfare system deleted; replaced by Israeli-built SPS-2100 integrated system including active jamming, radar and missile warning, and dispenser subsystems.

Otherwise identical to USAF F-15E, with F100-PW-229 engines, LANTIRN pods, full capability AN/APG-70 radar, Kaiser holographic HUD, Litton ring laser INS and VHSIC central computer. Associated equipment includes four Sanders mission planning subsystems and one Sanders common mapping production system (CMPS) to assist ground planning, briefing and debriefing activities at total cost of US$6.2 million. F-15I includes significant number of co-produced components, such as airframe and wing subassemblies, heat exchangers and weapons pylons.

F-15K: Version conceived to satisfy Republic of Korea's F-X fighter requirement; preliminary bids submitted in June 2000. Selection was expected in second half of 2001, but decision delayed, with formal announcement being made on 19 April 2002, when Korea revealed intent to purchase 40 aircraft at total cost of US$4.2 billion. F-15K incorporates General Electric F110-GE-129 engine, AN/APG-63(V)1 radar, expanded weapons capability (including JDAM, SLAM-ER and AIM-9X) and improved environmental control system, plus Lockheed Martin TIGER Eyes sensor suite including AN/AAS-42 infra-red search and track system, Boeing Joint Helmet-Mounted Cueing System and revised cockpit with seven 152 × 152 mm (6 × 6 in) Kaiser Electronics AMLCDs. First pair of aircraft will be delivered in 2005, followed by 10 in 2006, 16 in 2007 and 12 in 2008.

F-15L: Proposed less costly version offered to Israel by Boeing in unsuccessful, last-minute, attempt to secure order for new combat aircraft; F-16I eventually selected.

F-15S: Saudi Arabian export version of F-15E, lacking some air-to-air and air-to-ground capabilities; Saudi Arabian request for 72 aircraft approved by US government in December 1992; initially designated **F-15XP**; first funds assigned by US government on 23 December 1992; contract signature by Saudi government May 1993; planned delivery rate halved, early 1994, to one per month, beginning 1995. First F-15S flown 19 June 1995; official roll-out and handover 12 September 1995. First two examples delivered to Saudi Arabia in November 1995 were second and third built; total of 49 received by end of 1998 and 70 by end of 1999, with final two following in late July 2000.

Saudi versions comprise 24 optimised for air-to-air missions and 48 optimised for air-to-ground; AN/APG-70 radar. Despite planned restrictions, aircraft delivered with full F-15E capability, plus conformal fuel tanks and tangential stores attachments. Armament includes AGM-65D/G Maverick, AIM-7 Sparrow, AIM-9M and AIM-9S Sidewinder missiles, CBU-87 submunitions dispenser and GBU-10/12 bombs. Saudi programme includes about 154 Pratt & Whitney F100-PW-229 engines.

F-15SE: Proposed single-seat version of F-15E for USAF, for which pricing data supplied to Department of Defense as part of Quadrennial Defense Review. Not proceeded with.

F-15T: Version to be offered to Singapore, which planned to issue request for proposals for new fighter in May 2003. Is expected to feature multimode version of Raytheon AN/APG-63(V)3 AESA radar and more modern countermeasures suite as well as improved sensor systems and navigation equipment. Singapore anticipates service entry of new fighter in late 2007.

F-15U: Version conceived to satisfy United Arab Emirates requirement for long-range interdictor aircraft, in which it was competing against Lockheed Martin F-16 (selected), Dassault Rafale, Eurofighter Typhoon and Sukhoi Su-30MK. **F-15U Plus** proposal anticipated extended range, with additional 2,570 kg (5,665 lb) of fuel in thicker clipped-delta, 50° leading-edge sweep wing; more stores stations and internally situated IR navigation and targeting sensor suite in lieu of LANTIRN. Typical ordnance loads would have comprised nine 2,000 lb Mk 84 bombs or seven laser-guided GBU-24s.

F-15MANX: Stealthy, tail-less proposal based on technology developed for ACTIVE thrust-vectoring programme.

CUSTOMERS: USAF funding for originally planned 392 reduced to 200; however, further nine funded in FY91 and FY92, comprising three Gulf War loss replacements and six with proceeds of sale to Saudi Arabia of 24 F-15C/Ds. Additional six in FY96 budget, despite not being requested by USAF. Further six aircraft in FY97 and five in FY98, raising total USAF buy to 226, with another five in FY00 and five in FY01. Saudi Arabia 72 (F-15S); Israel 25 (F-15I); Republic of Korea 40 (F-15K).

USAF F-15E PROCUREMENT

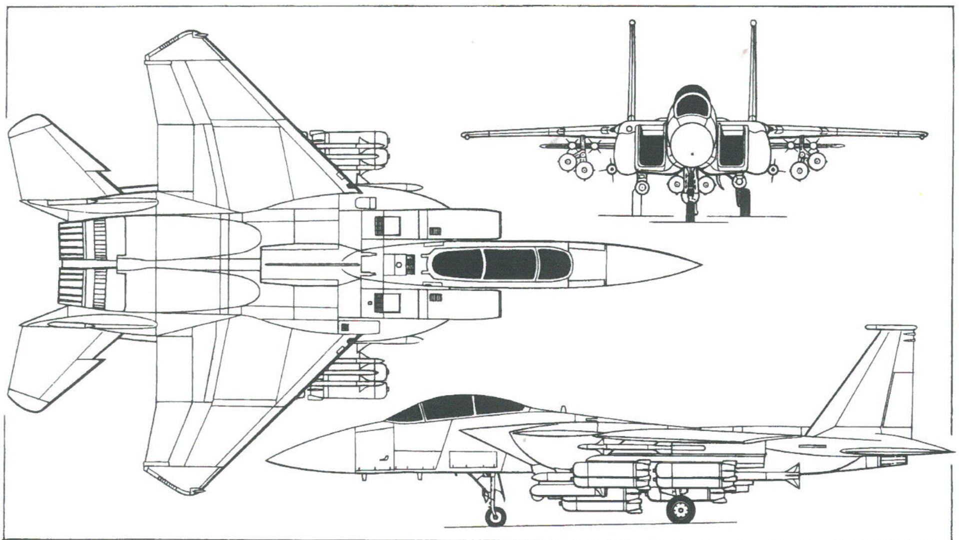
FY	Batch	Qty	First aircraft
86	Lot 1	8	86-0183
87	Lot 2	42	87-0169
88	Lot 3	42	88-1667
89	Lot 4	36	89-0471
90	Lot 5	36	90-0227
91	Lot 6	36	91-0300
91	Lot 7	6	91-0600
92	Lot 8	3	92-0364
96	Lot 9	6	96-0200
97	Lot 10	6	97-0217
98	Lot 11	5	98-0131
00	Lot 12	5	00-3000
01	Lot 13	5	01-2000
Total		**236**	

Initial USAF combat-capable unit, 4th Wing, declared operational October 1989, currently with 333, 334, 335 and 336 Fighter Squadrons; and others with 57th Wing USAF Weapons School at Nellis AFB, Nevada; 90th FS of 3rd Wing at Elmendorf, Alaska, received first F-15E on 29 May 1991; 391st FS, sole F-15E squadron in multitype 366th Wing at Mountain Home AFB, Idaho, received first aircraft (reallocated from early production) 6 November 1991; 492nd and 494th FS of 48th FW at Lakenheath, UK, received first aircraft on 21 February 1992. Deliveries of Lot 7 began to 48th FW on 13 April 1994 and 209th USAF F-15E (92-0366) to 57th Wing on 11 July 1994. First aircraft from Lot 9 flown on 1 April 1999 and delivered to 57th Wing on 7 June; remaining five F-15Es from this batch all assigned to 48th Fighter Wing by November 1999; subsequent deliveries to 48th FW comprised all Lot 10 and Lot 11 aircraft, with final pair arriving on 26 August 2000. First Lot 12 aircraft (00-3000) delivered 21 June 2002; subsequently assigned to 48th FW. Last aircraft for USAF due for delivery in late 2004.

Initial contract placed with McDonnell Douglas by US government on 18 December 1992 for 72 Saudi aircraft; project name, Peace Sun IX.

COSTS: US$35 million, flyaway; US$2,000 million for 21 F-15Is (1993), Israel; US$288.5 million appropriation for five F-15Es in FY00. Total cost of South Korean purchase expected to be US$4.2 billion.

DESIGN FEATURES: Conceived as air superiority fighter (F-15A to F-15D), but further developed for strike/attack mission, with provision for increased weight of ordnance. Typical 1970s fighter configuration, with twin fins positioned to receive vortex flow off wing and maintain directional stability at high angles of attack. Straight two-dimensional external compression engine air inlet each side of fuselage. High-mounted cockpit for all-round vision



Boeing F-15E Eagle equipped for high ordnance payload air-to-ground mission ***(Jane's/Dennis Punnett)***

Mission includes approach and attack at night and in all weathers; main systems of F-15E include high-resolution, synthetic aperture Raytheon AN/APG-70 radar, wide field of view FLIR, Lockheed Martin LANTIRN navigation (AN/AAQ-13) and targeting (AN/AAQ-14) pods beneath starboard and port air intakes respectively; air-to-air capability with AIM-7 Sparrow, AIM-9 Sidewinder and AIM-120 AMRAAM retained; rear cockpit has four multipurpose CRT displays for radar, weapon selection, and monitoring enemy tracking systems; front cockpit modifications include redesigned up-front controls, wide field of view HUD, colour CRT multifunction displays for navigation, weapon delivery, moving map, precision radar mapping and terrain-following. Engines have digital electronic control, engine trimming and monitoring; fuel tanks are foam-filled; more powerful generators; better environmental control.

NACA 64A aerofoil section with conical camber on leading-edge; sweepback 38° 42′ at quarter-chord; thickness/chord ratio 6.6 per cent at root, 3 per cent at tip; anhedral 1°; incidence 0°.

FLYING CONTROLS: Powered. Plain ailerons and all-moving tailplane with dog-tooth extensions, both powered by National Water Lift hydraulic actuators; rudders have Ronson Hydraulic Units actuators; no spoilers or trim tabs; Moog boost and pitch compensator for control column; plain flaps; upward-opening airbrake panel in upper fuselage between fins and cockpit. Digital triple-redundant BAE Systems flight control system capable of automatic coupled terrain-following.

STRUCTURE: Wing based on torque box with integrally machined skins and ribs of light alloy and titanium; aluminium honeycomb wingtips, flaps and ailerons; airbrake panel of titanium, aluminium honeycomb and graphite/epoxy composites skin. F-15E version includes 60 per cent of earlier F-15 structure redesigned to allow 9 *g* and 16,000 hours fatigue life; superplastic forming/diffusion bonding used for upper rear fuselage, rear fuselage keel, main landing gear doors, and some fuselage fairings, plus engine bay structure.

LANDING GEAR: Hydraulically retractable tricycle type, with single wheel on each unit. All units retract forward. Cleveland nose and main units, each incorporating an oleo-pneumatic shock-absorber. Honeywell wheels and Michelin AIR X radial tyres on all units. Nosewheel tyre size 22×7.75-9 or 22×7.75R9 (26 ply) tubeless; mainwheel tyres size 36×11-18 or 36×11R18 (30 ply) tubeless; tyre pressure 21.03 bar (305 lb/sq in) on all units. Honeywell five-rotor carbon disc brakes.

POWER PLANT: Initially, two Pratt & Whitney F100-PW-220 turbofans, each rated for take-off at 104.3 kN (23,450 lb st), installed, with afterburning. USAF aircraft 135 onwards (90-0233), built from August 1991, have 129.4 kN (29,100 lb st) Pratt & Whitney F100-PW-229s, which also ordered for Saudi F-15S and Israeli F-15I. F-15K for South Korea fitted with General Electric F110-GE-129 turbofans. Air inlet controllers by Hamilton Sundstrand. Air inlet actuators by National Water Lift.

Internal fuel in foam-filled structural wing tanks and six Goodyear fuselage tanks, total capacity 7,643 litres (2,019 US gallons; 1,681 Imp gallons). Simmonds fuel gauge system. Optional conformal fuel tanks (CFT) attached to side of engine air intakes, beneath wing, each containing 2,737 litres (723 US gallons; 602 Imp gallons). Provision for up to three additional 2,309 litre (610 US gallon; 508 Imp gallon) external fuel tanks. Maximum total internal and external fuel capacity 20,044 litres (5,295 US gallons; 4,409 Imp gallons).

ACCOMMODATION: Two crew, pilot and weapon systems officer, in tandem on Boeing ACES II zero/zero ejection seats. Single-piece, upward-hinged, bird-resistant canopy; in-service modification undertaken by USAF replaced original windscreen with laminated polycarbonate material.

SYSTEMS: Lucas Aerospace generating system for electrical power, with Hamilton Sundstrand 60/75/90 kVA constant-speed drive units. Litton molecular sieve oxygen generating system (MSOGS) introduced in 1991 to replace liquid oxygen system. Honeywell air conditioning system. Three independent hydraulic systems (each 207 bar; 3,000 lb/sq in) powered by Abex engine-driven pumps; modular hydraulic packages by Hydraulic Research and Manufacturing Company. AlliedSignal APU for engine starting, and for provision of limited electrical or hydraulic power on the ground independently of main engines.

AVIONICS: *Comms:* Raytheon AN/ARC-164 UHF transceiver and UHF auxiliary transceiver with cryptographic capability; Honeywell AN/APX-101 IFF transponder; BAE Systems AN/APX-76 IFF interrogator with Litton reply evaluator. Some aircraft have AN/ARC-190 HF radio for very long-range communications. F-15K will be fitted with BAE Systems AN/APX-113 combined interrogator transponder (CIT) unit.

Radar: Raytheon AN/APG-70 I-band pulse Doppler radar provides air-to-air capability equal to F-15C, plus high-resolution synthetic aperture mode for air-to-ground. Republic of Korea F-15K to have AN/APG-63(V)1 radar. Raytheon studying possible application of AESA radar for export customers and retrofit to USAF aircraft as part of upgrade.

Flight: Triple redundant BAE Systems digital flight control system with automatic terrain-following standard. IBM CP-1075C very high-speed integrated circuit (VHSIC) central computer introduced in 1992 (replacing CP-1075). Honeywell AN/ASK-6 air data computer, Honeywell AN/ASN-108 AHRS, Honeywell CN-1655A/ASN ring laser gyro INS providing basic navigation data and serving as primary attitude reference system, Rockwell Collins AN/ARN-118 Tacan, Rockwell Collins HSI presenting aircraft navigation information on a symbolic pictorial display, Rockwell Collins AN/ARN-112 ILS receiver, Rockwell Collins ADF receiver, Dorne & Margolin glideslope localiser antenna and Teledyne Avionics angle of attack sensors. Rockwell Collins Miniaturised Airborne GPS Receiver installed from 1995. Latest aircraft to join USAF (FY96 and subsequent production) feature new embedded GPS/INS.

In July 1998, Boeing began flight test of commercial computing technology in F-15E as part of Phantom Works Bold Stroke project, whereby commercial technology is being used to provide non-proprietary computer systems for installation on military aircraft. F-15E installation embodied advanced display core processor (ADCP) using PowerPC hardware to replace existing central computer and multipurpose display processor; initial trial demonstrated same capabilities as current military hardware.

Instrumentation: FLIR imagery displayed on Kaiser IR-2394/A wide field of view HUD; Honeywell vertical situation display set using CRT to present radar, electro-optical identification and attitude director indicator formats to pilot under all light conditions; moving map display by Honeywell RP-341/A remote map reader. Honeywell digital map system intended to replace remote map reader from 1996. F-15I has Elbit helmet-mounted sight and other cockpit displays. Final 10 aircraft for USAF have Kaiser 125 × 125 mm (5 × 5 in) flat panel colour display (FPCD) instead of current CRT; this unit may also be retrofitted to earlier F-15Es. F-15K will feature four 152 × 152 mm (6 × 6 in) Multipurpose Displays (MPDs) and three 127 × 127 mm (5 × 5 in) FPCDs; all produced by Kaiser Electronics and all incorporating AMLCD technology.

Mission: Lockheed Martin LANTIRN externally mounted sensor package comprising AN/AAQ-13 navigation pod and AN/AAQ-14 targeting pod. Following hurried integration and evaluation in latter half of 2002, Rafael/Northrop Grumman Litening Extended Range (ER) system is to be installed on some USAF aircraft; initial batch of 24 pod systems ordered in early 2003 at cost of US$32.6 million, with deliveries beginning during first quarter of year. Lockheed Martin TIGER Eyes sensor suite to be installed on aircraft for Republic of Korea.

Self-defence: Northrop Grumman Enhanced AN/ALQ-135(V) internal countermeasures set provides automatic jamming of enemy radar signals; BAE Systems AN/ALR-56C RWR, Raytheon AN/ALQ-128 EW warning set, (initially) BAE Systems AN/ALE-45 chaff dispenser. Unique SPS-2100 EW system developed by Elisra and Rokar for Israeli F-15I. Sanders and ITT Avionics AN/ALQ-214 Integrated Defensive Electronic CounterMeasures (IDECM) under development and will be installed on F-15E; IDECM package incorporates Sanders AN/ALE-55 fibre optic towed decoy (FOTD). Saab BOL chaff dispensers to be adopted universally, with first contract awarded to BAE Systems in fourth quarter of 2001. F-15K will have BAE Systems AN/ALR-56C(V)1 RWR and AN/ALE-47 countermeasures dispenser system, plus Northrop Grumman AN/ALQ-135 internally mounted jamming system.

ARMAMENT: 20 mm M61A1 six-barrel gun in starboard wing-root, with 512 rounds. General Electric lead computing gyro. Provision on underwing (one per wing) and centreline pylons for air-to-air and air-to-ground weapons and external fuel tanks. Wing pylons use standard rail and launchers for AIM-9 Sidewinder (Israeli F-15I also compatible with Rafael Python 4) and AIM-120 AMRAAM air-to-air missiles; AIM-7 Sparrow and AIM-120 AMRAAM can be carried on ejection launchers on the fuselage or on tangential stores carriers on CFTs. Maximum aircraft load (with or without CFTs) is four each AIM-7 and AIM-9, or up to eight AIM-120. Single or triple rail launchers for AGM-65 Maverick air-to-ground missiles can be fitted to wing stations only.

Tangential carriage on CFTs provides for up to six bomb racks on each tank, with provision for multiple ejector racks on wing and centreline stations. Edo BRU-46/A and BRU-47/A adaptors throughout, plus two LAU-106A/As each side of lower fuselage. F-15E can carry a wide variety and quantity of guided and unguided air-to-ground weapons, including Mk 20 Rockeye (26), Mk 82 (26), Mk 84 (seven), BSU-49 (26), BSU-50 (seven), GBU-10 (seven), GBU-12 (15), GBU-15 (two), GBU-24 (five), CBU-52 (25), CBU-58 (25), CBU-71 (25), CBU-87 (25) or CBU-89 (25) bombs; SUU-20 training weapons (three); A/A-37 U-33 tow target (one); and B57 and B61 series nuclear weapons (five). Is only USAF strike aircraft able to carry GBU-28. An AN/AXQ-14 datalink pod is used in conjunction with the GBU-15; LANTIRN pod illumination is used to designate targets for laser-guided bombs; AGM-130 powered standoff bomb integrated in 1993; AGM-88 HARM capability in 1996. Integration of JDAM, JSOW and WCMD weapons currently under way. AN/AWG-27 armament control system; Programmable Armaments Control Set adopted by final 10 new-build USAF aircraft and likely to be retrofitted to most earlier aircraft.

Pneumatic weapon ejection system under development in early 2000; makes use of compressed air for weapons separation from aircraft.

DIMENSIONS, EXTERNAL:

Wing span	13.05 m (42 ft 9¾ in)
Wing aspect ratio	3.0
Length overall	19.43 m (63 ft 9 in)
Height overall	5.63 m (18 ft 5½ in)
Tailplane span	8.61 m (28 ft 3 in)
Wheel track	2.75 m (9 ft 0¼ in)
Wheelbase	5.42 m (17 ft 9½ in)

AREAS:

Wings, gross	56.49 m^2 (608.0 sq ft)

US F-15 PRODUCTION

	F-15A	F-15B	F-15C	F-15D	F-15DJ	F-15E	F-15I	F-15J	F-15K	F-15S	Total
Israel	19	2	18	13			25				77
Japan					12			10[1]			22
Saudi Arabia			55	19						72	146
South Korea									40[4]		40
USA	365[2]	59[3]	409	61		236					1,120
Total	**384**	**61**	**482**	**93**	**12**	**236**	**25**	**10**	**40**	**72**	**1,415**

Note: Mitsubishi of Japan also produced 155 F-15Js and 36 F-15DJs to complete total JASDF procurement of 165 and 48, respectively
[1] Including eight kits to Mitsubishi
[2] Including 10 YF-15s
[3] Including two YF-15s, of which one converted to F-15E prototype
[4] On order for delivery during 2005-08.

Ailerons (total) 2.46 m² (26.48 sq ft)
Flaps (total) 3.33 m² (35.84 sq ft)
Fins (total) 9.78 m² (105.28 sq ft)
Rudders (total) 1.85 m² (19.94 sq ft)
Tailplanes (total) 10.34 m² (111.36 sq ft)

WEIGHTS AND LOADINGS (F100-PW-220 engines):
Operating weight empty (no fuel, ammunition, pylons or external stores) 14,515 kg (32,000 lb)
Max weapon load 11,113 kg (24,500 lb)
Max fuel weight: internal (JP4) 5,952 kg (13,123 lb)
CFTs (two, total) 4,265 kg (9,402 lb)
external tanks (three, total) 5,396 kg (11,895 lb)
max internal and external 15,613 kg (34,420 lb)
Max T-O weight 36,741 kg (81,000 lb)
Max landing weight:
unrestricted 20,094 kg (44,300 lb)
at reduced sink rates 36,741 kg (81,000 lb)
Max zero-fuel weight 28,440 kg (62,700 lb)
Max wing loading 650.5 kg/m² (133.22 lb/sq ft)
Max power loading 176 kg/kN (1.73 lb/lb st)

PERFORMANCE:
Max level speed at height M2.5
Max combat radius 685 n miles (1,270 km; 790 miles)
Max range 2,400 n miles (4,445 km; 2,762 miles)

UPDATED

BOEING F/A-18 SUPER HORNET

US Navy designations: F/A-18E, F/A-18F and EA-18G

TYPE: Multirole fighter.

PROGRAMME: Proposed 1991 as replacement for cancelled GD/MDC A-12 and follow-on for early F/A-18As and other USN/MC tactical aircraft as they phase out; based on earlier versions of Hornet; development funding approved by Congress for FY92; US$4.88 billion engineering and manufacturing development contract awarded June 1992, covering seven flight test aircraft (five Es; two Fs) and three ground test articles, plus associated 7½-year test programme; US$754 million award in 1992 to GE for F414 engine development.

Critical design review (CDR) undertaken 13 to 17 June 1994 at St Louis by team of independent government evaluators; successfully negotiated, with F/A-18E/F satisfying or surpassing all timescale, cost, technical, reliability and maintainability requirements.

Principal subcontractor Northrop Grumman launched assembly of first aircraft on 24 May 1994 with start of work on centre/aft fuselage section at Hawthorne, California. First forward fuselage section followed suit on new assembly line at St Louis, Missouri, 23 September 1994; completed 12 January 1995, except for wiring; mating with centre/aft section from Hawthorne effected 8 May 1995. Roll-out of prototype (E1/165164) on 18 September 1995; first flight 29 November 1995.

Prototype delivered to Naval Air Warfare Center at Patuxent River, Maryland, on 14 February 1996 for start of three year flight test programme involving seven aircraft; initial flight from Patuxent River made by E1 on 4 March 1996. Second F/A-18E prototype (E2/165165) made first flight on 26 December 1995 and first F/A-18F (F1/165166) on 1 April 1996. Supersonic speed exceeded for first time on 12 April 1996 when E1 achieved M1.1. Carrier suitability trials began mid-1996 and F1 completed three successful catapult launches at Patuxent River on 6 August that year.

By 1 February 1997, when the last development aircraft was delivered to Patuxent River, test fleet had flown 390 sorties, for a total of 631 flight hours. Subsequent milestones were passed on 13 May 1997 (1,000th flight hour); 9 September 1997 (1,500th flight hour); 24 September 1997 (1,000th sortie); 11 December 1997 (2,000th flight hour and 1,300th sortie); 1 July 1998 (3,000th hour) and 12 January 1999 (4,000th hour). First missile launch (an AIM-9 Sidewinder) accomplished by aircraft F2 on 5 April 1997; other weapons expended by mid-May 1997 included AIM-7 Sparrow, AIM-120 AMRAAM, SLAM/SLAM-ER, AGM-84 Harpoon, Mk 82 and Mk 83 bombs plus Rockeye CBUs. Successful deployment of AN/ALE-50 towed radar decoy also accomplished by mid-May 1997.

Flight test programme briefly halted in October 1997 for engine inspection after discovery of cracks in stator vanes. More intractable problem concerned wing-drop, with uncommanded departures from controlled flight evident as early as the seventh sortie in March 1996. Boeing and US Navy considered three solutions to eradicate this in January 1998, including fitting stall strips on upper surface; adding a chord-wise fence just inboard of the hinge fairing; and switching to a porous hinge fairing with slots that allow air to flow in both directions through wing fold fairing. Last-mentioned option selected in early 1998; subsequent flight testing confirmed efficacy of solution.

EMD phase of test programme completed end April 1999, by which time seven aircraft had accumulated 4,673 flight hours in 3,172 sorties; in the process, over 15,000 test points completed and 29 weapons configurations cleared for flight. By mid-2000, follow-on testing had increased totals to more than 5,500 flight hours in 3,800 flights.

Static testing began in August 1995 with airframe ST50; shock loading assessment from February 1996 with DT50; fatigue testing from 30 June 1997 with FT50, which completed first lifetime (6,000 hours) one month ahead of schedule, on 27 August 1998. ST50 transferred to Lakehurst, New Jersey, for series of six emergency barricade engagements; first successfully completed on 3 September 1997, but ST50 damaged during third test on 23 September when restraint cable failed. ST50 subsequently repaired and returned to test duty, for live-fire testing at China Lake, California; trials included firing large armour-piercing incendiary projectile through inlet duct into aft fuel tank, with resultant hole showing little evidence of leakage.

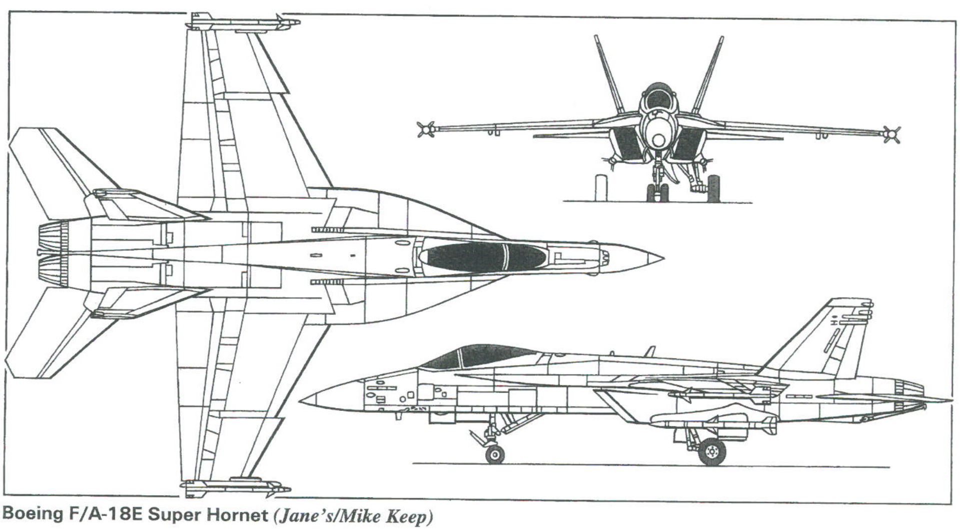
Approval for low-rate initial production (LRIP) of 62 aircraft in three lots given on 26 March 1997; first lot composed of eight F/A-18Es and four F/A-18Fs. Assembly of first LRIP F/A-18E (165533) started at Northrop Grumman in May 1997 and at Boeing in September 1997; final assembly began at St Louis on 19 June 1998, with mating of centre/aft and forward fuselage sections; first flight 6 November 1998, six weeks ahead of schedule; this aircraft officially accepted by US Navy on 18 December 1998 and flown to Patuxent River to join flight test programme before attachment to VX-9 squadron at China Lake, California, for operational evaluation. Latter programme began 27 May 1999 and involved total of 1,233 flight hours in 866 sorties by seven LRIP aircraft (three F/A-18Es and four F/A-18Fs) in six-month period, including testing of all mission capabilities in varying climates as well as operations at sea aboard USS *John C Stennis* and participation in 'Red Flag' exercise at Nellis AFB, Nevada. Results of operational evaluation announced 15 February 2000, with report stating aircraft to be "operationally effective and operationally suitable" and recommending fleet introduction with the US Navy.

First USN squadron is VFA-122, at Lemoore, California, as specialist FRS (Fleet Replacement Squadron), training pilots and ground crew; VFA-122 received first seven aircraft (of eventual 34) 17 November 1999. First operational squadron is VFA-115, which began transition from F/A-18C to F/A-18E in third quarter 2000; made first deployment in USS *Abraham Lincoln* from 24 July 2002 and experienced combat debut on 6 November 2002 when VFA-115 aircraft dropped four GPS-guided JDAMs on SAM sites in southern Iraq. See table for further details of transition programme.

CURRENT VERSIONS: **F/A-18E:** Single-seat. Initial aircraft (all LRIP examples plus those purchased in FY00 and FY01) to so-called Block 1 standard, with AN/APG-73 and introducing other items of equipment as they become available; subsequent aircraft (FY02 and later) to so-called Block 2 standard, incorporating revised forward fuselage as part of ECP 6038, with fibre optic data network and advanced crew station for NFO among other improvements. Will also eventually feature AN/APG-79

CURRENT AND PLANNED US NAVY SUPER HORNET SQUADRONS

Squadron number	Variant	FY of conversion	Previous equipment	Remarks
VFA-2	F/A-18F	03	F-14D	
VFA-11	F/A-18E	07	F-14B	
VFA-14	F/A-18E	01	F-14A	
VFA-22	F/A-18E	03	F/A-18C	
VFA-31	F/A-18F	07	F-14D	
VFA-32	F/A-18F	05	F-14B	
VFA-41	F/A-18F	01	F-14A	
VFA-81	F/A-18E	05	F/A-18C	
VFA-86	F/A-18F	06	F/A-18C	
VFA-102	F/A-18F	02	F-14B	
VFA-103	F/A-18F	05	F-14B	
VFA-105	F/A-18E	07	F/A-18C	
VFA-115	F/A-18F	00	F/A-18C	
VFA-122	F/A-18E/F	00	-	First squadron to deploy Training unit
VFA-137	F/A-18E	03	F/A-18C	
VFA-143	F/A-18F	07	F-14B	
VFA-146	F/A-18E	08	F/A-18C	
VFA-154	F/A-18F	04	F-14A	
VFA-211	F/A-18F	06	F-14A	
VFA-213	F/A-18F	06	F-14D	



Boeing F/A-18E Super Hornet *(Jane's/Mike Keep)*

Two-seat F/A-18F of training squadron VFA-122 *(Paul Jackson)* ***NEW***/0547131

AESA which was due to be evaluated at China Lake, California, from 2003 onwards, clearing way for first deliveries to fleet units by 2005.

F/A-18F: Two-seat. Also produced in Block 1 and Block 2 versions as detailed above.

F/A-18 C²W: Original name of private venture development of F/A-18F as two-seat electronic warfare aircraft; announced 7 August 1995; following merger, Boeing is prime contractor, with Northrop Grumman as principal subcontractor with special responsibility for integration of electronic warfare suite; minimal structural changes; wideband receiver pods replace wingtip Sidewinder AAMs; other pods and antennas on weapon pylons; satcom receiver behind cockpit. US Navy formulated requirements for new EW aircraft to replace Prowler from 2008 onwards. Boeing will utilise EA-6B equipment such as AN/ALQ-99 jamming system pods on Super Hornet. Future of this proposal, now designated **EA-18G**, is more assured, with US Navy planning to acquire initial production examples in FY05, when it will buy four, to be followed by 86 more. Deliveries will comprise four, 12, 16, 33 and 25 in FYs 08 to '12.

Initial flight demonstration of first EMD F/A-18F configured with three AN/ALQ-99 jamming pods and two fuel tanks in November 2001; further trials in 2002 expanded performance envelope and provided data on noise and vibration characteristics.

Multimission capability will be retained by F/A-18G, which will carry special EW avionics on gun bay pallet, with AN/ALQ-218 receivers sited in two wingtip pods; 11 weapon stations can be configured for carriage of jamming pods and/or ordnance. It is planned to begin the system development and demonstration (SDD) phase in FY04, with IOC expected to follow in FY09.

CUSTOMERS: US Navy. Seven prototypes; approval for 12 LRIP aircraft in FY97 (Lot 1). See table for details of three LRIP batches and first multiyear procurement (MYP) batch; contract for latter signed on 15 June 2000. All 62 LRIP aircraft delivered by end of third quarter of 2001, with first full-rate production Super Hornet (an F/A-18F) being handed over in late September; 100th Super Hornet (an F/A-18F) delivered 14 June 2002. Broad requirement originally identified for over 1,000 by FY15, but Quadrennial Defense Review reduced this to minimum of 548 and maximum of 785; defence guidance planning proposal in first quarter of 2002 advocated cutting procurement to 460. Latest procurement plans (late 2002) anticipate purchase of 460 F/A-18E/Fs plus at least 90 EW-dedicated F/A-18Gs. Boeing seeking export sales, following approval by US government; Malaysia is prime candidate to be first export customer, with proposed sale involving total of 18 F/A-18F. Super Hornet will also be offered to Australia, which seeking new multirole fighter under Project Air 6000.

SUPER HORNET PROCUREMENT

FY	Batch	Block	F/A-18E	F/A-18F	Total
97	LRIP 1	52	8	4	12
98	LRIP 2	53	8	12	20
99	LRIP 3	54	14	16	30
00	MYP1	55	15	21	36
01	MYP1	56	14	25	39
02	MYP1	57	29	19	48
03	MYP1	58	12	33	45
Subtotal			**100**	**130**	**230**
04	MYP1				42
05					42
Total					**314**

COSTS: Development estimated US$4.8 billion (1992); US$1,089 million in FY92 budget; US$943 million in FY93; approximately US$1,500 million in FY94 and US$1,348 million requested for FY95. US$2,600 million in provisional FY97 budget for first 12 aircraft; with US$2,100 million requested for FY98 procurement of 20 aircraft. US GAO estimated flyaway unit cost as being of the order of US$43.6 million in 1996, based on original planned procurement of 1,000. Most recent figures, for first MYP batch, put total cost at US$8.9 billion for 222 aircraft, although now appears MYP1 will include only 210 Super Hornets. Unit cost quoted as US$48 million in mid-2000, when Boeing pursuing measures to drive cost down to around US$40 million by 2005. Estimated cost of F/A-18G approximately US$60 million.

DESIGN FEATURES: Generally as for first-generation Hornet. Stretched versions of F/A-18C/D; gross landing weight increased by 4,536 kg (10,000 lb); 0.86 m (2 ft 10 in) fuselage plug; wings photometrically increased in size to provide 9.29 m² (100.0 sq ft) extra area and 1.31 m (4 ft 3½ in) span increase; control surfaces disproportionately enlarged and dogtooth added to leading-edge for increased aileron authority. Wings 2.5 cm (1 in) deeper at root; larger horizontal tail surfaces; LEX size substantially increased in early 1993 (from total 5.8 m²; 62.4 sq ft to 7.0 m²; 75.3 sq ft, compared with 5.2 m²; 56.0 sq ft on F/A-18C/D), ensuring full manoeuvre capability at beyond 40° AoA; also incorporates spoilers on upper surface of LEX as speedbrake and to increase nose-down control authority. Nevertheless, has 42 per cent fewer parts than immediate predecessor.

Additional 1,637 kg (3,600 lb) of internal and 1,406 kg (3,100 lb) of external fuel; 40 per cent extra range; further two (making 11) weapon hardpoints (stations 2 and 10, inboard of wingtips, for AAMs and ASMs of up to 520 kg; 1,146 lb); 'bring-back' weapons load increased to 4,082 kg (9,000 lb); additional survivability measures; air intakes redesigned and slewed to increase mass flow to more powerful F414-GE-400 engines and also changed to 'caret' shape to reduce radar signature. Incorporates several other 'affordable' stealth features to reduce radar cross-section, including saw-toothed doors and panels, realigned joints and edges and angled antennas.

FLYING CONTROLS: Full digital fly-by-wire controls using ailerons and tailerons for lateral control, plus flaps in flaperon form at low airspeeds; leading- and trailing-edge flaps scheduled automatically for high manoeuvrability, fast cruise and slow approach speed; horizontal stabilisers automatically assume neutral position if one is damaged, with pitch control then being passed to other surfaces; both rudders turned in at take-off and landing to provide extra nose-up trim effort; fly-by-wire returns towards 1 *g* flight if pilot releases controls; lateral and then directional control progressively washed out as angle of attack reaches extreme values; height, heading and airspeed holds provided in fly-by-wire system; aircraft can land automatically using carrier-based guidance system. Bertea hydraulic actuators for trailing-edge flaps; Hydraulic Research actuators for ailerons; National Water Lift actuators for tailerons.

STRUCTURE: Multispar wing mainly of light alloy, with graphite/epoxy inter-spar skin panels and trailing-edge flaps; tail surfaces mainly graphite/epoxy skins over aluminium honeycomb core; graphite/epoxy fuselage panels and doors; titanium engine firewall. Northrop Grumman responsible for rear and centre fuselages and delivered 100th shipset to St Louis at end of January 2002; assembly and test at St Louis factory; CASA produces horizontal tail surfaces, flaps, leading-edge extensions, speedbrakes, rudders and rear side panels for all F/A-18s.

LANDING GEAR: Messier-Dowty retractable tricycle type, with twin-wheel nose and single-wheel main units. Nose unit retracts forward, mainwheels rearward, turning 90° to stow horizontally inside the lower surface of the engine air ducts. Bendix wheels and brakes. Nosewheel tyres size 22×6.6-10 (20 ply) tubeless, pressure 24.13 bar (350 lb/sq in) for carrier operations, 10.34 bar (150 lb/sq in) for land operations. Mainwheel tyres size 30×11.5-14.5 (24/26 ply) tubeless, pressure 24.13 bar (350 lb/sq in) for carrier operations, 13.79 bar (200 lb/sq in) for land operations. Ozone nosewheel steering unit. Nose unit towbar for catapult launch. Arrester hook, for carrier landings, under rear fuselage.

POWER PLANT: Two General Electric F414-GE-400 turbofans, each rated at approximately 97.9 kN (22,000 lb st) with afterburning. Internal fuel capacity (JP-5 fuel) 8,063 litres (2,130 US gallons; 1,774 Imp gallons). Wing tanks protected from combat damage by low-density foam. Provision for five 1,250 litre (330 US gallon; 275 Imp gallon) or Lincoln Composites 1,817 litre (480 US gallon; 400 Imp gallon) external tanks, giving maximum fuel capacity of 17,148 litres (4,530 US gallons; 3,772 Imp gallons) and ability to operate in air refuelling role using hose drum unit on centreline station. Normal operational fit anticipated as three external tanks of either size.

ACCOMMODATION: Pilot only F/A-18E, on Martin-Baker SJU-5/6 NACES zero/zero ejection seat, in pressurised, heated and air conditioned cockpit. Upward-opening canopy, with separate windscreen, on all versions. Two pilots or pilot and Naval Flight Officer in F/A-18F.

SYSTEMS: High commonality with F/A-18C/D, incorporating two separate and independent hydraulic systems, each at 207 bar (3,000 lb/sq in), but with more powerful actuators to accommodate enlarged control surfaces with increased deflections. Leland Electrosystems power generating system; provides 60 per cent more electrical power than in F/A-18C. Hamilton Sundstrand air conditioning; Vickers hydraulic pumps; oxygen system; fire detection and extinguishing systems. Honeywell GTC36-200 APU.

AVIONICS: Over 90 per cent commonality with F/A-18C, but differences include following:

Comms: Rockwell Collins AN/ARC-210 secure UHF/VHF radio. Multifunction information distribution system (MIDS) datalink, Rockwell Collins digital communication system and Hazeltine combined interrogator transponder to be installed as part of upgrade package, before first operational deployment.

Radar: Raytheon AN/APG-73 multimode, digital air-to-air and air-to-ground radar as standard. Raytheon AN/APG-79 active electronically scanned array (AESA) X-band radar under development for use on Super Hornet from 2006; first radar unit formally rolled out by Raytheon on 21 November 2002. Current plans anticipate procurement of 413 AESA radars, comprising 277 for new-build aircraft and 136 for retrofit to existing F/A-18E/Fs. Delivery of AN/APG-79-equipped aircraft expected to begin by 2005, following start of low-rate initial production in FY03, when eight radars will be acquired for trials and operational evaluation in 2006.

Flight: Litton embedded GPS; Smiths/Harris tactical aircraft moving map capability (TAMMAC); DRS Technologies deployable flight incident recorder set (DFIRS).

Instrumentation: Cockpit has 76 × 127 mm (3 × 5 in) touch-panel LCD upfront display and 159 mm (6¼ in) square colour LCD tactical situation display; also two 127 mm (5 in) square monochrome displays and will have monochrome programmable LCD in place of F/A-18C engine/fuel display; Kaiser AN/AVQ-28 HUD. Planar Advance/dpiX awarded joint development contract for Eagle-6 multifunction AMLCD in first half of 1998. Aft cockpit to be 'missionised' for strike operations, including 25 × 20 cm (10 × 8 in) AMLCD and two hand controllers for use by NFO.

Mission: Raytheon developing AN/ASQ-228 advanced targeting forward-looking infra-red (ATFLIR) targeting and navigation system, with award of US$900 million EMD contract in March 1998. Low-rate production authorised in March 2001 with first of planned 574 production units delivered 21 May 2002. Shared Reconnaissance Pod (SHARP) system, incorporating Recon/Optical cameras, under development. Initial deployment to occur in USS *Nimitz* in early 2003, albeit with some key elements, such as high-resolution sensor and datalink, omitted. DRS Technologies WRR-818 cockpit video recording system.

Advanced mission computers based on commercial hardware and software and colour flat panel LCD displays are in development for incorporation in FY05, with DY4 Systems awarded US$1 million order to upgrade existing system which relies on Control Data Corporation AN/AYK-14 digital computers; upgrade will involve replacement of AN/AYK-14 by DMV-179 single board computers and PMC-642 fibre channel network interface module. Vision Systems International joint helmet-mounted cueing system (JHMCS) also to be installed to target the AIM-9X high off-boresight missile; testing of JHMCS on Super Hornet began at China Lake, California, in 2001, with delivery expected in FY03.

Self-defence: Management by BAE Systems (formerly Sanders) AN/ALQ-214(V)2 integrated defensive electronic countermeasures suite (IDECM); interfaces with Raytheon AN/ALR-67(V)3 radar warning receiver, BAE Systems (formerly Sanders) AN/ALE-55 fibre optic towed radar decoy (with triple dispenser stowed between jetpipes); and four BAE Systems AN/ALE-47 chaff/flare dispensers. However, delay and cost growth of IDECM means that first three operational squadrons will have aircraft fitted with less sophisticated Raytheon AN/ALE-50 towed decoy in conjunction with either AN/ALQ-165 ASPJ (first two squadrons) or IDECM. Definitive AN/ALQ-214 and AN/ALE-55 combination to be deployed with effect from fourth squadron, by the end of 2003, while earlier aircraft will be updated.

ARMAMENT: See diagram. Full range of USN offensive and defensive ordnance. At least 29 weapons combinations cleared before service entry. M61A2 20 mm cannon with 400 rounds; will be compatible with forthcoming AIM-9X Advanced Sidewinder missile.

DIMENSIONS, EXTERNAL (approx):

Wing span over missiles	13.62 m (44 ft 8½ in)
Wing aspect ratio	4.0
Width, wings folded	9.94 m (32 ft 7¼ in)
Length overall	18.38 m (60 ft 3½ in)
Height overall	4.88 m (16 ft 0 in)

AREAS:

Wings, gross	46.45 m² (500.0 sq ft)

WEIGHTS AND LOADINGS:

Operating weight empty: F/A-18E	14,552 kg (32,082 lb)
F/A-18F	14,875 kg (32,794 lb)
F/A-18G	14,806 kg (32,642 lb)
Max fuel weight (JP-5): internal	6,354 kg (14,008 lb)
external	7,381 kg (16,272 lb)
Max external stores load: T-O	8,028 kg (17,700 lb)
landing	4,082 kg (9,000 lb)
T-O weight, attack mission	29,937 kg (66,000 lb)
Max wing loading	644.5 kg/m² (132.00 lb/sq ft)
Max power loading	153 kg/kN (1.50 lb/lb st)

PERFORMANCE (estimated):

Max level speed at altitude	more than M1.8
Approach speed	125 kt (232 km/h; 144 mph)
Combat ceiling	15,240 m (50,000 ft)
Min wind over deck: launching	30 kt (56 km/h; 34.5 mph)
recovery	15 kt (28 km/h; 17.5 mph)
Combat radius: interdiction with two SLAM-ER, two AMRAAMs, two Sidewinders and three 1,817 litre (480 US gallon; 400 Imp gallon) external tanks, hi-hi-hi (including flight of SLAM-ER)	945 n miles (1,750 km; 1,087 miles)
fighter escort with four AMRAAMs, two Sidewinders and three 1,817 litre (480 US gallon; 400 Imp gallon) external tanks	795 n miles (1,472 km; 914 miles)
Combat endurance: maritime air superiority, six AAMs, three 1,818 litre (480 US gallon; 400 Imp gallon) external tanks, 150 n miles (278 km; 173 miles) from aircraft carrier	2 h 15 min
g limit	+7.5

UPDATED

BOEING C-17A GLOBEMASTER III

TYPE: Strategic transport.

PROGRAMME: US Air Force selected McDonnell Douglas to develop C-X cargo aircraft 28 August 1981; full-scale development called off January 1982 and replaced on 26 July 1982 by slow-paced preliminary development order; development and three prototypes (one flying) ordered 31 December 1985; fabrication of prototype C-17A (T1/87-0025) began 2 November 1987; first production C-17A contract 20 January 1988; assembly started at Long Beach 24 August 1988; assembly of prototype completed 21 December 1990. Programme transferred from Douglas Aircraft Company to McDonnell Douglas Aerospace in 1992; to McDonnell Douglas Military Transport Aircraft in 1996 and to Boeing following merger of August 1997.

First flight (T1/87-0025) 15 September 1991 – also delivery to Edwards AFB; first flight of initial production aircraft (P1/88-0265) 18 May 1992; first delivery to operational unit 14 June 1993. First overseas service flight (P11/92-3291) to Mildenhall, UK, 25 May 1994.

C-17 was named Globemaster III on 5 February 1993; peak production rate 15 per year (but could be increased to 18); assembly in 102,200 m² (1.1 million sq ft) facility at Long Beach, California.

Development flight testing completed 15 December 1994, by which time 16 production aircraft delivered and 22nd record set (further 13 world records set by 71st production aircraft during testing at Edwards in November 2001). Initial AMC Squadron (17th AS) received its 12th C-17A 22 December 1994; achieved IOC 17 January 1995 with acceptance of 13th (nominal spare) aircraft. Second squadron (14th AS) received its first aircraft 17 February 1995. Air Education and Training Command's 97th AMW at Altus AFB, Oklahoma, subsequently took delivery of eight aircraft between March 1996 and November 1997, all of which had previously been assigned to the 437th AW. Deliveries to 7th AS of 62nd AW at McChord AFB, Washington, began at end of July 1999. C-17 fleet passed 300,000 flying hours in 2001, excluding more than 1,000 hours accumulated by the test-dedicated prototype aircraft.

CURRENT VERSIONS: **C-17A:** Basic standard.

Detailed description applies to C-17A.

C-17B: Not assigned. Used unofficially (along with C-17ER) to identify aircraft with extended-range fuel tanks (Lot 12 and upwards).

KC-17: Private venture tanker/transport project, offered unsuccessfully as replacement for USAF KC-135R/T Stratotanker.

BC-17X: Projected civil cargo version, known until 2000 as MD-17. No recent information.

CUSTOMERS: US Air Force; original requirement 210; cut to 120 by 1991; capped at 40 in January 1994 for two year probationary period, during which contractor to achieve performance, cost and delivery targets; decision taken on 3 November 1995 to acquire the balance of 80 C-17s. Multiyear procurement contract signed 31 May 1996 for production through 2004; first aircraft from this contract (P41/97-0041) delivered 10 August 1998; last due on 30 November 2004.

Second multiyear procurement contract valued at US$9.7 billion for additional 60 aircraft announced on 15

Boeing C-17A Globemaster III strategic transport ***(Paul Jackson)*** 0527160

August 2002, raising total USAF buy to 180, with negotiations under way between Boeing and the USAF for further 42 C-17s that could be purchased with FY08-10 funds, sustaining production at rate of 14 per year.

Basing plans were revealed soon after the decision to procure 120 in all, when the USAF announced that the 437th AW at Charleston AFB, South Carolina, and the 62nd AW at McChord AFB, Washington, will each receive 48 Globemaster IIIs, with these respectively being supported by Air Force Reserve Command personnel of the 315th AW and 446th AW. A further eight C-17As are assigned to the 97th Air Mobility Wing at Altus AFB, Oklahoma, for training duties. Finally, six will be assigned from 2003 to the Air National Guard's 172nd AW at Jackson, Mississippi. The remaining 10 aircraft are to be distributed among those units as reserves to cover scheduled depot level maintenance. McGuire AFB, New Jersey, is expected to receive aircraft from the 60 that were ordered in 2002, but other locations earmarked to gain C-17s are Elmendorf AFB, Alaska, and Hickam AFB, Hawaii, both of which will eventually have eight each.

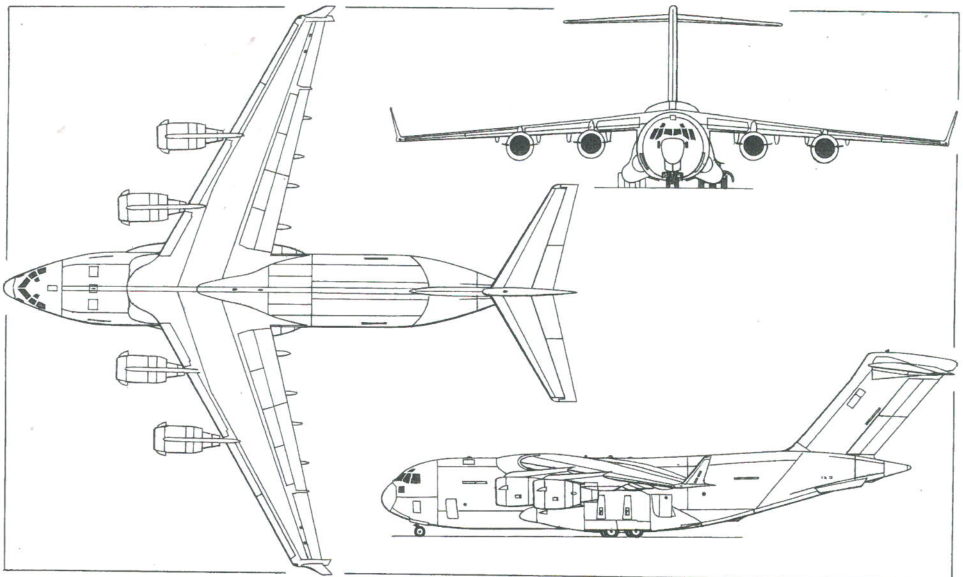
The first C-17A to be handed over to Air Mobility Command was the final aircraft from Lot 2 (P6/89-1192), which made its first flight on 8 May 1993 and was ferried to Charleston AFB for the 437th AW on 14 June 1993. Subsequent deliveries to Air Mobility Command comprise four Lot 3 aircraft between 26 August 1993 and 8 February 1994; four Lot 4 aircraft between 8 April and 20 August 1994; six Lot 5 aircraft between 28 September 1994 and 19 June 1995; six Lot 6 aircraft between 31 July 1995 and May 1996; six Lot 7 aircraft between August 1996 and June 1997; eight Lot 8 aircraft between August 1997 and May 1998; eight Lot 9 aircraft between August 1998 and February 1999; nine Lot 10 aircraft between April and December 1999, including the 50th C-17A, which was accepted by the USAF on 21 May 1999; 13 Lot 11 aircraft between March and December 2000; 19 Lot 12 aircraft (including four for RAF) between February 2001 and April 2002; and 12 Lot 13 aircraft between May 2002 and early 2003. By end of 2002, more than 90 C-17As had been received by the USAF, which anticipated taking delivery of its 100th aircraft in March 2003.

In early 1997, UK Ministry of Defence reportedly considering acquisition of a small number of C-17s for service with RAF in strategic airlift role; no formal requirement then existed, but cost data were received from the USA. Invitation to submit bids for supply on lease basis of up to four 'C-17 equivalent' Short Term Strategic Airlift aircraft issued September 1998, but subsequent criticism by other potential bidders that requirement was weighted in favour of C-17 prompted UK MoD to waive some requirements. Submissions made in early 1999, but competition then suspended in August 1999, when none of competing bids proved acceptable. Restarted, late 1999; announced that C-17 selected on 16 May 2000, with total of four aircraft to be acquired for No. 99 Squadron. These taken from Lot 12 production; assembly of first officially begun 28 June 2000, although lease agreement with Chase Manhattan Bank not signed until 12 January 2001. Lease duration set at seven years, with options for two one-year extensions. Each aircraft valued at £197 million. First aircraft (UK1/ZZ171/00-0201) accepted by RAF on 17 May 2001 at Long Beach; ferried to UK via Charleston AFB and arrived at Brize Norton 23 May. Final aircraft (UK4/ZZ174/00-0204) accepted 24 August 2001 and at Brize Norton by end of August; first operational sortie accomplished in early June; fleet in-service date officially 30 September 2001, at which time UK MoD requested information about availability of further two aircraft and Boeing allocated three further airframes (with provisional US civil registrations) in anticipation of early decision which failed to materialise because of a shortage of funds. However, RAF in late 2002 was still reported to be keen to acquire as many as 12 more Globemaster IIIs.

Canada has requirement for new strategic transport and is believed to be examining several options, including lease or outright purchase of C-17; Australia has also begun studies of requirements for strategic airlift aircraft. Version of the C-17 to be offered for Japanese C-X requirement.

COSTS: Multiyear procurement contract for 80 aircraft signed in May 1996 worth US$14.2 billion; separate US$1.6 billion contract followed in December 1996 for 320 F117 engines. Unit price proposed in November 1995 was US$190 million; recent figures (early 2000) refer to unit cost of US$199 million. Second multiyear procurement contract for 60 aircraft valued at US$9.7 billion.

DESIGN FEATURES: Typical T tail, upswept rear fuselage, high-wing, podded-engine transport, deriving much detail, including externally blown flap system, from McDonnell Douglas YC-15 medium STOL transport prototypes, which involves extended flaps being in exhaust flow from engines during take-off and landing. Combines load-carrying capacity of Lockheed C-5 with STOL performance of Lockheed Martin C-130; required to operate routinely from 915 m (3,000 ft) long and 27.45 m (90 ft) wide runways, complete 180° three-point turn in 25 m (82 ft) and back-taxi up 1 in 50 gradient when fully loaded using thrust reversers. Structure designed to survive battle damage and protect crew; rear-loading ramp.



Boeing C-17A Globemaster III long-range heavy cargo transport ***(Jane's/Dennis Punnett)***

Supercritical wing with 25° sweepback; 2.72 m (8.9 ft) high NASA winglets, angled at 15° from vertical and with 30° sweep.

FLYING CONTROLS: First military transport with all-digital FBW control system and two-crew cockpit with central stick controllers; outboard ailerons and four spoilers per wing; four elevator sections; two-surface rudder split into upper and lower segments; full-span leading-edge slats; two-slot, fixed-vane, simple hinged flaps over about two-thirds of trailing-edge; small strakes under tail. Quadruple-redundant BAE Systems digital fly-by-wire flight control system, with mechanical back-up.

STRUCTURE: Major subassemblies produced in factory at Macon, Georgia; some 50 subcontractors, of which 21 for airframe; subcontractors include Vought (composites ailerons, rudder, elevators, vertical and horizontal stabilisers, engine nacelles and thrust reversers), McCoak Metals (wing skins), Contour Aerospace (wing spars and stringers), Kaman Aerospace (wing ribs and bulkheads), Hitco Technologies (tailcone), Heath Tecna (wing-to-fuselage fillet), Aerostructures Hamble (composites flap hinge fairings and trailing-edge panels) and Northwest Composites (main landing gear pod panels). Raytheon was original supplier of composites winglets and landing gear doors, but replaced by Marion Composites with effect from 41st aircraft; Marion Composites also fabricates nose and tail radomes for last 80 aircraft of USAF order. C-17A structure is 69.3 per cent aluminium; 12.3 per cent steel alloys; 10.3 per cent titanium and 8.1 per cent composites. Wings of P1-P10 underwent local strengthening as consequence of load test of 1 October 1992; first rework to P8/90-0533 at McDonnell Douglas, Tulsa, between 3 January and 9 April 1994.

Proposal, early 1994, to design all-composites horizontal tail surfaces for weight-saving resulted in McDonnell Douglas (later Boeing) securing a US$40.7 million contract to build new unit; revised tail manufactured by Northrop Grumman (now Vought) using AS-4 carbon fibre for spars and skins and machined 7075 aluminium for ribs, resulting in assembly said to be 50 per cent cheaper and 20 per cent lighter than existing tail. Incorporates 2,000 fewer components and 42,000 fewer fasteners. Following testing on prototype, completed April 1999, it was incorporated on production aircraft beginning with P51/98-0051.

Landing gear pod entirely redesigned in 1995, drastically reducing number of parts and fasteners and simplifying process of attachment to aircraft; introduced on first Lot 8 aircraft (P33/96-0001) and expected to save US$88 million over remainder of production programme for USAF. New, lighter and less costly engine nacelle, saving 113 kg (250 lb) per unit, flight tested at Edwards AFB between December 1997 and February 1998; first production aircraft with new nacelles (P41/97-0041) delivered to USAF on 10 August 1998.

LANDING GEAR: Hydraulically retractable tricycle type, with free-fall emergency extension; designed for sink rate of 3.81 m (12 ft 6 in)/s and suitable for operation from paved runways or unpaved strips. Mainwheel units, each consisting of two legs in tandem with three wheels on each leg, rotate 90° to retract into fairings on lower fuselage sides; tyre size 50×21.0-20 (30 ply) tubeless; pressure 9.52 bar (138 lb/sq in). Menasco (Goodrich from 41st aircraft) twin-wheel nose leg retracts forwards; tyre size 40×16-14 (26 ply) tubeless; pressure 10.69 bar (155 lb/sq in). Honeywell wheels and carbon brakes initially fitted; with effect from aircraft P90/01-0190, Messier-Bugatti wheels, tyres and brakes fitted as standard. Permitting C-17 to be certified to 278,959 kg (615,000 lb) MTOW, these are to be retrofitted to entire fleet. Minimum ground turning radius at outside mainwheels 17.37 m (57 ft 0 in); minimum taxiway width for three-point turn 27.43 m (90 ft 0 in); wingtip/tailplane clearance 74.24 m (237 ft 0 in).

POWER PLANT: Four Pratt & Whitney F117-PW-100 (PW2040) turbofans, with maximum flat rating of 179.9 kN (40,440 lb st), pylon-mounted in individual underwing pods and each fitted with a directed-flow thrust reverser deployable both in flight and on the ground. With effect from the 20th production aircraft, an improved version of the F117 was adopted, this embodying single-

C-17 PROCUREMENT

FY	Lot	Qty	Cum	Line Numbers	First aircraft	Delivery
-	Proto	1	(1)	T1	87-0025	15 Sep 1991
88	1	2	2	P1-P2	88-0265	18 May 1992
89	2	4	6	P3-P6	89-1189	7 Sep 1992
90	3	4	10	P7-P10	90-0532	26 Aug 1993
91	-	-	-	-	-	-
92	4	4	14	P11-P14	92-3291	8 Apr 1994
93	5	6	20	P15-P20	93-0599	29 Sep 1994
94	6	6	26	P21-P26	94-0065	31 Jul 1995
95	7	6	32	P27-P32	95-0102	3 Jul 1996
96	8	8	40	P33-P40	96-0001	28 Aug 1997
97	9	8	48	P41-P48	97-0041	10 Aug 1998
98	10	9	57	P49-P57	98-0049	22 April 1999
99	11	13	70	P58-P70	99-0058	17 March 2000
00	12	15	85	P71-P85	00-0171	8 Feb 2001
	12	4 (RAF)	89	UK1-UK4	00-0201/ZZ171	17 May 2001
01	13	12	101	P86-P97	01-0186	May 2002
02	14	15	116	P98-P112	02-1098	Aug 2003
03	15[1]	15	131	P113-P127	-	Aug 2004
04	16	11	142	P128-P138	-	-
05	17	14	156	P139-P152	-	-
06	18	14	170	P153-P166	-	-
07	19	14	184	P167-P180	-	-
Total		**184 + 1**				

Notes

[1] Includes first seven aircraft from follow-on batch of 60 C-17s.

Globemaster III of No. 99 Squadron, Royal Air Force *(Paul Jackson)* 0527159

crystal turbine blade technology, a supercharged compressor and enhanced thermal barrier coatings; benefits include a 20 per cent reduction in cost of maintenance, increased reliability and slightly better sfc. Provision for in-flight refuelling. Two outboard wing fuel tanks of 21,210 litres (5,603 US gallons; 4,665 Imp gallons) each; two inboard wing fuel tanks of 30,056 litres (7,940 US gallons; 6,611 Imp gallons) each; total capacity 102,532 litres (27,086 US gallons; 22,554 Imp gallons). BAE Systems fuel pumps. With effect from the 71st (first Lot 12) aircraft, an extended-range fuel tank containment system (ERFCS) was adopted; this converts wing dry bay into additional fuel tank containing approximately 36,339 litres (9,600 US gallons; 7,994 Imp gallons) of fuel, thus increasing range with 18,144 kg (40,000 lb) payload by 900 n miles (1,667 km; 1,036 miles). ERFCS also installed on four UK aircraft.

ACCOMMODATION: Normal flight crew of pilot and co-pilot side by side and two observer positions on flight deck, plus loadmaster station at forward end of main floor; access to flight deck via downward-opening airstair door on port side of lower forward fuselage. Bunks for crew immediately aft of flight deck area; crew comfort station at forward end of cargo hold.

Main cargo hold able to accommodate US Army wheeled and tracked vehicles up to M1 main battle tank, including 5 ton expandable vans in two rows, or up to three AH-64 Apache attack helicopters, with loading via hydraulically actuated rear-loading ramp which forms underside of rear fuselage when retracted. Aircraft fitted with 27 stowable tip-up seats along each sidewall and another 48 seats carried on board which can be erected along the centreline; optionally up to 36 litters for medical evacuation mission or up to 90 passengers on 10-passenger pallets in addition to 54 sidewall seats. Air delivery system capability for nine 463L pallets plus two on ramp in single row; or logistics handling system for 18 463L pallets in double row. Airdrop capability includes single platforms of up to 27,215 kg (60,000 lb), multiple platforms of up to 54,430 kg (120,000 lb), container delivery system (CDS) for up to 40 CDS bundles or 40 Tri-wall Aerial Delivery System (TRIADS) containers, or up to 102 paratroops; aircraft originally configured for single-row airdrop, but dual-row capability operationally certified in 1998 and is standard feature of 51st and subsequent C-17s, as well as being retrofitted to earlier aircraft. Equipped for low-altitude parachute extraction system (LAPES) drops.

Cargo handling system includes rails for airdrops and rails/rollers for normal cargo handling. Each row of rails/rollers can be converted quickly by a single loadmaster from one configuration to the other. Total of 295 cargo tiedown rings, each stressed for 11,340 kg (25,000 lb), all over cargo floor forming grid averaging 74 cm (29 in) square. Three quick-erecting litter stanchions, each supporting three litters, permanently carried. Main access to cargo hold is via rear-loading ramp, which is itself stressed for 18,145 kg (40,000 lb) of cargo in flight. Underfuselage door aft of ramp moves upward inside fuselage to facilitate loading and unloading. Paratroop door at rear on each side; four overhead FEDS (flotation equipment deployment system) escape hatches, three of which are equipped with a liferaft.

SYSTEMS: Include Honeywell computer-controlled integrated environmental control system and cabin pressure control system; 2,440 m (8,000 ft) equivalent cabin pressure up to 11,280 m (37,000 ft); quad-redundant flight control and four independent 276 bar (4,000 lb/sq in) hydraulic systems; independent fuel feed systems; electrical system; Honeywell GTCP331-250G APU (at front of starboard landing gear pod), provides auxiliary power for environmental control system, engine starting, and on-ground electronics requirements; onboard inert gas generating system (OBIGGS) for the explosion protection system, pressurised by engine bleed air at 4.14 bar (60 lb/sq in) to produce NEA (nitrogen-enriched air) and governed by a Parker-Gull system controller; fire suppression system; smoke detection systems. Separate OBIGGS for ERFCS-configured aircraft. All phases of cargo operation and configuration change capable of being handled by one loadmaster.

Electrical system includes single 90 kVA generator per engine and an APU, providing 115/200 V, three-phase, 400 Hz AC power; four 200 A transformer-rectifiers providing 28 V DC; single-phase, 1,000 VA inverter for ground refuelling and emergency AC; and two 40 Ah Ni/Cd batteries for APU starting and emergency DC. Aeromedical equipment provided with 60 Hz power.

AVIONICS: *Comms:* Telephonics Corporation IRMS integrated radio management system; Rockwell Collins AN/ARC-210 secure radio (from P50/98-0050, replacing Raytheon AN/ARC-187 plus Honeywell KY 58 encoder); satcom; VHF-AM/FM; HF; secure voice and jam-resistant UHF/VHF-FM intercom; IFF/SIF; en route army/marine UHF LOS and satcom hook-up; cockpit voice recorder; crash position indicator. Automatic communications processor and multiband radio in new-build aircraft starting with P50/98-0050 and retrofitted to earlier C-17As. In December 1998, Rockwell Collins selected by Boeing to provide SAT-2000 Aero-1 satcom systems and CMU-900 communication management units for future global air traffic management (GATM) environment; initial order for support and preproduction hardware, with options to install equipment on all 120 aircraft. Production line GATM introduction at P71/00-0171, involving TCAS, Mode S IFF, ADS-A (automatic dependent surveillance) and Inmarsat Aero I satcom, plus liquid crystal displays replacing all head-down CRTs. GATM augmented from P97 by HF datalink and RNP 4 (required navigation performance) measures. Under development in 1999 were two SOLL II (special operations low-level) roll-on/roll-off communications suites for use on specific missions; and carry-on radio suite for use on special forces flights, beginning in 2002.

Radar: Honeywell AN/APS-133(V) weather/mapping radar; this will be replaced by new unit identical to that selected for C-130 Hercules as part of the Avionics Modernization Program. New radar to be fitted from outset to all aircraft of follow-on order and will be retrospectively installed on older C-17s as their existing systems become inoperative.

Flight: Three Delco Electronics mission computers with MDC software and electronic control system on P1 to P40; beginning with P41/97-0041, two Lockheed Martin core integrated processors (CIPs) replaced Delco Electronics equipment and retrofitted on earlier aircraft by September 1998; additional memory added from P50/98-0050 onwards. Hamilton Sundstrand aircraft and propulsion data management computer; Honeywell dual air data computers; Litton warning and caution system; master warning system provides aural and voice alerts plus visual alerts on glareshields; General Dynamics automatic test equipment, and support equipment data acquisition and control system; GPS and four Honeywell inertial reference units, although new, embedded GPS INS introduced from P50/98-0050; VOR/DME; Tacan; ILS/marker beacon; UHF-DF; ground proximity warning system; radar altimeter; flight data recorder; flight plan entry manually or via laptop computer. BAE Systems terrain awareness warning system (TAWS) to be installed in conjunction with Lockheed Martin Control Systems video integrated processor (VIP), currently under development, from P86 onwards; TAWS underwent initial flight testing from Edwards AFB in 2001-02 and will complete further trials in first half of 2002.

Instrumentation: Advanced digital avionics and four Honeywell full-colour cathode ray tube (CRT) displays; new Honeywell 152 × 152 mm (6 × 6 in) AMLCD colour multifunction displays (MFDs) in 71st and subsequent production aircraft; two BAE Systems full flight regime foldable head-up displays.

Mission: Litton integrated mission and communications keyboards (MCKs) and displays (MCDs); Sierra Technologies AN/APN-243A(V) station-keeping equipment (SKE 2000) fitted as standard commencing with P33/96-0001, retrofitted to earlier aircraft and upgraded from P86 (first Lot 13) onwards to increase capacity from 17 to 100 aircraft. Loadmaster's laptop computer from P41/97-0041 onwards; this replaced from P58/99-0058 by Dolch aircrew data device.

Self-defence: Development of defensive electronic systems completed in 1994. ATK, Lockheed Martin or Honeywell AN/AAR-47 missile approach warning system and associated BAE Systems AN/ALE-47 automatic flare dispenser installed on five aircraft; USAF has adopted this equipment across the fleet. USAF seeking to counter IR homing missiles with laser jamming system and has plans to deploy these on C-17 from early 2004 onward.

EQUIPMENT: Removable crew armour can be fitted around flight deck and loadmaster's area.

DIMENSIONS, EXTERNAL:

Wing span: wings only	50.29 m (165 ft 0 in)
at winglet tips	51.74 m (169 ft 9 in)
Wing aspect ratio	7.2
Length: overall	53.04 m (174 ft 0 in)
fuselage	48.49 m (159 ft 1¼ in)
Height: to flight deck roof	7.34 m (24 ft 1 in)
to winglet tips	6.93 m (22 ft 9 in)
overall	16.79 m (55 ft 1 in)
Fuselage diameter	6.85 m (22 ft 6 in)
Tailplane span	19.81 m (65 ft 0 in)
Wheel track	10.26 m (33 ft 8 in)
Wheelbase: to front mainwheel	17.60 m (57 ft 8¾ in)
to rear mainwheel	20.05 m (65 ft 9½ in)
Ground clearance under engine pods:	
inboard	2.71 m (8 ft 10½ in)
outboard	2.35 m (7 ft 8½ in)
Distance between fuselage centreline and engine	
centreline: inboard	7.44 m (24 ft 5 in)
outboard	13.94 m (45 ft 9 in)
Height of winglets	2.72 m (8 ft 11 in)

DIMENSIONS, INTERNAL:

Cargo compartment:	
Length, incl 6.05 m (19 ft 10 in) rear-loading ramp	26.82 m (88 ft 0 in)
Loadable width	5.49 m (18 ft 0 in)
Max height: under wing	3.96 m (13 ft 0 in)
aft of wing	4.50 m (14 ft 9 in)
Height to sill	1.63 m (5 ft 4 in)
Volume	591.8 m^3 (20,900 cu ft)

AREAS:

Wings, gross	353.03 m^2 (3,800.0 sq ft)
Winglets (total)	3.33 m^2 (35.85 sq ft)
Ailerons (total)	11.83 m^2 (127.34 sq ft)
Tailplane	78.50 m^2 (845.00 sq ft)

WEIGHTS AND LOADINGS:

Operating weight empty:	
non-ERFCS aircraft	125,645 kg (277,000 lb)
ERFCS aircraft	127,685 kg (281,500 lb)
Max payload (2.5 *g* load factor):	
non-ERFCS aircraft	76,655 kg (169,000 lb)
ERFCS aircraft	75,250 kg (165,900 lb)
Max weight on rear-loading ramp	18,143 kg (40,000 lb)
Max usable fuel weight:	
non-ERFCS aircraft	82,125 kg (181,054 lb)
ERFCS aircraft	110,990 kg (244,688 lb)
Max T-O weight: ERFCS aircraft	278,959 kg (615,000 lb)

Precision 'piano keys' landing by a Boeing C-17A Globemaster III of 437th AW, Charleston AFB *(Paul Jackson)* ***NEW***/0546854

Max wing loading: ERFCS aircraft
790.2 kg/m² (161.84 lb/sq ft)
Max power loading: ERFCS aircraft
388 kg/kN (3.80 lb/lb st)

PERFORMANCE:
Normal cruising speed at 8,535 m (28,000 ft) M0.74-0.77
Max cruising speed at low altitude
350 kt (648 km/h; 403 mph) CAS
Airdrop speed: at S/L
115-250 kt (213-463 km/h; 132-288 mph) CAS
at 7,620 m (25,000 ft)
130-250 kt (241-463 km/h; 150-288 mph) CAS
Approach speed with max payload
115 kt (213 km/h; 132 mph) CAS
Service ceiling 13,715 m (45,000 ft)
Runway LCN (paved surface) better than 49
T-O field length at MTOW 2,360 m (7,740 ft)
Landing field length with 72,575 kg (160,000 lb)
payload, using thrust reversal 915 m (3,000 ft)
Range with payloads indicated, with no in-flight refuelling
18,144 kg (40,000 lb) payload:
non-ERFCS aircraft
4,400 n miles (8,148 km; 5,063 miles)
ERFCS aircraft
5,300 n miles (9,815 km; 6,099 miles)
72,575 kg (160,000 lb), T-O in 2,286 m (7,500 ft), land in 915 m (3,000 ft), load factor of 2.25 *g*
both: 2,400 n miles (4,444 km; 2,761 miles)
self-ferry (zero payload), T-O in 1,128 m (3,700 ft), land in 701 m (2,300 ft), load factor of 2.5 *g*:
non-ERFCS aircraft
4,700 n miles (8,704 km; 5,408 miles)
ERFCS aircraft
6,250 n miles (11,575 km; 7,192 miles)

UPDATED

BOEING 737 AEW&C

TYPE: Airborne early warning and control system.

PROGRAMME: Adaptation of Boeing Business Jet (BBJ, which combines 737-700 fuselage with strengthened wing and landing gear of 737-800). Additional features include extra fuel tanks in former baggage hold. Proposed for Australian Project Air 5077 Wedgetail by Boeing, Northrop Grumman Electronic Sensor Systems Division (ESSD) and BAE Australia. Competed against proposals from Lockheed Martin and Raytheon. Secured initial design activity contract worth about US$6 million in December 1997, paving way for submission of full tenders in early 1999. Selection of Boeing submission officially announced on 21 July 1999. RAAF initially planned to acquire seven aircraft for US$1.32 billion; cost concerns resulted in reduction to six plus one option in May 2000, but when contract signed on 20 December, this had further reduced to four and three options, at reported cost of US$1.65 billion. Delivery of first two aircraft scheduled for the end of 2006, with operating unit to be No. 2 Squadron. Second pair to be handed over at end of 2007. Main base at Williamtown, New South Wales, with two aircraft permanently deployed to forward operating location at Tindal, Northern Territories; IOC to be achieved at end of 2008. Preliminary design review of radar and IFF systems successfully completed in September 2001; further reviews of navigation system, mission computing hardware and other airborne mission systems undertaken by January 2002, with ground-based elements not scheduled to undergo PDR until 2004.

ESSD L-band multirole electronically scanned array (MESA) radar mounted above rear fuselage ('top hat' configuration) providing 360° coverage from stationary antenna 10.7 m (35 ft) long and 2.35 m (7 ft 9 in) high. Operating modes will include acute long-range or broad short-range scanning and track-while-scan; maximum detection range said to exceed 216 n miles (400 km; 249 miles). Initial radar to be installed in Boeing 737 in 2003 for testing, with modification of this and remaining three aircraft to be undertaken in Wichita, Kansas. In late 1998, demonstrator BBJ temporarily fitted with full-scale replica of MESA radar, six operator consoles and equipment cabinets for inspection by Australian defence department officials; mockup also featured in-flight refuelling probe above cockpit and EW/ECM sensors. Definitive aircraft will, however, feature 10 operator consoles initially, with potential to add further two. Aerodynamic effects of MESA offset by two large strakes below rear fuselage. Electronic warfare self-protection (EWSP) system will include Northrop Grumman AN/AAQ-24(V) directed infra-red countermeasures system, plus chaff and flares; Elta providing advanced ESM/elint systems; these will be controlled by the ALR-2001 computer. Other mission equipment to include Link 11, JTIDS, Mode S IFF and satcom; flight deck tactical displays, three HF and eight VHF/UHF radios. Patrol endurance of 9 hours at 300 n miles (555 km; 345 miles) from base can be extended by airborne refuelling, with modification to include installation of flying boom receptacle and a removable probe. Maximum T-O weight 77,565 kg (171,000 lb); service ceiling 12,500 m (41,000 ft).

First Australian aircraft rolled out at Seattle on 31 October 2002; subsequently, flown to Georgetown, Delaware, on 4 January 2003 for installation of an auxiliary fuel system and tanks. Latter procedure should require about three months to complete, whereupon aircraft was due to return to Boeing for structural modifications associated with installation of radar and mission systems. First MESA radar rolled out at beginning of November 2002 and installed on test range by Northrop Grumman; delivery to Boeing for installation on 737 was expected in May 2003, with first flight due in early 2004.

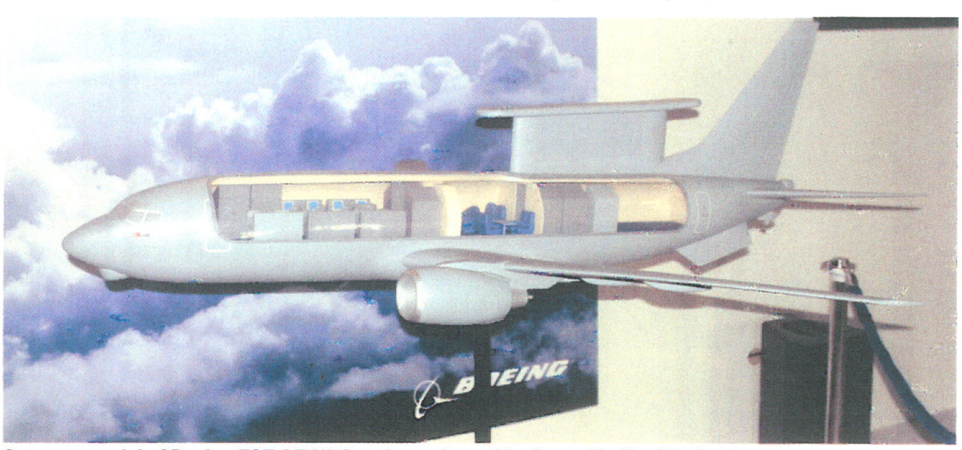
Republic of Korea interested in AEW-configured 737 as less costly solution to E-X requirement in lieu of Boeing 767, which considered too expensive; Boeing proposal in competition with rival offerings from Raytheon and Thales, both of which have Airbus A321 as platform. Total of four aircraft required by Korea, which is expected to announce winner in 2005.

After studying proposals for AEW aircraft involving Airbus A310/Phalcon and Boeing 737/MESA combinations, in early December 2000 Turkey announced selection of latter and revealed intent to obtain total of six aircraft (with option on two more) at cost of US$1.5 billion; these will include some indigenous equipment. Contract signature was expected in early 2001, but negotiations continued throughout remainder of 2001; contract finally signed on 4 June 2002, at which time the number of aircraft to be purchased had been reduced to four (with two on option).

Boeing originally forecasting potential sales of up to 50 737 AEW&C aircraft, with other possible customers including Italy, Singapore, Spain and the United Arab Emirates; by the beginning of 2002, this had fallen to 30 over next 10 years.

UPDATED

Model of a potential Boeing 737 MMA configuration *(Paul Jackson)* ***NEW***/0552832



Cutaway model of Boeing 737 AEW&C variant adopted by Australia *(Paul Jackson)* ***NEW***/0530173

BOEING 737 MMA

TYPE: Maritime surveillance twinjet.

PROGRAMME: Design study for 737 MMA (Multi-mission Maritime Aircraft) revealed 18 April 2000 as potential replacement for Lockheed Martin P-3C Orion and EP-3E Aries II. Based on C-40A (see Boeing 737 entry under Boeing Commercial Airplanes), combining 737-800 wing and 737-700 fuselage, latter with internal weapons bay beneath forward section and former with hardpoints for air-to-surface missiles. Full range of maritime patrol equipment envisaged, including enlarged nose accommodating Raytheon AN/APS-137 search radar, up to seven operators' consoles and rotary sonobuoy launcher, plus additional fuel in aft baggage hold.

Maximum T-O weight 77,565 kg (171,000 lb); maximum transit speed 490 kt (907 km/h; 564 mph); mission radius 2,000 n miles (3,704 km; 2,301 miles). US Navy awarded US$493,000 concept exploration study contract to Boeing in July 2000; this followed in September 2002 by US$7 million contract for Phase 1 of component advanced development (CAD), during which air vehicle performance validated and mission system parameters were developed and analysed. Subsequently, in February 2003, a further contract, worth US$20.5 million, was awarded for Phase 2 of CAD, including additional performance analysis and continuing development of the associated mission system. Similar contracts went to Lockheed Martin, which proposes an Orion derivative for the MMA.

On completion of Phase 2, Navy will award single contract for the system development and demonstration (SDD) programme. Downselect is expected in early 2004, with low-rate initial production beginning in 2009, followed by service entry in 2012.

Boeing is also offering a version of the 737 for the joint German-Italian MPA-R programme, which could result in a contract for a total of 24 aircraft. Selection of a winner is set for 2003, with contract award following in 2004 and Boeing is seeking 'harmonisation', so that it can offer a single proposal to satisfy both the MMA and MPA-R requirements.

UPDATED

BOEING 767 MILITARY VERSIONS

TYPE: Tanker-transport; airborne ground surveillance system.

PROGRAMME: Variants of Boeing 767 twin-turbofan airliner (which see under Boeing Commercial Airplanes for technical description).

CURRENT VERSIONS: **767 AWACS**: Production complete.

KC-767 Global Tanker Transport Aircraft (GTTA): Tanker-transport version announced by Boeing, February 1995, in anticipation of Japanese order; Boeing in discussions with Kawasaki by mid-1996, concerning co-operative venture to offer tanker version of the 767 to Japan ASDF. Kawasaki involvement then expected to take form of post-production work (including fitment of boom refuelling gear, extra tanks and associated plumbing) on 767-300 derivative. JASDF intended to request funding from FY99, but economic downturn and reductions in defence budget caused delay. Purchase intention reaffirmed on 14 December 2001, by Japanese government, which announced plan to buy four aircraft. On 4 April 2003, Boeing announced signature of contract for first of planned four tanker-transports; this due for

Boeing 767 tanker-transport, as offered to the Royal Air Force by Tanker Transport Services Company ***(TTSC)*** 0528622

delivery in "Spring 2007", with remainder following at rate of one aircraft per year.

Version of 767 with three hose drum units offered to UK Royal Air Force which has FSTA requirement for a new tanker aircraft to replace VC-10 and Tristar from about 2008 onwards. Total of 20 to 30 aircraft needed, with six consortia invited in September 1999 to tender submissions for a public-private finance initiative to satisfy requirement. Combinations had reduced this to four by late 1999, but only two consortia submitted proposals on 3 July 2001, of which one (Tanker & Transport Service Company) offering 767 solution based on use of ex-British Airways 767-300s. Selection of successful bid expected in June 2002, but delayed as result of slow progress in contract negotiations. Outcome still awaited at beginning of June 2003.

Tanker-transport proposals most recently based on 767-200ER (see Boeing Commercial Airplanes entry); fuel dispensed through Boeing 'flying boom' and two Smiths Aerospace underwing pods; boom remotely controlled from cabin, assisted by CCTV and/or three-dimensional helmet-mounted display; proximity trials at Patuxent River NAS in June 2000 showed 767 to be stable refuelling platform. Fuel capacity 91,380 litres (24,140 US gallons; 20,101 Imp gallons), in standard (wing) tanks, plus 21,198 litres (5,600 US gallons; 4,663 Imp gallons) in supplementary underfloor tanks; total 112,578 litres (29,740 US gallons; 24,764 Imp gallons). As freighter (side cargo door and reinforced floor), can carry up to 18 463L pallets on main deck or 216 passengers, with additional cargo capacity on lower deck dependent upon auxiliary tank configuration. Version offered to RAF, with HDU in place of 'flying boom', has underfloor fuel of 29,942 litres (7,910 US gallons; 6,586 Imp gallons).

First Boeing 767 tankers will be flown by Italian Air Force, which revealed intention in July 2001 to purchase four new-build aircraft as replacements for current Boeing 707 tankers. Signature of final contract took place in early December 2002; delivery will be accomplished during 2005-08 and total cost, including option on two additional aircraft, is about US$618 million. Based on the 767-200ER commercial transport, it will be powered by CF6-80C2 turbofans and will feature a Boeing air-refuelling boom, a RARO II remote air-refuelling operator station, wing pods containing hose and drogue refuelling apparatus and a centreline hose and drogue system. It will also have a refuelling receptacle fitted as standard.

A derivative of the Boeing 767 is also to begin process of replacing the USAF KC-135 Stratotanker. In 2001, proposal to lease 100 aircraft emerged, with this envisaging a 10-year period, after which the USAF could negotiate outright purchase; this won more support after September 2001 terrorist attack on USA, and USAF formally notified Congress in April 2002 of intention to begin negotiations immediately. Discussions between Boeing and the USAF still proceeding at end of 2002, when decision expected early in 2003; at beginning of April, talks were still continuing. On 23 May 2003, the US Department of Defense announced approval of lease arrangement and revealed more details of this US$16 billion programme; lease said to be for "six years starting in 2006", at unit cost of US$131 million, plus US$7 million in lease-unique costs per aircraft; same announcement noted that agreement included provision to buy the aircraft outright for about US$4 billion when lease terminates in "2017". USAF anticipates receiving first aircraft in 2005 and is likely to accept about 20 per year; longer-term goal is to acquire up to 500 new tankers, allowing eventual retirement of veteran KC-135.

Boeing formed 767 Tanker Programs office in March 2001 and subsequently selected its Wichita, Kansas facility as the centre for tanker modification work.

Multimission Command and Control Aircraft (MC2A): Now designated Northrop Grumman E-10.

COSTS: Estimated US$216 million for Japanese 767 tanker (2001). Boeing price varies from US$150 million to US$225 million, according to quantity procured.

Data follow for Tanker-Transport.

WEIGHTS AND LOADINGS (estimated):

Operational weight, empty	90,720 kg (200,000 lb)
Max T-O weight	179,170 kg (395,000 lb)
Max ramp weight	179,625 kg (396,000 lb)
Max zero-fuel weight	117,934 kg (260,000 lb)

UPDATED

BOEING AL-1A

TYPE: Missile defence system.

PROGRAMME: Prototype YAL-1A (USAF serial number 00-0001) ordered on 12 November 1996; purchase of 747-400F airframe from Boeing confirmed on 30 January 1998. Formal authority to proceed received on 26 June 1998, after TRW successfully demonstrated laser firing and missile tracking. First metal cut on YAL-1A on 10 August 1999; rolled out at Everett on 12 December 1999; first flight 6 January 2000; delivered to Boeing Wichita on 21 January 2000 for outfitting with strengthened floor and modifications to take nose-mounted laser turret; subsequent critical design review completed in late April.

On completion of 1.6 million man-hours of work at Wichita, aircraft was originally expected to fly in February 2002, then be ferried to Edwards AFB, California, for installation of six-module COIL laser from May 2002, followed by trials against various missiles, with PDRR phase culminating with demonstration against a ballistic missile fired from Vandenberg AFB, California, in September 2003; however, by early 2002, a combination of changed defence priorities and technical issues had combined to cause delay in programme and it had been confirmed that the ballistic missile shoot-down demonstration had been postponed to 2004; 30-month EMD phase expected to begin in early 2004, with IOC of first three aircraft set for late 2007 and full operational capability (seven aircraft) in 2009.

Maiden flight following modification eventually achieved on 18 July 2002. YAL-1A completed short evaluation of aircraft performance and system operation from Wichita before being painted and prepared for delivery to Edwards AFB, where laser to be installed. Initial stage of evaluation revealed problems with buffet and lateral acceleration forces acting on pylon for active ranging system pod located above flight deck; this was sufficiently severe to necessitate removal of pylon and pod after third flight and has forced Boeing to redesign this unit. YAL-1A ferried to Edwards on 19 December 2002 and is currently expected to begin airborne laser firing tests in 2005; before that, laser unit to be tested on ground in special laboratory facility that contains a 747 fuselage.

CUSTOMERS: US Air Force (seven required).

COSTS: Programme cost (1997, estimated) US$5 billion for one concept prototype and one EMD (both eventually to be fully upgraded) and five production aircraft. Initial programme definition and risk reduction (PDRR) contract of November 1996 valued at US$1.1 billion. US$598 million requested for FY03, including US$85 million for long-lead items for EMD aircraft.

DESIGN FEATURES: Based on airframe of Boeing 747-400F (which see under Boeing Commercial Airplanes). Equipped with TRW multihundred kW chemical oxygen

Prototype YAL-1A arriving at Edwards AFB on 19 December 2002 ***(USAF)*** ***NEW***/0547142

Boeing YAL-1A missile defence aircraft ***(USAF)*** ***NEW***/0547143 iodine laser (COIL) and Lockheed Martin beam control/fire-control system, for target acquisition, plus aiming and firing of laser. Active ranging system housed in pod sited above forward fuselage section. Intended to destroy theatre ballistic missiles during their boost phase, but with additional capability against low-flying cruise missiles; other potential applications began emerging in 1998, these including protection of high-value aircraft such as AWACS and Joint STARS by destroying SAMs and AAMs; imaging and reconnaissance with aid of optical telescope; SEAD, by combining intelligence data to engage hostile missile sites and radar control systems; and command and control through search/detection of infra-red signatures to aid cueing of other weapons. Laser able to fire 20 to 30 times per mission; titanium to be used instead of aluminium in certain areas to protect against heat damage to undersides caused by laser exhaust gases. Mission crew to comprise four specialists at individual consoles at rear of forward compartment, specifically the mission crew commander, airborne surveillance officer, weapon system operator and special equipment operator; standard flight deck crew of two could be augmented for long missions.

UPDATED

BOEING 114 and 414

US Army designations: CH-47 and MH-47 Chinook
Royal Air Force designations: Chinook HC. Mk 2, HC. Mk 2A and HC. Mk 3
Spanish Army designation: HT.17
JASDF and JGSDF designations: CH-47J and CH-47JA

TYPE: Medium-lift helicopter.

PROGRAMME: Design of all-weather medium transport helicopter for US Army began 1956; first flight of YCH-47A 21 September 1961. initial production concerned CH-47A and CH-47B. Performance increased in CH-47C by uprated transmissions and 2,796 kW (3,750 shp) T55-L-11A; internal fuel capacity increased; first flight 14 October 1967; delivered to US Army from 1968.

CURRENT VERSIONS: **CH-47D:** US Army contract to modify one each of CH-47A, B and C to prototype Ds placed 1976; first flight 11 May 1979; first production contract October 1980; first flight 26 February 1982; first delivery 31 March 1982; initial operational capability (IOC) achieved 28 February 1984 with 101st Airborne Division; first multiyear production contract for 240 CH-47Ds awarded 8 April 1985; second multiyear production contract for 144 CH-47Ds (including 25 MH-47Es) awarded 13 January 1989, bringing total CH-47D (and MH-47E) ordered to 472; two Gulf War attrition replacements authorised August 1992 (these new-build); seven ex-Australian rebuilds funded June 1993 for delivery January to November 1995. Additional new-build CH-47D ordered for US Army in June 1999 was delivered to Fort Hood, Texas, on 19 June 2002.

CH-47D update included strip down to bare airframe, repair and refurbish, fit Honeywell T55-L-712 turboshafts, uprated transmissions with integral lubrication and cooling, composite rotor blades, new flight deck compatible with night vision goggles (NVG), new redundant electrical system, modular hydraulic system, advanced automatic flight control system, improved avionics and survivability equipment, Solar T62-T-2B APU operating hydraulic and electrical systems through accessory gear drive, single-point pressure refuelling, and triple external cargo hooks. Principal external change is large, rectangular air intake in leading-edge of rear sail. Composites account for 10 to 15 per cent of structure. About 300 suppliers involved.

At maximum gross weight of 22,680 kg (50,000 lb), CH-47D has more than double useful load of CH-47A. Sample loads include M198 towed 155 mm howitzer, 32 rounds of ammunition and 11-man crew, making internal/external load of 9,980 kg (22,000 lb); D5 caterpillar bulldozer weighing 11,225 kg (24,750 lb) on centre cargo hook; US Army Milvan supply containers carried at up to 130 kt (256 km/h; 159 mph); up to seven 1,893 litre (500 US gallon, 416 Imp gallon), 1,587 kg (3,500 lb) rubber fuel blivets carried on three hooks.

MH-47D Special Operations Aircraft: Element of 160th Special Operations Aviation Regiment (at Hunter AAF, Georgia) equipped with 11 CH-47Ds modified to **MH-47D SOA** standard with refuelling probes (first refuelling July 1988), thermal imagers, Honeywell RDR-1300 weather radar, Rockwell Collins 'glass cockpits', improved communications and navigation equipment, and two pintle-mounted 7.62 mm six-barrel miniguns. Navigator/commander's station also fitted. It is intended to update all MH-47Ds to MH-47G configuration, incorporating technology improvements developed for the CH-47F.

GCH-47D: Limited number of Chinooks grounded for maintenance training at Fort Eustis, Virginia.

HH-47D: South Korean Air Force's 235 Squadron received six aircraft with this local designation for SAR.

JCH-47D: At least two aircraft (84-24159 and 90-0180) modifed for temporary test tasks; both current in April 2001.

US ARMY CH-47D PROCUREMENT

FY	Qty	First aircraft	Remarks
81	9	81-23381	
82	19	82-23762	
83	24	83-24102	
84	36*	84-24152	
85	48	85-24322	MYP1
86	48	86-1635	MYP1
87	48	87-0069	MYP1
88	48†	88-0062	MYP1
89	48	89-0130	MYP2
90	48[1]	90-0180	MYP2
91	48[2]	91-0230	MYP2
92	48[3]	92-0280	MYP2
	2[4]	92-0367	
93	7[5]	93-0928	
98	1[6]	98-2000	
Total	**482**		

* One crashed on test
† One to YMH-47E
Notes: All except one prototype issued with new serial numbers on remanufacture to CH-47D
MYP1 First multiyear procurement contract, 8 April 1985
MYP2 Second MYP, 13 January 1989
[1] This batch includes one aircraft subsequently further modified to MH-47E configuration under separate contract
[2] Total includes six which were further modified to MH-47E under separate contract
[3] This batch includes two of original three prototypes (remaining prototype used as maintenance trainer at Fort Eustis, Virginia) and 11 from Italian production; total includes 18 which were further modified to MH-47E under separate contract
[4] New-build Gulf War attrition replacements, authorised 2 August 1992
[5] Former Australian Air Force CH-47Cs; contract 2 June 1993
[6] New-build aircraft; delivered 19 June 2002

MH-47E: Special Forces variant; planned procurement 51, all originally to be deducted from CH-47D conversions, but only 25 initially received, plus prototype. Additional example converted after use as VRTA testbed; prototype development contract 2 December 1987; long-lead items for next 11 helicopters authorised 14 July 1989; firm order for 11, plus option on next 14, awarded 30 June 1991; Lot 2 (14 helicopters) confirmed 23 June 1992. Prototype (88-0267) flew 1 June 1990; delivered 10 May 1991; initial production aircraft (90-0414) flown 1992; first 11 (of 24 intended) originally due to be delivered from November 1992 to 2 Battalion of 160th Special Operations Aviation Regiment at Fort Campbell, Kentucky. Following mission software problems, deliveries began January 1994 with 91-0498 to Fort Campbell; last of original 26 (including prototype) received at Fort Campbell April 1995. The 27th conversion (previously 86-1678) is expected to enter service by early 2003, this being a replacement for an earlier loss; at least three destroyed by April 2002.

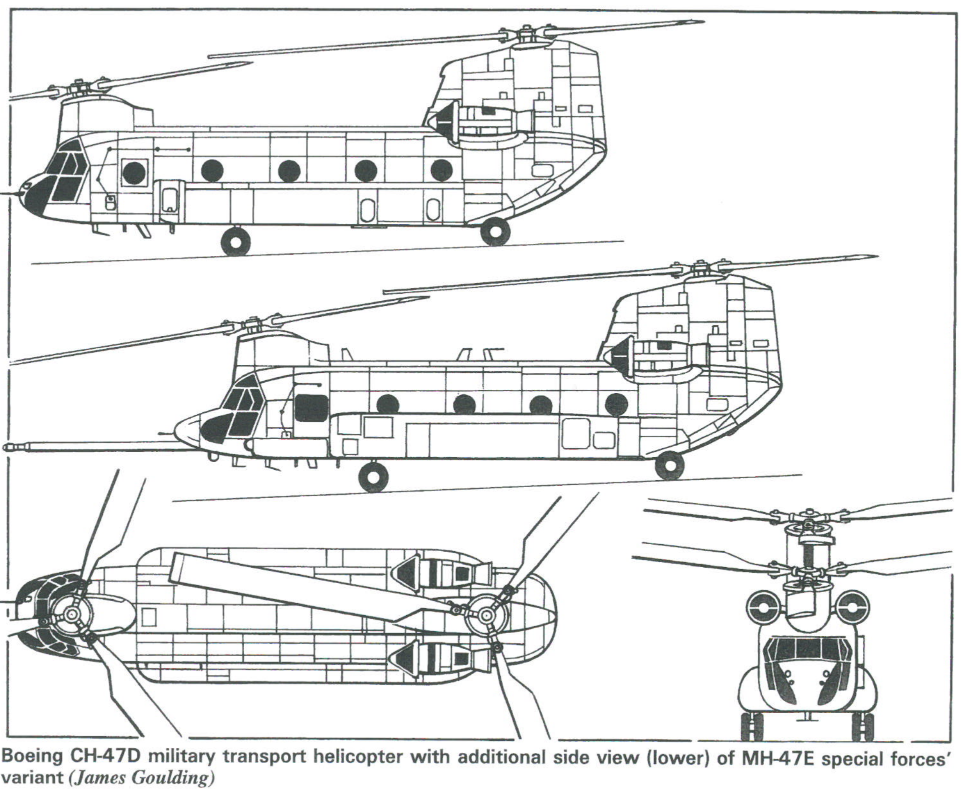
Mission profile 5½ hour covert deep penetration over 300 n mile (560 km; 345 mile) radius in adverse weather, day or night, all terrain with 90 per cent success probability. Requirements include self-deployment to Europe in stages of up to 1,200 n miles (2,222 km; 1,381 miles), 44-troop capacity, powerful defensive weapons and ECM. Equipment includes IBM-Honeywell integrated avionics with four-screen NVG-compatible EFIS; dual MIL-STD-1553B digital databusses; AN/ASN-145 AHRS; jamming-resistant radios; Rockwell Collins CP1516-ASQ automatic target handoff system; inertial AN/ASN-137 Doppler, Rockwell Collins AN/ASN-149(V)2 GPS receiver and terrain-referenced positioning navigation systems; Rockwell Collins ADF-149; laser (Raytheon AN/AVR-2), radar (Lockheed Martin AN/APR-39A) and missile (Honeywell AN/AAR-47) warning systems; ITT AN/ALQ-136(V) pulse jammer and Northrop Grumman AN/ALQ-162 CW jammer; BAE Systems M-130 chaff/flare dispensers; Raytheon AN/APQ-174A radar with modes for terrain-following down to 30 m (100 ft), terrain-avoidance, air-to-ground ranging and ground-mapping; Raytheon AN/AAQ-16 FLIR in chin turret; digital moving map display; Elbit ANVIS-7 night vision goggles; uprated T55-L-714 turboshafts with FADEC; increased fuel capacity; additional troop seating (44 maximum); OBOGS; rotor brake; 272 kg (600 lb) rescue hoist with 61 m (200 ft) usable cable; two six-barrel miniguns in forward port and starboard positions (also on MH-47D); provisions for Stinger AAMs using FLIR for sighting. This system largely common with equivalent Sikorsky MH-60K (which see). In November 2002, Smiths Aerospace received contract for more than US$3 million to demonstrate maintenance, analysis, safety and training (MAST) programme, incorporating integrated HUMS; contract calls for provision of two systems to be installed on MH-47 in second quarter of 2003, with further systems subject to option.

MH-47E has nose of Commercial Chinook to allow for weather radar, if needed; forward landing gear moved 1.02 m (3 ft 4 in) forward to allow for all-composites external fuel pods (also from Commercial Chinook) that double fuel capacity; Brooks & Perkins internal cargo handling system. Plans are under way to update 24 surviving MH-47Es to MH-47G configuration to improve performance and extend service life. See also Chinook HC. Mk 3, below.

US ARMY MH-47E PROCUREMENT

FY	Qty	First aircraft
90	1	90-0414
91	6	91-0496
92	4	92-0400
	14	92-0464
01	1	(86-1678)
Total	**26**	

Notes: Excludes prototype (88-0267); final aircraft is attrition replacement.



Boeing CH-47D military transport helicopter with additional side view (lower) of MH-47E special forces' variant *(James Goulding)*

Royal Air Force Chinook HC. Mk 2 *(Paul Jackson)* **NEW**/0546855

Chinook HC. Mk 2/2A: RAF version; Mk 1 designation CH47-352; all survivors of original 41 HC. Mk 1s upgraded to HC. Mk 1B; UK MoD authorised Boeing to update 33 (later reduced to 32) Mk 1Bs to Mk 2, equivalent to CH-47D, October 1989; changes include new automatic flight control system, updated modular hydraulics, T55-L-712F power plants with FADEC, stronger transmission, improved Solar 71 kW (95 shp) T62-T-2B APU, airframe reinforcements, low IR paint scheme, fuel system and standardisation of defensive aids package (IR jammers, chaff/flare dispensers, missile approach warning and machine gun mountings). Smiths Industries Health and Usage Monitoring System (HUMS) installed on fleet-wide basis at cost of about £100 million during 1997 to 2000. Requirement exists for FLIR.

Conversion continued from 1991 to July 1995. Chinook HC. Mk 1B ZA718 began flight testing Chandler Evans/ Hawker Siddeley dual-channel FADEC system for Mk 2 in October 1989. Same helicopter to Boeing, March 1991; rolled out as first Mk 2 19 January 1993; arrived RAF Odiham 20 May 1993; C(A) clearance November 1993. Initial deliveries pooled at Odiham by Nos 7 and 27 (Reserve) Squadrons – latter for training; first delivery to No 18 Squadron at Laarbruch, Germany, 1 February 1994; to No 78 Squadron, Falkland Islands, February 1994. Final Mk 1 withdrawn from service, May 1994, at which time 11 Mk 2s received. Further three new-build Mk 2s ordered 1993 (as Lot 2), for delivery from late 1995; decision to order further 14 Mks 2A/3 for delivery 1997-2000 at cost of US$365 million announced March 1995; these comprise Lots 3 and 4, respectively; Mk 2A has dynamically tuned fuselage. Latest purchase raised total RAF procurement to 58. First Lot 3 HC. Mk 2A (ZH891) handed over in USA 6 December 1997; shipped to UK and arrived Boscombe Down for clearance trials 18 December 1997. Rest of Lot 3 delivered by end 1998. Retrofits announced in 1996 comprise Smiths HUMS and Racal RA 800 secure communications control system. Thales AMS 2000 control display navigation units at core of upgrade to RAF Chinook HC. Mk 2/2A that began in mid-2002. Current squadron dispositions are Nos. 7, 18 and 27 at Odiham; and No. 78 in Falkland Islands.

Chinook HC. Mk 3: Eight of 14 additional RAF Chinooks, announced March 1995, assigned to Special Forces; build standard as CH-47SD, but with MH-47E's large fuel panniers, weather radar and refuelling probes. First flight of initial aircraft (ZH897, as N2045G) in mid-October 1998. Following flight test, all transferred to temporary store at Shreveport, Louisiana, for six to eight months, pending fitment of avionics (including Sky Guardian RWR) which form subject of separate contract; delivery was expected to begin in February 2000, but UK refused to accept initial aircraft, citing software problems as cause. First example eventually accepted in December 2000; initial deliveries to UK were ZH898 and ZH899 to Bristol by sea, arriving 15 July 2001, with remainder following by December 2001 (apart from one retained by Boeing for trials); by mid-2002, two flying on Military Aircraft Release trials, one with RAF at Odiham for ground training and four in storage; RAF service entry with Joint Helicopter Command expected in 2004-05. US reported to be interested in 'buy-back' deal to increase its own fleet of special operations Chinooks, with UK expected to receive enhanced MH-47G equivalent at a later date. However, by mid-2003, UK had not received a formal request for repurchase of Mk 3s.

HT.17 Chinook: Spanish Army version.

Boeing 234: Commercial version, currently out of production.

Boeing 414: Export military version. Superseded by CH-47D International Chinook and CH-47SD versions (see below).

CH-47D International Chinook: Boeing 414-100 first sold to Japan; Japan Defence Agency ordered two for JGSDF and one for JASDF in 1984; first flight (N7425H) January 1986 and, with second machine, delivered to Kawasaki April 1986 for fitting out; co-production arrangement (see under Japan: Kawasaki **CH-47J**). International Chinook was available in four versions with combinations of standard or long-range (MH-47E-type) fuel tanks and T55-L-712 SSB or T55-L-714.

CH-47SD 'Super D': Latest export variant, first flown on 25 August 1999; embodies some improvements first installed on the MH-47E for US special operations forces, including increased max T-O weight. Honeywell T55-GA-714A turboshaft with Coltec Industries FADEC chosen as standard power plant; single-point pressure refuelling and jettison capability on both sides of aircraft, with fuel contained in two ballistic and crash-resistant tanks; total usable capacity is 7,828 litres (2,068 US gallons; 1,722 Imp gallons); CH-47SD also has Smiths digital fuel quantity gauging system in place of Ragen analogue system.

Simplified structure offers benefits in maintainability and reliability. Specific changes include machined frames instead of standard frames.

CH-47SD also incorporates modernised NVG-compatible cockpit with avionics control management system (ACMS), utilising proven military and commercial off-the-shelf equipment on single console to reduce pilot workload and with provisions for growth. ACMS organised into three separate functional groups, specifically air vehicle group (including engines, drive system, fuel, electrics, flight controls and warning indicators); mission group (including communications, navigation and survivability equipment such as INS/GPS, weather radar and digital map display); and pilotage group (including EFIS). Radar nose (but not necessarily radar) fitted as standard.

Avionics suite is comparable to that of baseline CH-47D, but features two embedded INS/GPS units as well as AN/ARN-147 VOR/ILS and AN/ARN-149 ADF, plus space and power provisions for Tacan. AN/ARC-210 frequency-hopping radios to be installed on CH-47SD for Taiwan.

Initial order from Singapore received shortly before March 1998 announcement of formal SD launch, with first acceptance (in US) accomplished in early June 2001. Second customer is Taiwan which, in January 2000, announced purchase of nine CH-47SDs for use by Army; delivery accomplished by mid-2002.

CH-47F Improved Cargo Helicopter (ICH): Boeing programme for improved Chinook configuration for US Army involving the development and production of a new version that will remain operational and cost-effective until 2033, when last examples expected to be replaced by a new cargo helicopter to be developed between 2015 and 2020 under the current Army Aviation Modernization Plan. Programme will coincide with the existing Chinook beginning to reach planned life cycle limits in 2002. Benefits envisaged include greater airframe and systems reliability arising from lower levels of vibration; reduced operating and support costs; reduced pilot workload; and more efficient cargo handling. Weights unchanged, although US Army aircraft, like CH-47D, will have peacetime MTOW of 22,680 kg (50,000 lb). Key goal of upgrade is ability to airlift 7,257 kg (16,000 lb) load over 50 n miles (92 km; 56 miles) under 35°C (95°F) and 1,220 m (4,000 ft) altitude daytime conditions.

Studies indicated that further remanufacture, rather than new production, offered best degree of affordability, with a key factor being fleet-wide fitment of the T55-GA-714A, an improved variant of the T55-L-714 engine, as installed in the MH-47E and the International Chinook. Provision of Coltec Industries FADEC will result in lower specific fuel consumption and a modest reduction (about 3 per cent) in fuel burn. The T55-GA-714A results from a Honeywell (at Greer, South Carolina) kit upgrade programme begun December 1997 and affecting approximately 1,150 existing T55-L-712 engines in the Army inventory; upgrading brings power ratings up to those of the T55-L-714 and adds marinisation features.

Increased versatility also derived from replacement of the existing cargo handling system by integral flip-over roller panels in the cargo deck.

Cockpit modernisation by Rockwell Collins will include adding two dual-redundant MIL-STD-1553B databusses, four 127 mm (5 in) square MFD 255 EFIS LCDs, two 152 × 203 mm (6 × 8 in) MFD-268E1 situation awareness displays, two CDU 900 controller/processors, DR-200 data loader, moving digital map display, digital communications and electronic instrument displays. This allows for updated communications and navigation, enabling the Chinook to meet US Army Force XXI Battlefield requirements. Rockwell Collins selected by Boeing in April 1998 to provide integrated avionics suite, which will feature open architecture to facilitate future growth and updating; CH-47F will be first US Army helicopter to incorporate improved data modem (IDM), allowing it to link with digital battlefield and automatically send and receive information concerning targeting and aircraft position.

Under terms of Army development contract awarded in late 1997, two Chinooks (83-24107 and 83-24115) have been refurbished for the engineering and manufacturing development (EMD) phase, for which contract worth US$76 million was awarded to Boeing in May 1998. Both

EMD aircraft arrived for conversion on 5 January 1999; first (98-0011/M8001; ex-83-24107) officially rolled out on 11 July 2001, having flown for the first time on 25 June; second (98-0012/M8002; ex-83-24115) completed upgrade in September 2001, with EMD phase planned to end in December 2002; second CH-47F was delivered to the US Army on 15 May 2002 and flown to Fort Campbell, Kentucky, for further test flights. Low-rate initial production (LRIP) scheduled to have begun in January 2003 with batch of seven aircraft, followed by 17 more in 2005-06. Thereafter, procurement of up to 26 per year until 2016 will give a total fleet of 300; delivery of first LRIP CH-47F due in September 2004, with first unit fully equipped by first quarter of FY05. More recently US Army said to be considering converting almost all surviving CH-47Ds to CH-47F standard.

MH-47G: Upgraded version embodying improvements developed for the CH-47F. Plans are in hand to modernise existing MH-47D and MH-47E helicopters from 2003, but specific details of extent of upgrade not yet available, although it will include a 'glass cockpit' and is expected to have enhanced self-protection equipment in the form of a radio frequency jammer and a directed-infra-red countermeasures system. Some 'new-build' MH-47Gs also to be acquired, following US decision to more than double the number of special operations-configured Chinooks; six MH-47Gs are included in the first LRIP CH-47F batch, for delivery in 2004-05, with six more in the second batch. In conjunction with upgrading of existing MH-47s, total fleet now expected to be 78; this total may ultimately be achieved through buy-back programme involving three Singaporean CH-47SDs and, possibly, the Chinook HC. Mk 3 helicopters that have yet to attain operational status with the RAF.

CH-47X: Proposed follow-on programme to CH-47F in response to diversion of funds from Future Transport Rotorcraft (FTR). MTOW would be in region of 31 tonnes (68,000 lb), requiring new engine in 4.5 MW (6,000 shp) class, as well as new dynamic components, including four-blade rotor system.

CUSTOMERS: US Army has received five YCH-47A, 349 CH-47A, 108 CH-47B, 270 CH-47C and three CH-47D as new-build aircraft from US production plus 11 CH-47C from Italian production; further 479 CH-47D/MH-47E obtained from conversion programme involving CH-47A/B/C models as detailed in table elsewhere. CH-47D, MH-47D and MH-47E inventory was 466 in September 1999 and had declined to just over 450 in mid-2002.

Exports include five CH-47Cs to Argentina (three Air Force; two Army); Australia 12 CH-47Cs with crashworthy fuel system (four refurbished as CH-47D and redelivered from May 1995 to C Squadron of Army's 5 Aviation Regiment at Townsville; seven sold to US Army and converted to CH-47D for Hawaii National Guard; contract for further two signed 19 June 1998, with delivery to Townsville for further modification on 10 March 2000; these accepted by Army in first half of 2001); Canada nine CH-47Cs designated **CH-147**, delivered from September 1974, but withdrawn from use and seven sold to Netherlands in July 1993; Egypt finalised contract for four CH-47Ds on 20 August 1998, with delivery effected in mid-2000; Greece ordered seven CH-47Ds in October 1998, deliveries being effected between May 2001 and March 2002; Japan (two CH-47D International Chinooks, plus five kits to initiate licensed production, with further 54 co-produced by Kawasaki); Netherlands, six ordered in December 1993 for delivery in 1998-99 (first, D-101, on 29 May 1998), plus seven ex-Canadian CH-147s upgraded to CH-47D (including nose radar) by Boeing and redelivered from December 1995 for service with No. 298 Squadron at Soesterberg; Spanish Army 19, designated **HT.17**, of which 10 CH-47Cs (one lost), three Boeing 414-176s and six CH-47D International Chinooks delivered to 5th Helicopter Transport Battalion (Bheltra-V) at Colmenar Viejo, Madrid (last six have Honeywell RDR-1400 weather radar), nine survivors of original 10 upgraded by Boeing in USA to CH-47D between August 1990 and mid-1993, first redelivery to Spain on 27 September 1991, with three Boeing 414s also upgraded in 1997; South Korea, total 30 International Chinooks, comprising 24 for Army (deliveries from January 1989 to March 1991); and six for Air Force (ordered early 1990; delivered November 1991 to February 1992); Singapore, six ordered April 1994 for delivery in 1996-97, (training operations conducted in 1996-97 at Grand Prairie, Texas, before transfer to Singapore base) followed by 10 CH-47SDs ordered in 1998 and delivered to 127 Squadron from December 2001 to February 2002; Taiwan (three, notionally civil Boeing 234MLR; finalised contract for nine CH-47SDs in January 2000; deliveries between February and November 2002); Thailand, six for Army (three ordered August 1988, three early 1990, deliveries 1990 to February 1992; all are International Chinook); UK (58, see entries for Chinook HC. Mk 2/2A/3); 16 civilian, of which few left operating in original oilfield support role; two for trials; 46 in kits, comprising 40 for assembly in Italy and six for Japan.

Agusta sold licence-built CH-47Cs to Egypt (15; 12 survivors being upgraded to CH-47D standard); Greece (10, of which nine converted to CH-47D by Boeing between March 1992 and 1995; first redelivery in October 1993), Iran (68), Italy (37, including 10 CH-47C Plus, to which standard 23 earlier helicopters converted), Libya (20), Morocco (nine) and Pennsylvania US Army National Guard (11). Further six Italian helicopters to Civil Protection Agency. Kawasaki (which see) has firm orders for 70 by FY01.

Total Chinook orders, including civil, 1,168, excluding additional order for unknown quantity of CH-47SD version from unspecified customer. Six CH-47Ds, ordered by China January 1989, embargoed by US government.

CHINOOK PRODUCTION

Customer	Boeing	Boeing kits	Agusta	Kawasaki
Civilian	10*		6*	
Argentina	5			
Australia	14			
Canada	9			
Egypt	4		15	
Greece	7		10	
Iran		38	30	
Italy		2	35	
Japan	2	5		54
Libya			20	
Morocco			9	
Netherlands	6			
Singapore	16			
South Korea	30			
Spain	19			
Taiwan	12‡			
Thailand	6			
UK (RAF)	58			
US Army	735		11	
(Total 1,168)	**933**	**45**	**136**	**54**
Rebuilds to CH-47D				
Australia	4			
Egypt			12	
Greece	9			
Italy			23	
Netherlands	7			
Spain	12			
UK (RAF)	32			
US Army	479			
(Total 578)	**543**		**35**	

* Civilian standard
‡ Includes three to notional civilian standard and nine CH-47SD

COSTS: First US Army MYP (1985) US$1,200 million for 240 upgrades from CH-47C; second MYP (1989) US$773 million for 144 upgrades; US$67 million (1993) for 11 upgrades (four Australian Army; seven US Army); approximately US$23 million for two new-build CH-47Ds (1992). Unit cost of CH-47SD quoted as US$30-32 million (2002).

MH-47E: US$81.8 million (placed 1987) for development of MH-47E and conversion of one prototype; US$422 million (1989-91) for 11 MH-47Es and option on further 14. US$25.6 million allocated for conversion of single CH-47D to MH-47E (2000).

US Army estimates cost of CH-47F programme, including R&D, long-lead production and upgrade of 300 Chinooks, as approximately US$3.3 billion (1999).

DESIGN FEATURES: Two three-blade intermeshing contrarotating tandem rotors; front rotor turns anti-clockwise, viewed from above; rotor transmissions driven by connecting shafts from engine gearbox, which is driven by rear-mounted engines; normal rotor speed 225 rpm. Classic rotor heads with flapping and drag hinges; manually foldable blades, using Boeing VR7 and VR8 aerofoils with cambered leading-edges; blades can survive hits from 23 mm HEI and API rounds; rotor brake optional.

Development of new, low-maintenance elastomeric rotor hub begun at end August 1999, following signature of contract with US Army; development, testing and installation to be completed over four-year period, with new assembly to be installed on all US Army regular and reserve force Chinooks. Also under consideration for CH-47F and will be incorporated in CH-47SD; UK expected to participate in development programme, with view to adoption. Will have longer fatigue life (4,500 hours), 75 per cent fewer parts and offer 70 per cent reduction in requirement for special maintenance tools; will also retain same rotor flight dynamics and be fully interchangeable with existing hub.

Constant cross-section cabin with side door at front; rear-loading ramp that can be opened in flight; underfloor section sealed to give flotation after water landing; access to flight deck from cabin; main cargo hook mounting covered by removable floor panel so that load can be observed in flight.

FLYING CONTROLS: Differential fore and aft cyclic for pitch attitude control; differential lateral cyclic pitch (from rudder pedals) for directional control; automatic control to keep fuselage aligned with line of flight. Dual hydraulic rotor pitch-change actuators: secondary hydraulic actuators in control linkage behind flight deck for autopilot/autostabiliser input; autopilot provides stabilisation, attitude hold and outer-loop holds.

STRUCTURE: Blades based on D-shaped glass fibre spar, fairing assembly of Nomex honeycomb core and crossply glass fibre skin.

LANDING GEAR: Non-retractable quadricycle type, with twin wheels on each front unit and single wheels on each rear unit. Oleo-pneumatic shock-absorbers in all units. Rear units fully castoring; power steering on starboard rear unit. All wheels are size 24×7.7, with tyres size 8.50-10, pressure 6.07 bar (88 lb/sq in). Single-disc hydraulic brakes on all six wheels. Provision for fitting detachable wheel/skis.

POWER PLANT: Two Honeywell T55-L-712 turboshafts, pod-mounted on sides of the rear pylon, each with a standard power rating of 2,237 kW (3,000 shp) and maximum rating of 2,796 kW (3,750 shp). Honeywell T55-L-712 SSB engine has standard power rating of 2,339 kW (3,137 shp) and maximum of 3,217 kW (4,314 shp). Standard in MH-47E and International Chinook are two Honeywell T55-L-714 turboshafts, each with a standard power rating of 3,108 kW (4,168 shp) continuous and emergency rating of 3,629 kW (4,867 shp). CH-47SD (and Netherlands CH-47Ds) have T55-GA-714A turboshafts, with maximum continuous rating of 3,039 kW (4,075 shp). FADEC installed on late production CH-47Ds and CH-47SD. From January 1991, more than 100 CH-47Ds fitted with engine air particle separator (also available for RAF variant). Transmission capacity (CH-47D/SD and MH-47E) 5,617 kW (7,533 shp) on two engines and 3,430 kW (4,600 shp) OEI; rotor rpm 225.

Self-sealing pressure refuelled crashworthy fuel tanks in external fairings on sides of fuselage. Total usable fuel capacity 3,914 litres (1,034 US gallons; 861 Imp gallons) in CH-47D. Provision for up to three additional long-range tanks in cargo area, each of 3,028 litres (800 US gallons; 666 Imp gallons); maximum fuel capacity (fixed and auxiliary) 12,998 litres (3,434 US gallons; 2,859 Imp gallons). Oil capacity 14 litres (3.7 US gallons; 3.1 Imp gallons).

Normal fuel (MH-47E, International Chinook and CH-47SD) 7,828 litres (2,068 US gallons; 1,722 Imp gallons) but MH-47E can operate with three long-range tanks in cargo area, each containing 3,028 litres (800 US gallons; 666 Imp gallons), raising total fuel capacity to 16,913 litres (4,468 US gallons; 3,720 Imp gallons). MH-47D SOA and MH-47E have 8.97 m (29 ft 5 in) refuelling probe on starboard side of forward fuselage, which extends 5.41 m (17 ft 9 in) forward of the nose. Refuelling probe also an option for International Chinook.

ACCOMMODATION: Two pilots on flight deck, with dual controls. Lighting compatible with pilots' NVGs (Nite-Op in RAF variant). Jump seat for crew chief or combat commander. Jettisonable door on each side of flight deck. Depending on seating arrangement, 33 to 55 troops can be accommodated in main cabin, or 24 litters plus two attendants, or (see under Current Versions) vehicles and freight. Rear-loading ramp can be left completely or partially open, to permit transport of extra-long cargo and in-flight parachute or free-drop delivery of cargo and equipment.

Main cabin door, at front on starboard side, comprises upper hinged section which can be opened in flight, and lower section with integral steps. Upper section has a panel with window that is jettisonable. Triple external cargo hook system, with US Army aircraft having centre hook rated to carry maximum load of 11,793 kg (26,000 lb) and the forward and rear hooks 7,711 kg (17,000 lb) each, or 10,433 kg (23,000 lb) in unison, while International Chinook and CH-47SD ratings are 12,701 kg (28,000 lb) for centre hook and 9,072 kg (20,000 lb) each for forward and rear hooks, or 11,340 kg (25,000 lb) in unison. Options are available for a power-down ramp and water dam to permit ramp operation on water, internal ferry fuel tanks, external rescue hoist, and windscreen washers.

SYSTEMS: Hydraulic system contains a utility system, a No. 1 flight control system and a No. 2 flight control system. Each includes a separate, variable delivery pump and a reservoir cooler module. Utility system contains a pressure control module and a return control module. Both flight control systems contain a power control module, incorporating pressure and return in one module for each system. Each flight control system can be driven by the utility system for ground checkout through a power transfer unit without intermixing of hydraulic fluids. All hydraulic systems have a pressurised reservoir to prevent pump cavitation and are serviced by a common filter.

The CH-47D has a significant reduction in the number of hydraulic lines and fittings; approximately 200 tubes and hoses eliminated, thereby obviating approximately 700 leak points. Majority of all lines now swaged together for permanent joining; Rosan fluid adaptors for hardpoint connections. All systems capable of being monitored, both in flight and on the ground, for servicing prechecks and fault isolation. Subsystems designed for pressurisation on demand; power transfer units now used for flight control ground system checkout. Electrical system includes two 40 kVA oil-cooled alternators driven by transmission drive system. Solar T62-T-2B APU drives a 20 kVA generator and hydraulic motor pump, providing electrical and hydraulic power for main engine start and system operation on the ground.

Boeing MH-47E Chinook of 160th SOAR, detached to South Korea *(Peter R Foster)* 0525078

AVIONICS: Baseline CH-47D. Specific MH-47E avionics listed under that heading. Avionics for RAF HC. Mk 1 listed in 1985-86 and earlier editions. Netherlands aircraft have Honeywell advanced cockpit management system (ACMS) and EFIS, latter adopted by Boeing as baseline for subsequent sales.

Comms: Honeywell AN/ARC-199 HF com radio, Rockwell Collins AN/ARC-186 VHF/FM-AM, Magnavox AN/ARC-164 UHF/AM com; C-6533 intercom (Netherlands aircraft have Telephonics Corp STARCOM); Honeywell AN/APX-100 IFF.

Flight: Honeywell AN/APN-209 radar altimeter; AN/ARN-89B ADF; BAE Systems AN/ASN-128 Doppler; AN/ARN-123 VOR/glideslope/marker beacon receiver; and AN/ASN-43 gyromagnetic compass. AFCS maintains helicopter stability, eliminating the need for constant small correction inputs by the pilot to maintain desired attitude. The AFCS is a redundant system using two identical control units and two sets of stabilisation actuators. RAF Chinooks have Racal RNS252 Super TANS INS including GPS.

Instrumentation: Flight instruments are standard for IFR, and include an AN/AQU-6A horizontal situation indicator. CH-47F will incorporate Integrated Engine Crew Advisory System (IECAS).

Mission: Chelton 19-400 satellite communications antenna on some RAF helicopters.

Self-defence: Provisions for Lockheed Martin AN/APR-39A RWR, Sanders AN/ALQ-156 missile warning equipment and BAE Systems M-130 chaff/flare dispensers. RAF Chinooks have BAE Systems M-206/M-1 chaff/flare dispensers, BAE Systems ARI 18228 Sky Guardian RWR and (from 1990) Lockheed Martin AN/ALQ-157 IR jammers and Honeywell AN/AAR-47 missile approach warning equipment; Elisra SPS-65V-3 integrated airborne self-protection system chosen for installation on HC. Mk 3 version. Northrop Grumman AN/AAR-54(V) passive missile approach warning system selected by Royal Netherlands Air Force, with installation to be accomplished during 2001-04.

EQUIPMENT: Hydraulically powered winch for rescue and cargo handling, rearview mirror, plus integral work stands and step for maintenance.

ARMAMENT: Provision for two machine guns or miniguns in crew door (starboard) and forward hold window (port).

DIMENSIONS, EXTERNAL:
Rotor diameter (each) 18.29 m (60 ft 0 in)
Rotor blade chord (each) 0.81 m (2 ft 8 in)
Distance between rotor centres:
CH-47SD 11.85 m (38 ft 10¾ in)
Length:
overall, rotors turning:
MH-47E and CH-47SD 30.14 m (98 ft 10¾ in)
fuselage: MH-47E and CH-47SD 15.87 m (52 ft 1 in)
MH-47D/E, incl probe 21.08 m (69 ft 2 in)
Width, rotors removed: MH-47E 4.78 m (15 ft 8 in)
Height to top of rear rotor head:
CH-47SD 5.70 m (18 ft 8½ in)
MH-47E 5.59 m (18 ft 4 in)
Ground clearance, rotors turning:
rear approach 5.77 m (18 ft 11 in)
Ground clearance, static:
rear approach:
MH-47E and CH-47SD 4.90 m (16 ft 0¾ in)
forward approach: CH-47SD 2.29 m (7 ft 6 in)
Wheelbase: MH-47E and CH-47SD 7.87 m (25 ft 10 in)
Passenger door (fwd, stbd): Height 1.68 m (5 ft 6 in)
Width 0.91 m (3 ft 0 in)
Height to sill 1.09 m (3 ft 7 in)
Rear-loading ramp entrance: Height 1.98 m (6 ft 6 in)
Width 2.31 m (7 ft 7 in)
Height to sill 0.79 m (2 ft 7 in)

DIMENSIONS, INTERNAL (MH-47E and CH-47SD):
Cabin, excl flight deck: Length 9.19 m (30 ft 2 in)
Width: mean 2.29 m (7 ft 6 in)
at floor 2.51 m (8 ft 3 in)
Height 1.98 m (6 ft 6 in)
Floor area 21.0 m² (226 sq ft)
Usable volume 41.7 m³ (1,474 cu ft)

AREAS:
Rotor blades (each) 7.43 m² (80.0 sq ft)
Rotor discs (total):
MH-47E and CH-47SD 525.3 m² (5,655 sq ft)

WEIGHTS AND LOADINGS:
Weight empty: MH-47E 12,210 kg (26,918 lb)
CH-47SD 11,550 kg (25,463 lb)
Useful load: MH-47E 12,284 kg (27,082 lb)
CH-47SD 12,944 kg (28,537 lb)
Max underslung load: CH-47SD 12,700 kg (28,000 lb)
Max fuel weight:
MH-47E, CH-47SD 6,815 kg (15,025 lb)
Max T-O weight:
MH-47E, CH-47SD 24,494 kg (54,000 lb)
Transmission loading at max T-O weight and power:
MH-47E, CH-47SD 4.36 kg/kW (7.17 lb/shp)

PERFORMANCE (at 22,680 kg; 50,000 lb):
Max level speed: MH-47E 154 kt (285 km/h; 177 mph)
CH-47SD 155 kt (287 km/h; 178 mph)
Max cruising speed at S/L:
MH-47E, CH-47SD 140 kt (259 km/h; 161 mph)
Max rate of climb: MH-47E 561 m (1,840 ft)/min
CH-47SD 563 m (1,846 ft)/min
Service ceiling: MH-47E 3,090 m (10,140 ft)
CH-47SD 3,385 m (11,100 ft)
Hovering ceiling:
IGE: MH-47E 2,985 m (9,800 ft)
CH-47SD 2,835 m (9,300 ft)
IGE, ISA + 20°C (68°F): MH-47E 2,410 m (7,900 ft)
CH-47SD 2,180 m (7,160 ft)
OGE: MH-47E, CH-47SD 1,675 m (5,500 ft)
OGE, ISA + 20°C (68°F):
MH-47E, CH-47SD 1,005 m (3,300 ft)
Radius of action, MH-47E, deploy special forces team (1,814 kg; 4,000 lb) at 1,220 m (4,000 ft), 35°C (95°F) ambient temperature 505 n miles (935 km; 581 miles)
Range:
MH-47E, self-deployment at 24,494 kg (54,000 lb)
T-O weight 1,260 n miles (2,333 km; 1,449 miles)
CH-47SD with 12,558 kg (27,686 lb) payload
651 n miles (1,207 km; 750 miles)

UPDATED

BOEING AH-64 APACHE

US Army designations: AH-64A and AH-64D
Israel Defence Force name: Pethen (Cobra)

TYPE: Attack helicopter.

PROGRAMME: Original Hughes Model 77 entered for US Army advanced attack helicopter (AAH) competition; first flights of two development prototype YAH-64s 30 September and 22 November 1975; selected by US Army December 1976; named Apache late 1981.

Deliveries started 26 January 1984; 900th delivered in October 1995, at which time US Army had ordered 821 AH-64As (excluding prototypes) with export contracts totalling 104; latter total increased to 258 (116 AH-64A; 142 AH-64D) by end of 2002. Last of 821 AH-64As delivered to US Army on 30 April 1996; aircraft concerned was production vehicle 915, and manufacture of AH-64A variant terminated with completion of 937th example (for Egypt), in November 1996. Delivery of 1,000th Apache (including AH-64D rebuilds) effected on 30 March 1999.

Boeing awarded four year, US$15.9 million, contract on 27 May 1998 to design, manufacture and flight test new centre fuselage section incorporating advanced composites materials; Phantom Works responsible for design leadership, with support from Boeing facilities at Long Beach, Philadelphia and St Louis. If successful, new section from rear of aft cockpit to just behind engines will be simpler to manufacture as well as lighter and more durable than existing all-metal structure.

In separate development, on 5 October 1998, a modified AH-64D Apache Longbow prototype made initial flight with Rotorcraft Pilot's Associate (RPA) advanced cockpit management system. Also developed by Phantom Works over 60 month period, under terms of US$80 million advanced technology demonstration contract, this featured updated controls and displays, including Boeing-developed four-axis, full authority, advanced digital flight control system. Flight and mission data presented to pilots on three large multipurpose colour displays; RPA also features advanced data fusion and an advanced pilotage system, as well as the ability to recognise and respond to verbal commands. Company flight trials continued throughout remainder of 1998, with test aircraft then visiting US Army's Yuma Proving Grounds for demonstration flights in January-February 1999.

In 2001, Boeing proposed series of upgrades designed to keep AH-64D in operational force until 2030; these included adoption of new split-face power plant gearbox, new main rotor assembly using five composite blades and titanium hub, composites fuselage structure elements for enhanced payload, and open architecture avionics with gradual introduction of Boeing RPA features such as digital navigation and communications equipment. Objective of upgrade package to restore original performance, reduce purchase price by about 30 per cent and cut operating costs by 50 per cent, but US Army not enthusiastic and instead chose to direct available funding towards near-term reliability and sustainability concerns, such as adoption of Lockheed Martin Arrowhead targeting and navigation sensor system. However, in late 2003, it became apparent that some of these features could be adopted in a future upgrade project.

Some new features, including digital avionics incorporating commercial off-the-shelf (COTS) technology, tested on preproduction AH-64D Apache Longbow first flown 12 July 2001; Boeing introducing some of these enhancements during production of the second multiyear batch of helicopters (see **Block II**).

CURRENT VERSIONS: **AH-64A**: Produced for US Army and export; 937 built. First 603 had two 1,265 kW (1,696 shp) T700-GE-701 engines. Total of 501 US Army examples to be upgraded to AH-64D. Retrofit from 1993 with SINCGARS secure radios and GPS; first installed in Apaches of 5-501 Aviation Regiment on deployment to Camp Eagle, South Korea.

GAH-64A: Designation applies to at least 17 AH-64As that have been grounded and assigned as technical instruction training aids.

JAH-64A: Designation applied to seven AH-64As that have been used for special test duties; at least one subsequently reverted to standard.

AH-64B: Cancelled in 1992. Was planned near-term upgrade of 254 AH-64As with improvements derived from operating experience in 1991 Gulf War, including GPS SINCGARS radios, target handover capability, better navigation, and improved reliability.

AH-64C: Previous designation for upgrade of AH-64As to near AH-64D standard, apart from omission of Longbow radar and retention of -701 engines; provisions for optional fitment of both; Army requested draft proposal, August 1991; funding for two prototype conversions awarded in September 1992. Designation abandoned late 1993.

AH-64D Apache Longbow: Current improvement programme based on Lockheed Martin and Northrop Grumman joint venture development of mast-mounted AN/APG-78 Longbow millimetre-wave radar and Hellfire missile with RF seeker; Northrop Grumman has lead on Longbow with Lockheed Martin taking principal role for Hellfire. Programme also includes more powerful engines, larger generators, MIL-STD-1553B databus allied to dual 1750A processors, and a vapour cycle cooling system for avionics; early user tests completed April 1990.

Detailed description applies to AH-64D.

Full-scale development programme, lasting 51 months, authorised by Defense Acquisition Board August 1990, but airframe work extended in December 1990 to 70 months to coincide with missile development; supporting modifications being incorporated progressively; first flight of AH-64A (82-23356) with dummy Longbow radome 11 March 1991; first (89-0192) of six AH-64D prototypes flown 15 April 1992; second (89-0228) flew 13 November 1992; fitted with radar in mid-1993 and flown 20 August 1993; No.3 (90-0324) flown 30 June 1993; No.4 (90-0423) on 4 October 1993; No.5 (85-25477; formerly AH-64C No.1) 19 January 1994 (first Apache with new Hamilton Sundstrand lightweight flight management computer); No.6 (85-25408) flown 4 March 1994; last two mentioned lack radar. Following termination of AH-64C in late 1993, original plan was to convert 748 AH-64As to AH-64D, although only 227 (original AH-64D total) to carry Longbow radar; subsequent review, revealed at start of 1999, proposed reducing total number of conversions to 530 and increasing purchase of Longbow radars to 500; these to equip regular Army units, with remaining 218 AH-64As of Army National Guard and Army Reserve undergoing service life extension programme. Most recent news indicates that US Army may eventually receive 600 AH-64Ds.

Under original programme, AH-64D to equip 26 battalions, although this may be reduced to 16 of regular Army; three companies, each with eight helicopters, per battalion. Longbow can track flying targets and see through rain, fog and smoke that defeat FLIR and TV. RF Hellfire, delivered to US Army from November 1996, can operate at shorter ranges; it can lock on before launch or launch on co-ordinates and lock on in flight; Longbow scans through 360° for aerial targets or scans over 270° in 90° sectors for ground targets; mast-mounted rotating antenna weighs 113 kg (250 lb). Longbow radar transmitter subject of redesign in late 1997 to overcome poor performance of some electrical components in low temperatures; eliminate lengthy and costly manual integration necessary to achieve required output; and avoid shortages of critical components which suppliers reported in 1995 that they would no longer provide. New transmitter meets or surpasses original specification and is fully interchangeable with original unit.

Further modifications include 'manprint' cockpit with large displays, air-to-air missiles, digital autostabiliser, integrated GPS/Doppler/INS/air data/laser/radar altimeter navigation system, digital communications, faster target handoff system, and enhanced fault detection with data transfer and recording. Cockpit displays initially monochrome, but these replaced by colour displays with effect from 27th production conversion (97-5027); first flight of AH-64D with colour displays on 12 September 1997. AH-64D No.1 made first Hellfire launch on 21 May 1993; first RF Hellfire launch 4 June 1994 (first combat use of RF Hellfire in opening phase of ground conflict during Gulf War of 2003); first demonstration of digital air-to-ground data communications with Symetrics Industries improved data modem, 8 December 1993.

Advanced acquisition phase contract for remanufacture programme, worth US$279.6 million and covering 18 helicopters (later increased to 24), awarded on 14 December 1995; predated by arrival of first two AH-64As (85-25387 and 85-25394) at Mesa on 27 November 1995 for stripping to basic fuselage in readiness for start of remanufacture in early 1996. First fuselage moved to final assembly area on 15 August 1996; first flight (85-25387 with new identity 96-5001) 17 March 1997; formal roll-out at Mesa on 21 March.

Multiyear contract, worth US$1.87 billion, covering 232 AH-64Ds (retrospectively including advanced acquisition aircraft) over five year period signed 16 August 1996; further 269 conversions to be acquired in second multiyear contract covering FY01 to FY05, which signed 29 September 2000, at total cost of US$2.3 billion.

First of so-called **Block II** aircraft (02-5285) delivered to US Army on 25 February 2003; incorporates advanced avionics, digital enhancements and communications upgrades, permitting secure transfer of digitised battlefield information to air and ground forces. Future **Block III** upgrade expected to build on existing Block II architecture, but also likely to include other improvements such as image fusion of sensors, as well as ability to control UAVs and utilise newer, longer-range weapons; upgrade programme will affect at least 230 survivors of initial 284 Block I Apaches, with work likely to begin in 2008 and continue until 2012. New five-blade composites main rotor may also be adopted as part of Block III enhancements, which estimated to cost about US$1.3 billion; re-engining is also a possibility, as is installation of a more durable and uprated 2,530 kW (3,400 shp) gearbox from 2010.

AH-64D deliveries to US Army began 31 March 1997 and total of 18 handed over by end of 1997. Delivery of 24th and last Lot 1 aircraft accomplished 4 March 1998, with US Army having accepted total of 55 by end of 1998, 102 by end of 1999 and 159 by end of 2000; 100th remanufactured AH-64D delivered to US Army on 9 December 1999; 200th followed on 23 August 2001; 300th in second quarter of 2003. Final example of initial multiyear contract and first helicopter from second multiyear contract both delivered to US Army on 3 April 2002.

Initial AH-64D battalion (1-227 AvRgt) at Fort Hood, Texas fully equipped by end July 1998 and attained combat-ready status on 19 November 1998, after eight month training programme at company and battalion level which included four live fire exercises and more than 2,500 flight hours; see table for details of actual and planned re-equipment programme.

US ARMY AH-64D APACHE DEPLOYMENT

Unit	Base	IOC date	UE*
Regular Army Units:			
1-227 AVN	Robert Gray AAF, Tx	19 Nov 1998	18
2-101 AVN	Campbell AAF, Ky	Oct 1999	18
1-3 AVN	Hunter AAF, Ga	Mar 2001	18
1-2 AVN	Camp Page AAF, South Korea	Aug 2001	18
1-101 AVN	Campbell AAF, Ky	Dec 2001	18
6/6 CAV	Illesheim, Germany	May 2002	21
1-4 AVN	Hood AAF, Tx	Oct 2002	18
3/6 CAV	Desidero AAF, South Korea	Mar 2003	21
3-101 AVN	Campbell AAF, Ky	Aug 2003	18
1-229 AVN	Simmons AAF, NC	Jan 2004	21
2/6 CAV	Illesheim, Germany	May 2004	21
4/3 ACR	Butts AAF, Co	Sep 2004	9
1/6 CAV	Camp Eagle, South Korea	Feb 2005	21
1-1 AVN	Ansbach, Germany	Aug 2005	18
3-229 AVN	Simmons AAF, NC	Feb 2006	21
1-501 AVN	Hanau, Germany	May 2006	18
4/2 ACR	Polk AAF, La	Nov 2006	9
Army National Guard Units:			
1-285 AVN	Silver Bell AHP, Az	Aug 2006	21
1-183 AVN	Gowen Field, Id	Jul 2006	21
1-151 AVN	McEntire ANGS, SC	Aug 2007	21
Army Reserve Units:			
7/6 CAV	Conroe, Tx	Sep 2006	21
8-229 AVN	Godman AAF, Ky	Jul 2008	21

**Unit Establishment of aircraft*

AH-64DN: Designation assigned to 30 helicopters delivered to Royal Netherlands Air Force between May 1998 and April 2002.

WAH-64D: British Army version with Longbow radar and two Rolls-Royce/Turbomeca RTM 322 turboshafts; built by Westland in the UK.

CUSTOMERS: US Army 827 AH-64A (including six prototypes), of which last delivered 30 April 1996; see Programme and Current Versions for details; operational fleet in November 1999 totalled 743. Confirmed export orders and firm commitments totalled 242 in third quarter of 2001. Israel ordered 18 in March 1990; first two delivered 12 September 1990 to 113 Squadron; further 24 ex-US Army AH-64As supplied for 113 and 127 Squadrons at Ramon; deliveries to 190 Squadron at Ramat David, 1995. After rejecting new-build AH-64D Apache Longbow on cost grounds, Israel considered upgrade of existing AH-64A to AH-64D; however, subsequent change of plan involved abandoning upgrade proposal in favour of acquisition of new-build AH-64D; letter of offer and acceptance signed February 2001, covering nine helicopters (of which one will be a remanufactured AH-64A). Contract for eight new-build AH-64Ds awarded on 29 May 2002.

Deliveries began in April 1993 to Saudi Arabia (12) and in 1994 to Egypt (24). Further orders from Greece (20) and United Arab Emirates (20), both in December 1991; six handed over to UAE on 30 October 1993; 14 followed in 1994, with 10 more received later; following formal request in mid-2002, all UAE examples are likely to be upgraded to AH-64D standard, incorporating improved Lockheed Martin Arrowhead piloting and weapon aiming system as well as enhanced AN/ALQ-211 EW suite. Total cost of upgrading 30 UAE helicopters will be approximately US$1.5 billion. Greek deliveries from February 1995 for training in USA; initial six Apaches ferried to New Orleans, Louisiana, for shipment to Greece on 9 June 1995. Greece subsequently revealed intent in 2002 to purchase 24 AH-64Ds, although in late November 2002 it was announced that only 12 would be ordered; no further details have emerged concerning this possible sale. Another 12 AH-64As for Egypt approved early 1995, with Egypt revealing intent in July 2000 to upgrade 35 AH-64A to AH-64D. Contract signed in November 2001, with deliveries to begin in July 2003, although these will not have the Longbow radar.

Version of AH-64D Apache Longbow offered to British Army by consortium of McDonnell Douglas, Westland, Lockheed Martin, Northrop Grumman and Shorts; UK announced order for 67 on 13 July 1995; additional information under Westland entry in UK section. Netherlands signed contract on 24 May 1995 for 30 AH-64DN Apaches for Nos. 301 and 302 Squadrons at Gilze-Rijen; radar not required at outset, but formal request made in November 1999 and this will now be installed; US Army provided 12 AH-64As for use by No. 301 Squadron on lease basis for period 1996-99; all delivered 13 November 1996 and since returned. First AH-64DNs accepted by Netherlands at Mesa on 15 May 1998 and 21 had been delivered by late August 2001, with 30th and last handed over on 30 April 2002; No. 302 Squadron first unit to be equipped, with initial deliveries to Gilze-Rijen in mid-May 2000; No. 301 Squadron became operational in 2003, although Netherlands government in late 2003 announced intention to reduce size of fleet to 20 helicopters. Singapore selected AH-64D on 14 June 1999; total of eight initially to be acquired, with AGM-114K Hellfire 2 laser-guided missile, but lacking Longbow radar; option on further 12 taken up on 23 August 2001, at which time it was revealed that all 20 will have Longbow radar; first example accepted at Mesa on 17 May 2002. Initial eight remain in USA (with 'Peace Vanguard' detachment at Marana, Arizona) for pilot training. Kuwait was authorised in late 1997 to receive 16 AH-64Ds under FMS programme; letter of acceptance due for signature in last quarter of 1998, but deal stagnated because of concern over inclusion of Longbow radar. Letter of offer and acceptance finally signed at beginning of September 2002, with package including eight Longbow radars; total cost of FMS deal is US$868 million. On 27 August 2001, Japan announced selection of AH-64D to satisfy its AH-X combat helicopter requirement; an initial batch of 10 helicopters is being acquired with FY02 funds, with the total buy likely to number 60, some of which will be fitted with Longbow radar. Future customers could include South Korea, which initially needs 18 combat helicopters, but could eventually purchase 36. Taiwan has indicated desire to obtain as many as 75 AH-64D Apache Longbow helicopters, but may yet acquire the Bell AH-1Z.

US Army Boeing AH-64A Apache attack helicopter ***(Paul Jackson)*** 0527161

APACHE REMANUFACTURE PROGRAMME

Lot	Year	Qty	First aircraft
-	Prototypes	6	89-0192
-	Preproduction	2	
1	FY96	24	96-5001
2	FY97	24	97-5025
3	FY98	44	98-5049
4	FY99	66	99-5093
5	FY00	74	00-5159
6	FY01	52	01-5233
7	FY02	60	02-5285
8	FY03	74	03-5345
9	FY04	64	04-5419
10	FY05	19	05-5483
	Total	**509**[1]	

Notes:

[1] Total excludes aircraft to be remanufactured for overseas operators, including Israel (1), Egypt (35) and UAE (36)

APACHE PROCUREMENT

	Qty	Remarks	
US Army AH-64A			
FY73	3	Prototypes	
FY79	3	Preproduction	
FY82	11		
FY83	48		
FY84	112		
FY85	138		
FY86	116		
FY87	101		
FY88	77		
FY89	54		
FY90	132		
FY91	12		
FY92	10		
FY94	10		
Subtotal	**827**[1]		
Exports		**First aircraft and date**	
Israel (Lot 1)	18[2]	801	Sep 1990
Israel (Lot 2)	9[7]		
Saudi Arabia	12[3]	90-0291	Apr 1993
Egypt (Lot 1)	24[3]	3701	Feb 1994
Egypt (Lot 2)	12[3]	3725	1996
Greece	20[3]	E-1001	Feb 1995
UAE (Lot 1)	20[3]	050	Oct 1993
UAE (Lot 2)	10[3]	070	1996
Netherlands	30[4]	Q-01/98-0101	May 1998
UK	67[5]	ZJ166	Sep 1998
Singapore	20[6]		May 2002
Kuwait	16[6]		
Subtotal	**258**		
Total	**1,085**		

Notes:
[1] 501 programmed to be remanufactured as AH-64D
[2] AH-64A; further 24 obtained from US Army
[3] AH-64A
[4] Non-radar AH-64D; 12 US Army AH-64A operated during 1996-99 on lease pending delivery of AH-64DN
[5] WAH-64D
[6] AH-64D
[7] Includes one remanufactured helicopter

APACHE PRODUCTION

Lot	FY	Qty US	Qty Export	First aircraft
-	73	3[1]		73-22247
-	79	3[2]		79-23257
1	82	11		82-23355
2	83	48		83-23787
3	84	112		84-24200
4	85	138		85-25351
5	86	116		86-8940
6	87	101		87-0407
7	88	67		88-0197
		10		88-0275
8	89	54	18	89-0192
9	90	60	6	90-0280
10	90	72	36	90-0415
11	91/92	22	34	91-0112
12	94	10	10	94-0328
13	95		12	95-0108
-	98 et seq		142[3]	98-0101
Subtotals		**827**	**258**	
Total		**1,085**		

Notes:
[1] Prototypes; 73-22247 was static test airframe
[2] Preproduction
[3] AH-64D/WAH-64D; all other aircraft are AH-64A version. Total includes one remanufactured helicopter for Israel, which also to receive eight new-build AH-64Ds

COSTS: Programme cost (807 aircraft at 1991 values) US$1,169 million. Egyptian Lot 2 request costed at US$318 million for 12 Apaches plus four spare Hellfire launchers, thirty-four 70 mm (2.75 in) rocket launchers, six spare T700 engines, one spare TADS/PNVS system and miscellaneous spares. Second multiyear procurement contract valued at US$2.3 billion, including training devices, spares, logistics and support services. Israeli AH-64D purchase of nine helicopters expected to cost almost US$500 million, including ordnance, spare parts, training and other support.

DESIGN FEATURES: Modern, tandem-seat, armoured and damage-resistant combat helicopter; is required to continue flying for 30 minutes after being hit by 12.7 mm bullets coming from anywhere in the lower hemisphere plus 20°; also survives 23 mm hits in many parts; target acquisition and designation sight (TADS) and pilot night vision sensor (PNVS) sensors mounted in nose; low-airspeed sensor above main rotor hub; avionics in lateral containers; chin-mounted Chain Gun fed from ammunition bay in centre-fuselage; four weapon pylons on stub-wings (six when air-to-air capability is installed); engines widely separated, with integral particle separators and built-in exhaust cooling fittings; four-blade main rotor with lifting aerofoil blade section and swept tips; blades can be folded or easily removed; tail rotor consists of two teetering two-blade units crossed at 55° to reduce noise; airframe meets full crash-survival specifications. Six AH-64s will fit in C-5 and three in C-17A.

Main transmission, by Litton Precision Gear Division, can operate for 1 hour without oil; tail rotor drive, by Aircraft Gear Corporation, has grease-lubricated gearboxes with Bendix driveshafts and couplings; gearboxes and shafts can operate for 1 hour after ballistic damage; main rotor shaft runs within airframe-mounted sleeve, relieving transmission of flight loads and allowing removal of transmission without disturbing rotor.

FLYING CONTROLS: Fully powered controls with stabilisation and automatic flight control system; automatic hover hold; tailplane incidence automatically adjusted by Hamilton Sundstrand control to streamline with downwash during hover and to hold best fuselage attitude during climb, cruise, descent and transition.

STRUCTURE: Main rotor blades (by Tool Research and Engineering Corporation, Composite Structures Divisions) tolerant to 23 mm cannon shells, have five U-sections forming spars and skins bonded with structural glass fibre tubes, laminated stainless steel skin and composites rear section; blades attached to hub by stack of laminated steel straps with elastomeric bearings. Northrop Grumman produces all fuselages, wings, tail, engine cowlings, canopies and avionics containers.

LANDING GEAR: Menasco trailing arm type, with single mainwheels and fully castoring, self-centring and lockable tailwheel. Mainwheel tyres size 8.50-10 (10 ply) tubeless, tailwheel tyre size 5.00-4 (14 ply) tubeless. Hydraulic brakes on main units. Main gear is non-retractable, but legs fold rearward to reduce overall height for storage and transportation. Energy-absorbing main and tail gears are designed for normal descent rates of up to 3.05 m (10 ft)/s and heavy landings at up to 12.8 m (42 ft)/s. Take-offs and landings can be made at structural design gross weight on terrain slopes of up to 12° (head-on) and 10° (side-on).

POWER PLANT: Two General Electric T700-GE-701C turboshafts, each rated at 1,409 kW (1,890 shp) for 10 minutes, 1,342 kW (1,800 shp) for 30 minutes, 1,238 kW (1,660 shp) maximum continuous and 1,447 kW (1,940 shp) 2½ minutes OEI. Engines mounted one on each side of fuselage, above wings, with key components armour-protected. Upper cowlings let down to serve as maintenance platforms. General Electric and US Army to undertake joint remanufacture programme of existing engines into T700-GE-701D standard from mid-2003; intended to alleviate poor levels of reliability, this will also increase power slightly and may be installed on more than 700 Apaches.

AH-64 modernisation may ultimately lead to installation of new engine on Block III helicopters. In addition, Boeing proposing adoption of new five-blade main rotor system allied to new drive system, offering improved performance, greater reliability and simplified maintenance.

Two crash-resistant fuel cells in fuselage, combined capacity 1,421 litres (375 US gallons; 312 Imp gallons). Modifications ordered September 1993 for carriage of four 871 litre (230 US gallon; 192 Imp gallon) Brunswick Corporation external tanks on 437 Apaches. Total internal and external fuel 4,910 litres (1,295 US gallons; 1,078 Imp gallons). New crashworthy, ballistically self-sealing internal auxiliary fuel tank entered evaluation phase in fourth quarter of 1997; tank holds 492 litres (130 US gallons; 108 Imp gallons) and is interchangeable with ammunition storage magazine, enabling all four weapons pylons to carry ordnance on long-range missions. Testing of preproduction system undertaken in 1998 in addition to formal test and qualification programme by US Army; total of 48 units ordered from Robertson Aviation in 1999; smaller 379 litre (100 US gallon; 83.3 Imp gallon) internal tank utilised by AH-64D, this permitting carriage of up to 300 rounds of 30 mm ammunition for Chain Gun. 'Black Hole' IR suppression system protects aircraft from heat-seeking missiles: this eliminates an engine bay cooling fan, by operating from engine exhaust gas through ejector nozzles to lower the gas plume and metal temperatures.

ACCOMMODATION: Crew of two in tandem: co-pilot/gunner (CPG) in front, pilot behind on 48 cm (19 in) elevated seat. Crew seats, by Simula Inc, are of lightweight Kevlar. Northrop Grumman canopy, with PPG transparencies and transparent acrylic blast barrier between cockpits, is designed to provide optimum field of view. Crew stations are protected by Ceradyne Inc lightweight boron armour shields in cockpit floor and sides, and between cockpits, offering protection against 12.7 mm armour-piercing rounds. Sierracin electric heating of windscreen. Seats and structure designed to give crew a 95 per cent chance of surviving ground impacts of up to 12.8 m (42 ft)/s.

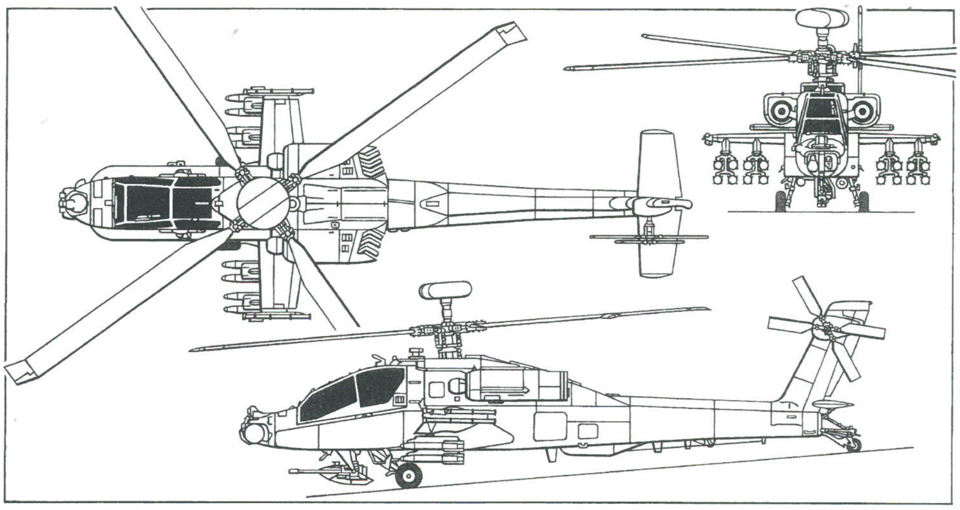
SYSTEMS: Honeywell totally integrated pneumatic system includes a shaft-driven compressor, air turbine starters, pneumatic valves, temperature control unit and environmental control unit. Fairchild Controls improved environmental control system comprises a distributed vapour-cycle cooling and heating unit, with two redundant systems incorporating dual-speed compressors, digital databus controllers and multiple heat exchangers, fans and control valves. Parker dual-hydraulic systems, operating at 207 bar (3,000 lb/sq in), with actuators ballistically tolerant to 12.7 mm direct hits. Redundant flight control system for both rotors. In the event of a flying control system failure, the system activates Honeywell secondary fly-by-wire control. Honeywell electrical power system, with two 45 kVA fully redundant engine-driven AC generators, two 300 A transformer-rectifiers, and URDC standby DC battery. Honeywell GTP 36-155(BH) 93 kW (125 shp) APU for engine starting and maintenance checking. DASA (TST) electric blade de-icing. Smiths Industries integrated electrical power management system (IEPMS) installed on AH-64D is currently being upgraded to incorporate multichannel remote interface unit (RIU) that will replace core electronics and wiring associated with conventional electrical control systems; improved IEPMS available from 2001 is being installed on approximately 300 Apaches for US Army.

AVIONICS: *Comms:* AN/ARC-164 UHF, AN/ARC-222 SINCGARS secure UHF/VHF; AN/ARC-220 UHF to be retrofitted; KY-28/58/TSEC crypto secure voice, C-8157 secure voice control; AN/APX-100 IFF unit with KIT-1A secure encoding; C-10414 Tempest intercom.

Radar: Lockheed Martin/Northrop Grumman AN/APG-78 Longbow mast-mounted 360° radar installed on most AH-64Ds, presenting up to 256 targets on tactical situation display;detects air targets in air-to-ground mode; air-to-air mode for flying targets only.

Flight: BAE North America AN/ASN-157 lightweight Doppler navigation system, Litton LR-80 (AN/ASN-143) strapdown AHRS, AN/ARN-89B ADF, GPS, Honeywell digital automatic stabilisation equipment (DASE), Astronautics Corporation HSI, Pacer Systems omnidirectional, low-airspeed air data system, remote magnetic indicator, BITE fault detection and location. Doppler system, with AHRS, permits nap-of-the-earth navigation and provides data for storing target locations. BAE Systems air data system, comprising two omnidirectional airspeed and direction sensors (AADSs) mounted on engine cowlings and a high integration air data computer (HIADC) installed in avionics bay.

Instrumentation: Honeywell all-raster symbology generator processes TV data from IR and other sensors,



Boeing AH-64D Apache Longbow tandem-seat advanced attack helicopter *(Jane's/Mike Keep)*

Netherlands Air Force Boeing AH-64DN Apache ***(Paul Jackson)*** ***NEW***/0568390

superimposes symbology, and distributes the combination to CRT and helmet-mounted displays; Honeywell AN/APN-209 radar altimeter video display unit. 'Manprint' (manpower integration) instrumentation including Litton Canada upfront display and two Honeywell 152 × 152 mm (6 × 6 in) monochrome CRT displays in each cockpit of early aircraft; from 27th AH-64D, Honeywell flat-panel, colour, active matrix LCD multipurpose displays (MPDs) installed in both cockpits, as well as in aircraft for UK and Netherlands. AH-64A's 1,200 cockpit switches reduced to approximately 200 on AH-64D.

Mission: Lockheed Martin target acquisition and designation sight and AN/AAQ-11 pilot's night vision sensor (TADS/PNVS) comprises two independently functioning, fully integrated systems mounted on nose.

TADS consists of a rotating turret (±120° in azimuth, +30/–60° in elevation) housing sensor subsystems, optical relay tube (being replaced under 1998 contract by Planar Advance/dpiX flat panel display) in the CPG's cockpit, three electronic units in the avionics bay, and cockpit-mounted controls and displays; used principally for target search, detection and laser designation, with CPG as primary operator (can also provide back-up night vision to pilot in event of PNVS failure). Once acquired by TADS, targets can be tracked manually or automatically for autonomous attack with gun, rockets or Hellfire missiles. TADS daylight sensor consists of TV camera with narrow (0° 50′) and wide angle (4° 0′) fields of view; direct view optics (4° narrow and 18° wide angle); laser spot tracker; and International Laser Systems laser range-finder/designator. New switchable eyesafe laser range-finder designator (SELRD) currently being developed by Kollsman Inc under US$2.8 million contract awarded at start of 2000; to be installed in existing TADS turret on AH-64A and AH-64D and will have 80 per cent commonality with Kiowa Warrior SELRD. Night sensor, in starboard half of turret, incorporates FLIR sight with narrow, medium and wide angle (3° 6′, 10° 6′ and 50°) fields of view.

PNVS consists of FLIR sensor (30 × 40° field of view) in rotating turret (±90° in azimuth, +20/–45° in elevation) mounted above TADS; electronic unit in the avionics bay; and pilot's display and controls; provides pilot with thermal imaging for nap-of-the-earth flight to, from and within battle area at night or in adverse daytime weather, at altitudes low enough to avoid detection. Second-generation FLIR sensor to be installed on AH-64D; Lockheed Martin Arrowhead and Raytheon FIREsight systems conceived to satisfy this requirement.

Arrowhead selected in late October 2000 to progress to EMD phase. Production is underway, with new sensor system to be introduced on first Lot 8 aircraft (03-5345), due for delivery at about the beginning of 2004. Arrowhead also being offered to overseas operators. PNVS imagery displayed on monocle in front of one of pilot's eyes; flight information including airspeed, altitude and heading is superimposed on this imagery to simplify piloting. Monocle is part of Honeywell integrated helmet and display sighting system (HADSS) worn by both crew members. Symetrics Industries improved data modem for transmission of target data (and eventually real-time imagery) between helicopters, tactical jet, Joint STARS airborne command posts, HQs and ground units at 16,000 bits/s, plus radio frequency interferometer beneath radome for identification of hostile transmitters.

Self-defence: Aircraft survivability equipment (ASE) consists of Litton AN/APR-39 passiye RWR, Sanders AN/ALQ-144 IR jammer, Raytheon AN/AVR-2 laser warning receiver, ITT AN/ALQ-136 radar jammer and chaff dispensers and Lockheed Martin AN/APR-48A radar frequency interferometer. Sanders AN/ALQ-212 Advanced Threat Infra-Red Countermeasures (ATIRCM) system and ITT AN/ALQ-211 suite of integrated RF countermeasures (SIRFC) system currently under development. ATIRCM combines next-generation directable IRCM system with Sanders AN/AAR-57 Common Missile Warning System (CMWS); contractor tests of SIRFC undertaken on Apache Longbow in latter half of 1999, followed by operational test and evaluation from early 2000. Elisra began flight test of passive airborne warning system in second half of 1999 and Israel plans to install this on its AH-64 fleet. Elisra-supplied EW equipment to be installed on IDF/AF AH-64D, which may also have LWS-20V-2 laser warning system. Upgraded Egyptian AH-64D to be fitted with Northrop Grumman AN/ALQ-162(V)6 'Shadowbox' high-band RF countermeasures system. Kuwaiti helicopters to be fitted with BAE Systems HIDAS (Helicopter Integrated Defensive Aids System).

EQUIPMENT: Avpro of UK cleared Exint transport pod for use with AH-64 at start of 2000, but certification to carry personnel still required. In special forces insertion role, Apache can carry maximum of four pods, each able to accommodate 226 kg (500 lb) payload.

ARMAMENT: Boeing M230 Chain Gun 30 mm automatic cannon, located between the mainwheel legs in an underfuselage mounting with Smiths Industries electronic controls. Normal rate of fire is 625 rds/min of HE or HEDP (high-explosive dual-purpose) ammunition, which is interoperable with NATO Aden/DEFA 30 mm ammunition. Maximum ammunition load is 1,200 rounds. 'Sideloader' system installed in starboard forward avionics bay; cut normal loading time of 30 minutes by up to half and reduced number of personnel required from three to one. Gun mounting designed to collapse into fuselage between pilots in the event of a crash landing.

New electric turret under development by Boeing, which received two year, US$5 million contract in first half of 1999; objective is to achieve accuracy of 0.5 mrads compared with current 3.0 mrads. Gun, mount and feed system to be retained in conjunction with redesigned mechanical system featuring electric rather than hydraulic drive as well as digital control; result should be at least 10 per cent lighter and require one instead of two electrical boxes. HR Textron responsible for controls, with Boeing providing the rest. Four underwing hardpoints, with Aircraft Hydro-Forming pylons and ejector units, on which can be carried up to 16 AGM-114 Hellfire anti-tank missiles or up to 76 2.75 in FFAR (folding fin aerial rockets) in their launchers or a combination of Hellfires and FFAR. Compatibility with AAM such as Raytheon Stinger or Thales Starstreak is under consideration, but appears unlikely in near-term future; provision of an AAM will require additional hardpoints if exisiting weapons capacity not to be compromised. Hellfire remote electronics by Rockwell Collins; Honeywell aerial rocket control system; multiplex (MUX) system units by Honeywell. Co-pilot/gunner (CPG) has primary responsibility for firing gun and missiles, but pilot can override his controls to fire gun or launch missiles.

DIMENSIONS, EXTERNAL:

Main rotor diameter	14.63 m (48 ft 0 in)
Main rotor blade chord	0.53 m (1 ft 9 in)
Tail rotor diameter	2.79 m (9 ft 2 in)
Length overall: tail rotor turning	15.54 m (51 ft 0 in)
both rotors turning	17.76 m (58 ft 3¼ in)
Wing span: clean	5.23 m (17 ft 2 in)
over empty weapon racks	5.82 m (19 ft 1 in)
Height: over tailfin	3.55 m (11 ft 7½ in)
over tail rotor	4.30 m (14 ft 1¼ in)
to top of rotor head	3.84 m (12 ft 7 in)
overall (top of air data sensor)	4.66 m (15 ft 3½ in)
overall, Longbow radar	4.95 m (16 ft 3 in)
Main rotor ground clearance (turning)	3.59 m (11 ft 9¼ in)
Distance between c/l of pylons:	
inboard pair	3.20 m (10 ft 6 in)
outboard pair	4.72 m (15 ft 6 in)
Tailplane span	3.40 m (11 ft 2 in)
Wheel track	2.03 m (6 ft 8 in)
Wheelbase	10.59 m (34 ft 9 in)

AREAS:

Main rotor disc	168.11 m² (1,809.5 sq ft)
Tail rotor disc	6.13 m² (66.0 sq ft)

WEIGHTS AND LOADINGS:

Weight empty:	
without Longbow	approx 5,165 kg (11,387 lb)
with Longbow	5,352 kg (11,800 lb)
Max fuel weight: internal	1,108 kg (2,442 lb)
external (four Brunswick tanks)	2,712 kg (5,980 lb)
Primary mission gross weight	7,480 kg (16,491 lb)
Design mission gross weight	8,006 kg (17,650 lb)
Max T-O weight: -701 engines	9,525 kg (21,000 lb)
-701C engines, ferry mission, full fuel	10,432 kg (23,000 lb)
Max disc loading	62.1 kg/m² (12.71 lb/sq ft)

PERFORMANCE (A: with -701 engines, without Longbow at 6,552 kg; 14,445 lb AUW, L: Apache Longbow at 7,530 kg; 16,601 lb with -701C engines):

Never-exceed speed (VNE)	197 kt (365 km/h; 227 mph)
Max level and max cruising speed:	
A	158 kt (293 km/h; 182 mph)
L	143 kt (265 km/h; 165 mph)
Max rate of climb at S/L: L	736 m (2,415 ft)/min
Max vertical rate of climb at S/L:	
A	762 m (2,500 ft)/min
L	450 m (1,475 ft)/min
Service ceiling: A	6,400 m (21,000 ft)
L	5,915 m (19,400 ft)
Service ceiling, OEI: A	3,290 m (10,800 ft)
Hovering ceiling:	
IGE: A	4,570 m (15,000 ft)
L	4,170 m (13,690 ft)
OGE: A	3,505 m (11,500 ft)
L	2,890 m (9,480 ft)
Max range, internal fuel: 30 min reserves:	
A	260 n miles (482 km; 300 miles)
L	220 n miles (407 km; 253 miles)
no reserves: L	257 n miles (476 km; 295 miles)
Ferry range, max internal and external fuel, still air, 45 min reserves	1,024 n miles (1,899 km; 1,180 miles)
Endurance at 1,220 m (4,000 ft) at 35°C	1 h 50 min
Max endurance, L: internal fuel	2 h 44 min
internal and external fuel	8 h 0 min
g limits at low altitude and airspeeds up to 164 kt (304 km/h; 189 mph)	+3.5/–0.5

WEIGHTS FOR TYPICAL MISSION PERFORMANCE: (all without Longbow; A: anti-armour at 1,220 m/4,000 ft and 35°C, four Hellfire and 320 rounds of 30 mm ammunition; B: as A, but with 1,200 rounds; C: as A, but with six Hellfire and 540 rounds; D: anti-armour at 610 m/2,000 ft and 21°C, 16 Hellfire and 1,200 rounds; E: air cover at 1,220 m/4,000 ft and 35°C, four Hellfire and 1,200 rounds; F: as E but at 610 m/2,000 ft and 21°C, four Hellfire, 19 rockets, 1,200 rounds; G: escort at 1,220 m/4,000 ft and 35°C, 19 rockets and 1,200 rounds; H: escort at 610 m/2,000 ft and 21°C, 38 rockets and 1,200 rounds):

Mission fuel: A	727 kg (1,602 lb)
G	741 kg (1,633 lb)
E	745 kg (1,643 lb)
C	902 kg (1,989 lb)
B	1,029 kg (2,269 lb)
D	1,063 kg (2,344 lb)
H	1,077 kg (2,374 lb)
F	1,086 kg (2,394 lb)
Mission gross weight: A	6,552 kg (14,445 lb)
E	6,874 kg (15,154 lb)
G	6,932 kg (15,282 lb)
B, C	7,158 kg (15,780 lb)
D	7,728 kg (17,038 lb)
F	7,813 kg (17,225 lb)
H	7,867 kg (17,343 lb)

TYPICAL MISSION PERFORMANCE (A-H as above):

Cruising speed at intermediate rated power:	
C	147 kt (272 km/h; 169 mph)
D	148 kt (274 km/h; 170 mph)
F	150 kt (278 km/h; 173 mph)
B	151 kt (280 km/h; 174 mph)
E, H	153 kt (283 km/h; 176 mph)
A	154 kt (285 km/h; 177 mph)
G	155 kt (287 km/h; 178 mph)
Max vertical rate of climb at intermediate rated power:	
B, C	137 m (450 ft)/min
H	238 m (780 ft)/min
F, G	262 m (860 ft)/min
E	293 m (960 ft)/min
D	301 m (990 ft)/min
A	448 m (1,470 ft)/min
Mission endurance (no reserves): A, E, G	1 h 50 min
C	1 h 47 min
D, F, H	2 h 30 min
B	2 h 40 min

UPDATED

BOEING COMMERCIAL AIRPLANES

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Single-aisle aircraft are 717, 737 and 757; twin-aisle are 747, 767 and 777.

BOEING AIRLINER BACKLOG
(at 1 January 2004)

717-200	36	
Total 717		**36**
737-600	19	
737-700	428	
737-700BBJ	8	
737-800	358	
737-800BBJ	1	
737-900	17	
Total 737		**831**
747-400	14	
747-400ERF	6	
747-400F	17	
Total 747		**37**
757-200	8	
757-300	5	
Total 757		**13**
767-200ER	4	
767-300ER	21	
Total 767		**25**
777-200	9	
777-200ER	74	
777-200LR	5	
777-300	9	
777-300ER	71	
Total 777		**168**
Total backlog		**1,110**

UPDATED

BOEING AIRLINER FIVE-YEAR DELIVERIES

Year	717	737	747	757	767	777	MD-11	MD-80	MD-90	Total
1999	12	320	47	67	44	83	8	26	13	**620**
2000	32	281	25	45	44	55	4		3	**489**
2001	49	299	31	45	40	61	2			**527**
2002	20	223	27	29	35	47				**381**
2003	12	173	19	14	24	39				**281**

BOEING COMMERCIAL AIRPLANE GROUP ORDERS AND DELIVERIES
(at 1 January 2004)

	Orders Total	Deliveries Total	Orders in 2003	Deliveries in 2003
707/720	1,010	1,010	0	0
Total 707/720	**1,010**	**1,010**	**0**	**0**
717-200	161	125	8	12
Total 717	**161**	**125**	**8**	**12**
727	1,831	1,831	0	0
Total 727	**1,831**	**1,831**	**0**	**0**
737-100	30	30	0	0
737-200	1,114	1,114	0	0
737-300	1,113	1,113	0	0
737-400	486	486	0	0
737-500	389	389	0	0
737-600	72	53	–9	6
737-700/C-40A	931	503	124	80
737-700BBJ	76	68	5	4
737-800	1,104	746	76	69
737-800BBJ	11	10	3	3
737-900	57	40	7	11
Total 737	**5,383**	**4,552**	**206**	**173**
747-100	250	250	0	0
747-200	393	393	0	0
747-300	81	81	0	0
747-400	451	437	–2	6
747-400D	19	19	0	0
747-400ER	6	6	0	3
747-400ERF	13	7	2	4
747-400F	101	84	4	6
747-400M	61	61	0	0
Total 747	**1,375**	**1,338**	**4**	**19**
757-200	913	905	7	3
757-200M	1	1	0	0
757-200PF	80	80	0	0
757-300	55	50	–8	11
Total 757	**1,049**	**1,036**	**–1**	**14**
767-200	128	128	0	0
767-200ER	118	114	1	2
767-300	104	104	0	0
767-300ER	514	493	9	22
767-300F	40	40	0	0
767-400ER	37	37	0	0
Total 767	**941**	**916**	**10**	**24**
777-200	91	82	5	1
777-200ER	402	328	–5	29
777-200LR	5	0	0	0
777-300	62	53	–3	9
777-300ER	71	0	15	0
Total 777	**631**	**463**	**12**	**39**
Grand Totals	**12,381**	**11,271**	**239**	**281**

Note: Table does not include one each of 727-100, 747-100, 757-200, 767-200 and 777-200 owned by Boeing. Annual order total is net (after deduction of cancellations), some being negative quantities

UPDATED

BOEING 737

US Navy designation: C-40A Clipper

TYPE: Twin-jet airliner.

PROGRAMME: Original Boeing 737 first flew 9 April 1967; -100 and -200 with Pratt & Whitney JT8D engines; -300 entered service with CFM56 engines, November 1984, followed by -400 and -500; 3,132nd and last of this generation delivered February 2000. These versions, including military T-43 and Surveiller, described in *Jane's Aircraft Upgrades*.

Current 'Next-Generation' of family (initially 737X) originated in 1991, when Boeing asked more than 30 airlines to help define improved series; company board authorised offer for sale June 1993; Southwest Airlines ordered 63 737-700s (32 converted from options for 737-300s) plus 63 new options (all, and more, taken up) 18 November 1993; roll-out (737-700) 8 December 1996; first flight (N737X) 9 February 1997; certification 7 November 1997, immediately followed by first deliveries. CFM56-7B power plant first flew on Boeing 747 testbed on 16 January 1996. Flight test programme involved 10 aircraft: four 737-700s, three 737-800s and three 737-600s. FAA approval for 180-minute ETOPS granted in September 1999. By January 2000, B737s of all subtypes had flown over 100 million hours. 1,000th NG 737 (N418WN) first flew 1 November 2001 and delivered to Southwest Airlines on 13 November.

Further enhancements, incorporated in 737-900 demonstrator, completed in March 2002; features include quiet climb system, GPS landing and synthetic vision system.

CURRENT VERSIONS: **737-600:** Smallest of current 737 family. Known as 737-500X until officially launched 15 March 1995; 110 two-class passengers; final assembly of prototype began at Renton 29 August 1997; roll-out December 1997; first flight 22 January 1998; FAA certification 18 August 1998; first delivery (SE-DNM to launch customer SAS) 18 September 1998.

737-700: First to be ordered and manufactured; mid-size version of family, equivalent to previous ('Classic') 737-300, seating 126 passengers in two-class layout. First aircraft (N737X) rolled out 2 (officially 8) December 1996; first flight 9 February 1997, followed by second aircraft 27 February that year; second aircraft attained maximum certified altitude of 12,500 m (41,000 ft) for the first time on 19 March 1997; FAA certification 7 November 1997, with first delivery (fourth built, N700GS to Southwest Airlines) on 17 December 1997.

737-700IGW: Formerly 737-700X; increased gross weight version, based on Boeing Business Jet airframe, including forward cargo door, port. Available as **737-700C** (Convertible) and **737-700C/QC** (Convertible/Quick change); latter interchangeable between 140 single-class (81 cm; 32 in pitch) passengers and eight 2.24 × 3.18 m (88 × 125 in) pallets within one hour, compared to six hours of standard -700C. Max T-O weight 77,560 kg (171,000 lb); max landing weight 60,780 kg (134,000 lb); max zero-fuel weight 57,155 kg (126,000 lb); operating weight empty: -700C passenger 40,000 kg (88,190 lb), -700C cargo 38,365 kg (84, 580 lb), -700C.QC passenger 41,840 kg (92,240 lb), -700C/QC cargo 38,905 kg (85,770 lb). Fuel capacity 26,025 litres (6,875 US gallons; 5,725 Imp gallons); design range: -700C passenger 3,210 n miles (5,944 km; 3,694 miles), -700C/QC passenger 3,115 n miles (5,769 km; 3,584 miles), cargo (both versions) 2,880 n miles

BOEING 737 NEXT-GENERATION ORDER BOOK
(at 1 January 2004)

Customer	Variant	First Order	First Delivery	600	700	800	900
Aeromexico	737-700	27 Dec 02	7 Oct 03		11		
Air Algérie	737-600	16 Jul 98	29 Apr 02	5			
	737-800	16 Jul 98	31 Jul 00			10	
Air Berlin	737-800	22 Dec 94	7 May 98			26	
Air China	737-700	31 Jul 01	17 Jun 03		11		
	737-800	30 Oct 97	17 Aug 99			11	
Air Europa	737-800	31 Oct 03	-			4	
Air Pacific	737-700	5 Sep 96	22 Sep 98		1		
	737-800	5 Sep 96	24 May 99			2	
AirTran	737-700	3 Jul 03	-		28		
Alaska Airlines	737-700	10 Nov 97	28 Jul 99		17		
	737-900	10 Nov 97	15 May 01				14
All Nippon	737-700	27 Jun 03	-		45		
American Airlines	737-800	21 Nov 96	7 Feb 99			124	
American Trans Air	737-800	30 Jun 00	29 Jun 01			20	
Ansett Worldwide	737-700	2 Sep 96	22 Mar 99		4		
Aramco Services Co	737-700	15 Dec 99	15 Sep 00		5		
Austrian	737-800	5 Mar 03	-			3	
Bavaria	737-700	30 Jan 95	27 Apr 98		6		
Bouillion Aviation	737-700	29 Jul 98	24 Jan 01		15		
	737-800	29 Jul 98	26 Apr 01			17	
Braathens	737-700	3 Feb 97	25 Aug 98		10		
Britannia Airways	737-800	18 Nov 98	6 Apr 00			4	
China Airlines	737-800	22 Dec 95	26 Oct 98			15	
China Eastern	737-700	2 Oct 01	10 Sep 02		4		
China Southern	737-700	2 Oct 01	-		8		
	737-800	2 Oct 01	22 Aug 02			12	
China Southwest	737-800	1 Jun 98	29 Oct 99			3	
China Yunnan	737-700	30 Oct 97	8 Dec 98		4		
CIT Leasing	737-700	14 Jun 99	11 Apr 01		16		
	737-800	14 Jun 99	26 Apr 01			15	
Continental	737-700	25 Jul 96	30 Mar 98		51		
	737-800	25 Jul 96	23 Jun 98			121	
	737-900	18 Mar 98	29 May 01				15
Copa Airlines	737-700	19 Jan 99	21 Jan 00		12		
	737-800	28 Jun 02	6 Oct 03			2	
Delta Air Lines	737-800	10 Jun 97	22 Oct 98			132	
Eastwind Airlines	737-700	20 Oct 97	13 May 98		2		
EasyJet	737-700	28 Jul 98	13 Oct 00		32		
El Al	737-700	1 Apr 98	11 Aug 99		2		
	737-800	1 Apr 98	24 Feb 99			3	
Ethiopian Airlines	737-700	28 Nov 02	24 Nov 03		3		
Garuda	737-700	15 Dec 99	-		18		
GATX Financial Corp	737-800	31 Jul 96	14 Dec 98			20	
GATX Jet Partners	737-800	31 May 00	29 Jun 00			18	
GECAS	737-600	22 Jan 96	24 Sep 99	7			
	737-700	22 Jan 96	30 Oct 98		96		
	737-800	22 Jan 96	29 Jul 98			59	
Germania	737-700	28 Mar 95	10 Mar 98		12		
Hainan Airlines	737-800	30 Oct 97	23 Aug 99			19	
Hapag-Lloyd	737-800	18 Nov 94	22 Apr 98			27	
ILFC	737-600	2 Sep 96	17 Oct 03	22			
	737-700	25 Jul 95	25 Mar 98		106		
	737-800	25 Jul 95	10 Jun 98			86	
Itochu AirLease	737-800	11 Jul 96	21 Jan 99			10	
Jet Airways	737-700	14 Jun 99	17 May 01		4		
	737-800	11 Dec 96	24 Dec 98			11	
	737-900	14 Jun 99	6 May 03				2
Kenya Airways	737-700	7 Mar 00	11 Dec 02		2		
KLM	737-800	14 Mar 97	25 Feb 99			13	
	737-900	7 Sep 98	29 Jun 01				5
Korean Air	737-800	9 Jun 98	15 Aug 00			6	
	737-900	9 Jun 98	21 Nov 01				16
Lauda Air	737-600	31 Dec 98	4 May 00	2			
	737-700	8 Jan 99	19 Apr 01		2		
	737-800	8 Jan 99	28 Jul 98			4	
Linas Aereas Azteca	737-700	13 Feb 01	29 Jun 01		2		
LOT	737-800	9 Oct 96	-			2	
Luxair	737-700	28 Feb 03	-		3		
Maersk	737-700	16 Jun 94	2 Mar 98		12		
Midway Airlines	737-700	14 Jun 99	29 Sep 00		7		
Oman Air	737-700	30 Apr 01	25 Jun 02		1		
	737-800	30 Apr 01	1 Jul 03			1	
Pegasus Airlines	737-800	4 Sep 97	25 Mar 99			1	
Pembroke Capital Ltd	737-600	14 Mar 95	27 Apr 99	1			
	737-700	6 Mar 97	15 Dec 98		8		
Qantas	737-800	9 Nov 01	14 Jan 02			26	
Royal Air Maroc	737-700	30 Aug 96	16 Apr 99		5		
	737-800	30 Aug 96	10 Jul 98			14	
Ryanair	737-800	9 Mar 98	19 Mar 99			153	
SAS	737-600	14 Mar 95	18 Sep 98	28			
	737-700	14 Mar 95	3 Nov 99		6		
	737-800	14 Mar 95	3 May 00			23	
Shandong Airlines	737-700	12 Nov 03	-		3		
	737-800	12 Nov 03	-			4	
Shanghai Airlines	737-700	30 Oct 97	25 May 00		4		
	737-800	2 Oct 01	14 Aug 02			1	
Shenzhen Airlines	737-700	30 Oct 97	30 Sep 98		6		
	737-900	12 Nov 03	-				5
South African Airways	737-800	31 May 00	26 Jul 02			5	
Southwest	737-700	17 Nov 93	17 Dec 97		266		
Sumitomo Corp	737-800	11 Jul 96	3 May 99			2	
Sunrock	737-700	17 Jun 97	-		2		
	737-800	17 Jun 97	20 Apr 00			3	
Taiwan Air Force	737-800	30 Nov 98	8 Dec 99			1	
TAROM	737-700	17 Jun 99	27 Mar 01		4		
Tombo Aviation	737-700	31 Dec 96	2 Dec 98		7		
	737-800	31 Dec 96	30 Nov 99			8	
Transavia	737-700	15 Nov 01	18 Feb 03		4		
	737-800	6 Nov 95	16 Jun 98			13	
TunisAir	737-600	28 Oct 97	25 May 99	7			
Turkish Airlines	737-800	7 Oct 97	30 Oct 98			26	
Ukraine Airlines	737-700	15 Dec 99	-		1		
US Navy	737-700	3 Sep 97	29 Sep 00		8		
Virgin Blue	737-800	31 Dec 02	13 Aug 03			15	
Westjet	737-700	23 Aug 00	18 Oct 02		32		
Wuhan Airlines	737-800	29 Jun 98	19 Mar 01			2	
Xiamen Airlines	737-700	30 Oct 97	21 Aug 98		11		
Various unidentified	737-700BBJ	22 Jan 96	23 Nov 98		76		
	737-800BBJ	19 Nov 97	28 Feb 01			11	
	737-700	18 Mar 02	-		12		
	737-800	18 Mar 02	-			7	
Subtotals				**72**	**1,007**	**1,115**	**57**
Total						**2,251**	

Note: For deliveries see Group Orders and Deliveries table

(5,333 km; 3,314 miles). Cargo volume: lower hold 27.4 m³ (966 cu ft), main deck (cargo conversion only) 99.7 m³ (3,520 cu ft).

Initial two ordered 29 August 1997 as **C-40A Clipper** to meet US Navy requirement for C-9B Skytrain II replacement. First C-40A flew 17 April 2000; first delivery to US Naval Reserve Fleet Logistics Support Squadron VR-59 at NAS/JRB Fort Worth, Texas 21 April 2001; three additional C-40As operated by VR-59, and two by VR-58 at NAS Jacksonville, Florida; sixth delivered 28 October 2002.

Commercial launch customer for the 737-700C/QC was Saudi Aramco of Saudi Arabia, which took delivery of two in 2001.

First civil equivalent, designated **737-700C**, was N743A, first flown 18 September 2001 and delivered to ARAMCO on 31 October.

737-800: Known as 737-400X Stretch until launched 5 September 1994; seats 162 two-class passengers; roll-out (N737BX) 30 June 1997; first flight 31 July 1997; certified by FAA 13 March and JAA 9 April 1998; first delivery (D-AHFC to launch customer Hapag-Lloyd) 22 April 1998. Hapag-Lloyd became first commercial courier to operate 737-800 fitted with optional winglets in May 2001.

737-900: Formerly 737-900X; launched 10 November 1997 with an order for 10, plus 10 options, from Alaska Airlines; largest 737 variant to date, with (compared to -800) stretch by means of 1.57 m (5 ft 2 in) forward plug and 1.07 m (3 ft 6 in) aft plug and strengthened fuselage; seating for 177 two-class passengers; deliveries from early 2001. One prototype/certification aircraft only; rolled out 23 July 2000; first flight (N737X) 3 August 2000; FAA certification achieved 17 April 2001 following 156 hours of ground testing and a two-aircraft flight test programme totalling 649 flight hours in 296 sorties; first delivery (Alaska Airlines) in April 2001.

737-900X: Increased capacity, long-range version under study in 2001 and offered from 2002 to compete with Airbus A321 in European charter market; additional Type II emergency exit aft of the wing, port side, to increase certification-limited maximum capacity to 204 or 210 passengers; increase in max take-off weight to 83,551 kg (184,200 lb); max payload range 2,710 n miles (5,018 km to 3,118 miles); CFM56-7B27/B1F engines and winglets.

Boeing Business Jet (BBJ): Corporate versions, *described separately.*

Special missions: Military versions, *described separately.*

CUSTOMERS: As per table.

COSTS: List price (2002 – but unchanged by mid-2003; all in millions): 737-600 US$41.0 to US$49.0; 737-700 US$47.0 to US$55.0; 737-800 US$57.5 to US$64.5; 737-900 US$60.5 to 68.5.

DESIGN FEATURES: Conventional, medium-size airliner with podded engines and sweptback wing and tail surfaces. Dihedral 6° at root; sweepback 25° at quarter-chord. Greater range and speed than previous 737s, with less noise and fewer emissions; wing area increased by some 25 per cent by means of 0.43 m (1 ft 5 in) increase in wing chord and about 4.83 m (15 ft 10 in) increase in wing span; new high-lift systems; larger tail surfaces; increased tankage gives US transcontinental range; new aircraft can use same runways, taxiways, ramps and gates as preceding variants; new variant of CFM56 turbofan derated from nominal thrust to suit smaller versions of the family. Noise on ground reduced by approximately 12 dB by new diffuser duct and cooling vent silencer on APU, new ECS fan and duct and new electrical/electronics cooling fan.

FLYING CONTROLS: Conventional and powered. All surfaces actuated by two independent hydraulic systems with manual reversion for ailerons and elevator; elevator servo tabs unlock on manual reversion; rudder has standby hydraulic actuator and system. Three outboard-powered overwing spoiler panels on each wing assist lateral control and also act as airbrakes. Variable incidence tailplane has two electric motors and manual standby.

Leading-edge Krueger flaps inboard and four sections of slats outboard of engines; two airbrake/lift dumper panels on each wing, inboard and outboard of engines; continuous-span, double-slotted trailing-edge flaps inboard and outboard of engines.

FAA Cat. II landing minima system standard using SP-300 dual digital integrated flight director/autopilot: Cat. IIIa capability optional.

STRUCTURE: Aluminium alloy dual-path fail-safe two-spar wing structure with corrosion-resistant 7055-T77 upper skin. Aluminium alloy two-spar tailplane. Graphite composites ailerons, elevators and rudder. Aluminium honeycomb spoiler/airbrake panels and trailing-edges of slats and flaps. Fuselage structure fail-safe aluminium. Elevators, rudder and ailerons contain graphite/Kevlar; other, unstressed, components in GFRP and CFRP include nosecone, wing/fuselage fairing, fin fillet, fintip and flap actuator fairings. Rears of engine nacelles are of graphite/Kevlar/glass fibre.

Germania Boeing 737-700 in the colours of a German tour operator ***(Paul Jackson)*** ***NEW***/0561648

LANDING GEAR: Hydraulically retractable tricycle type, with Boeing oleo-pneumatic shock-absorbers; inward-retracting main units have no doors, wheels forming wheel well seal; nose unit retracts forward; free-fall emergency extension. Twin nosewheels have tyres size 27×7.75. Main units have heavy-duty twin wheels, H40×14.5-19 heavy-duty tyres, and Honeywell or Goodrich heavy-duty wheel brakes as standard. Mainwheel tyre pressure 13.45 to 14.00 bar (195 to 203 lb/sq in). Nosewheel tyre pressure 11.45 to 11.85 bar (166 to 172 lb/sq in).

POWER PLANT: *737-600:* Two CFM International CFM56-7B18 turbofans, each rated at 86.7 kN (19,500 lb st) standard, or two CFM56-7B22s, each rated at 101 kN (22,700 lb st) in high gross weight version.

737-700: Two CFM56-7B20s, each rated at 91.6 kN (20,600 lb st) standard, or two CFM56-7B24s, each rated at 101 kN (22,700 lb st) in high gross weight version.

737-800: Two CFM56-7B24s, each rated at 107.6 kN (24,200 lb st) standard, or two CFM56-7B27s, each rated at 121.4 kN (27,300 lb st) in high gross weight version.

737-900: Two CFM56-7B26s, each rated at 117 kN (26,300 lb st) standard, or two CFM56-7B27s, each rated at 121.4 kN (27,300 lb st) in high gross weight version.

Fuel capacity (all) 26,025 litres (6,875 US gallons; 5,725 Imp gallons).

ACCOMMODATION: *All:* Crew of two side by side on flight deck. One plug-type door at each corner of cabin, with passenger doors on port side and service doors on starboard side. Airstair for forward cabin door optional. Overwing emergency exit on each side. One or two galleys and one modular vacuum lavatory forward and one or two galleys and lavatories aft; all lavatories interconnected to single waste collection tank at port side rear. Lightweight interior, of crushed core materials, has movable class divider, overnight seating-pitch flexibility and modular passenger service unit (PSU) including fold-down video screen in underside of baggage bin. Centreline stowage bins optional for emergency equipment and crew baggage.

Two underfloor baggage holds, forward and aft of wing. Rear hold has provision for post-delivery installation of telescopic baggage conveyor system (when additional fuel tanks not fitted). One baggage door in starboard side of each hold.

737-600: Alternative cabin layouts seat from 110 to 132 passengers. Typical arrangements offer eight first class seats four-abreast at 91 cm (36 in) pitch and 102 tourist class seats six-abreast at 81 cm (32 in) pitch in mixed class; and 132 all-tourist class at 76 cm (30 in) pitch. Total overhead baggage capacity of 6.1 m³ (216 cu ft), equivalent to 0.045 m³ (1.6 cu ft) per passenger.

737-700: Alternative cabin layouts seat from 126 to 149 passengers. Typical arrangements offer eight first class seats four-abreast at 91 cm (36 in) pitch and 118 tourist class seats six-abreast at 81 cm (32 in) pitch in mixed class; and 149 all-tourist class at 76 cm (30 in) pitch. Total overhead baggage capacity of 7.0 m³ (248 cu ft), equivalent to 0.05 m³ (1.8 cu ft) per passenger. *C-40A* options comprise 121 passengers, all-cargo (eight pallets) and combinations of 70 passengers and three pallets.

737-800: Alternative cabin layouts seat from 162 to 189 passengers. Typical arrangements offer 12 first class seats four-abreast at 91 cm (36 in) pitch and 150 tourist class seats six-abreast at 81 cm (32 in) pitch in mixed class; and 189 all-tourist class at 76 cm (30 in) pitch. Total overhead baggage capacity of 9.3 m³ (328 cu ft), equivalent to 0.05 m³ (1.7 cu ft) per passenger.

737-900: Alternative cabin layouts seat from 177 to 189 passengers. Typical arrangements offer 12 first class seats four-abreast at 91 cm (36 in) pitch and 165 tourist class seats six-abreast at 81 cm (32 in) pitch in mixed class; and 189 all-tourist class at 81 cm (32 in) pitch.

SYSTEMS: Honeywell 131-9(B) APU with air start capability to maximum certified altitude and 90 kVA electrical load capability to 11,278 m (37,000 ft). Three-wheel air cycle environmental control system with optional ozone converter and digital cabin pressure controls.

AVIONICS: *Flight:* Satellite navigation standard. Optional satcom and dual FMS (single standard) integrated with GPS.

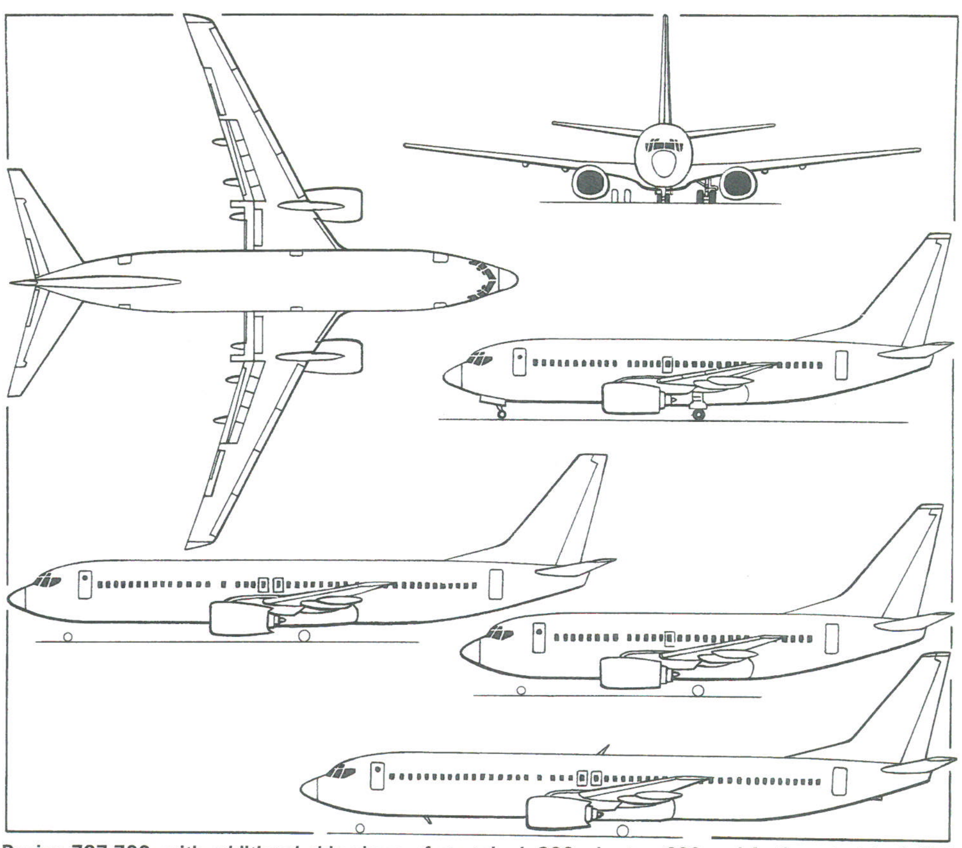
Instrumentation: Honeywell Air Transport Systems common display system (CDS) with five-screen flat-panel liquid crystal display (LCD) technology and programmable software, enables operators to emulate previous 737 electronic flight instrument system (EFIS) and 747-400/777 primary flight display-navigation display (PFD-ND) flight deck formats. Optional HUD.

DIMENSIONS, EXTERNAL:

Wing span (all versions): standard	34.31 m (112 ft 7 in)
with winglets	35.79 m (117 ft 5 in)
Wing chord: at root	5.71 m (18 ft 9 in)
at tip	1.25 m (4 ft 1¼ in)
Wing aspect ratio, standard	9.4
Length: overall: 600	31.24 m (102 ft 6 in)
700	33.63 m (110 ft 4 in)
800	39.47 m (129 ft 6 in)
900	42.11 m (138 ft 2 in)
fuselage: 700	32.18 m (105 ft 7 in)
800	38.02 m (124 ft 9 in)
900	40.67 m (133 ft 5 in)
Height overall: 600, 700	12.57 m (41 ft 3 in)
800, 900	12.55 m (41 ft 2 in)
Tailplane span: all	14.35 m (47 ft 1 in)
Wheel track (c/l shock-struts): all	5.71 m (18 ft 9 in)
Wheelbase: 700	12.60 m (41 ft 4 in)
800	15.60 m (57 ft 2 in)
900	17.17 m (56 ft 4 in)
Distance between engine centrelines	9.65 m (31 ft 8 in)
Main passenger door (port, fwd), all:	
Height	1.83 m (6 ft 0 in)
Width	0.86 m (2 ft 10 in)
Height to sill: at OWE	2.74 m (9 ft 0 in)
at MTOW	2.59 m (8 ft 6 in)
Passenger door (port, rear):	
Height: all	1.83 m (6 ft 0 in)
Width: all	0.76 m (2 ft 6 in)
Height to sill: 600, 700: at OWE	3.10 m (10 ft 2 in)
at MTOW	2.95 m (9 ft 8 in)
800, 900: at OWE	3.12 m (10 ft 2 in)
at MTOW	2.97 m (9 ft 9 in)
Emergency exits (overwing, port and stbd, each), all:	
Height	0.96 m (3 ft 2 in)
Width	0.51 m (1 ft 8 in)
Service door (stbd, fwd), all:	
Height	1.65 m (5 ft 5 in)
Width	0.76 m (2 ft 6 in)
Height to sill: at OWE	2.74 m (9 ft 0 in)
at MTOW	2.59 m (8 ft 6 in)
Service door (stbd, rear):	
Height: all	1.65 m (5 ft 5 in)
Width: all	0.76 m (2 ft 6 in)
Height to sill: 600, 700: at OWE	3.10 m (10 ft 2 in)
at MTOW	2.97 m (9 ft 9 in)
800, 900: at OWE	3.12 m (10 ft 3 in)
at MTOW	2.97 m (9 ft 9 in)
Baggage hold door (stbd, fwd), all:	
Height: door 1.30 m (4 ft 3 in) clear access	0.89 m (2 ft 11 in)
Width	1.22 m (4 ft 0 in)
Height to sill	1.45 m (4 ft 9 in)
Baggage hold door (stbd, rear), all:	
Height: door 1.22 m (4 ft 0 in) clear access	0.84 m (2 ft 9 in)
Width	1.22 m (4 ft 0 in)
Height to sill: 700	1.78 m (5 ft 10 in)
800, 900	1.80 m (5 ft 11 in)

DIMENSIONS, INTERNAL:

Cabin, aft of flight deck to rear pressure bulkhead:	
Length: 600	21.79 m (71 ft 6 in)
700	24.18 m (79 ft 4 in)
800	30.02 m (98 ft 6 in)
Max height: all	2.13 m (7 ft 0 in)
Floor area: 600	67.3 m² (725 sq ft)
700	75.1 m² (808 sq ft)
800	94.0 m² (1,012 sq ft)
Baggage hold:	
Length: 700: front	4.67 m (15 ft 4 in)
rear	8.03 m (26 ft 4 in)
800: front	7.67 m (25 ft 2 in)
rear	10.87 m (35 ft 8 in)
900: front	9.25 m (30 ft 4 in)
rear	11.94 m (39 ft 2 in)
Max width, all: at roof	3.15 m (10 ft 4 in)
at floor	1.22 m (4 ft 0 in)
Min height, all	1.13 m (3 ft 8½ in)
Volume:	
600: front	7.0 m³ (248 cu ft)
rear	13.4 m³ (472 cu ft)
700: front	11.5 m³ (406 cu ft)
rear	16.9 m³ (596 cu ft)



Boeing 737-700, with additional side views of stretched -800, shorter -600 and further stretched -900 (bottom) ***(James Goulding)*** 0089520

800: front 19.6 m³ (692 cu ft)
rear 25.5 m³ (899 cu ft)
900: front 23.8 m³ (840 cu ft)
rear 28.7 m³ (1,012 cu ft)

AREAS:
Wings, gross 125.00 m² (1,345.5 sq ft)
Vertical tail surfaces (total) 26.40 m² (284.2 sq ft)
Horizontal tail surfaces (total) 32.80 m² (353.1 sq ft)

WEIGHTS AND LOADINGS (600: A: CFM56-7B18 engines, B: CFM56-7B22s; 700: A: CFM56-7B20s, B: CFM56-7B24s; 800: A: CFM56-7B24s, B: CFM56-7B27s; 900: A: CFM56-7B26s, B: CFM56-7B27s):

Operating weight empty:
600, 110 passengers: A, B 37,104 kg (81,800 lb)
700, 126 passengers: A, B 38,147 kg (84,100 lb)
800, 162 passengers: A, B 41,145 kg (90,710 lb)
900, 177 passengers: A, B 42,493 kg (93,680 lb)

Max T-O weight:
600: A 56,245 kg (124,000 lb)
B 65,090 kg (143,500 lb)
700: A 60,330 kg (133,000 lb)
B 70,080 kg (154,500 lb)
800: A 70,535 kg (155,500 lb)
B 79,015 kg (174,200 lb)
900: A 74,840 kg (164,000 lb)
B 79,015 kg (174,200 lb)

Max ramp weight:
600: A 56,470 kg (124,500 lb)
B 65,315 kg (144,000 lb)
700: A 60,555 kg (133,500 lb)
B 70,305 kg (155,000 lb)
800: A 70,760 kg (156,000 lb)
B 79,245 kg (174,700 lb)
900: A 74,615 kg (164,500 lb)
B 79,245 kg (174,700 lb)

Max landing weight:
600 A, B 54,655 kg (120,500 lb)
700: A 58,060 kg (128,000 lb)
B 58,605 kg (129,200 lb)
800: A 65,315 kg (144,000 lb)
B 66,360 kg (146,300 lb)
900: A 66.360 kg (146,300 lb)
B 66,810 kg (147,300 lb)

Max zero-fuel weight:
600: A 51,480 kg (113,500 lb)
B 51,710 kg (114,000 lb)
700: A 54,655 kg (120,500 lb)
B 55,200 kg (121,700 lb)
800: A 61,690 kg (136,000 lb)
B 62,730 kg (138,300 lb)
900: A 62,730 kg (138,300 lb)
B 63,640 kg (140,300 lb)

Max wing loading:
600: A 450.0 kg/m² (92.16 lb/sq ft)
B 520.7 kg/m² (106.65 lb/sq ft)
700: A 482.6 kg/m² (98.85 lb/sq ft)
B 560.6 kg/m² (114.83 lb/sq ft)
800: A 564.3 kg/m² (115.57 lb/sq ft)
B 632.1 kg/m² (129.47 lb/sq ft)
900: A 595.1 kg/m² (121.89 lb/sq ft)
B 632.1 kg/m² (129.47 lb/sq ft)

Max power loading:
600: A 324 kg/kN (3.18 lb/lb st)
B 322 kg/kN (3.16 lb/lb st)
700: A 329 kg/kN (3.23 lb/lb st)
B 347 kg/kN (3.40 lb/lb st)
800: A 327 kg/kN (3.21 lb/lb st)
B 325 kg/kN (3.19 lb/lb st)
900: A 318 kg/kN (3.12 lb/lb st)
B 325 kg/kN (3.19 lb/lb st)

PERFORMANCE (A, B as above):
Max operating Mach No. (MMO): all 0.82
Cruising speed: all M0.785
Approach speed:
600: A, B 125 kt (232 km/h; 144 mph)
700: A 129 kt (239 km/h; 148 mph)
B 130 kt (241 km/h; 150 mph)
800: A 141 kt (261 km/h; 162 mph)
B 142 kt (263 km/h; 163 mph)
900: A, B 141 kt (261 km/h; 162 mph)

Max certified altitude: all 12,500 m (41,000 ft)

Initial cruising altitude, ISA +10°C:
600: A 12,500 m (41,000 ft)
B 12,220 m (40,100 ft)
700: A 12,500 m (41,000 ft)
B 11,700 m (38,400 ft)
800: A 11,675 m (38,300 ft)
B 10,955 m (35,940 ft)
900: A 11,215 m (36,800 ft)
B 10,820 m (35,500 ft)

T-O field length, S/L, 30°C:
600: A 1,616 m (5,300 ft)
B 1,796 m (5,890 ft)
700: A 1,744 m (5,720 ft)
B 1,677 m (5,500 ft)
800: A 2,100 m (6,890 ft)
B 2,308 m (7,570 ft)
900: A 2,591 m (8,500 ft)
B 2,439 m (8,000 ft)

Landing field length at max landing weight:
600: A, B 1,342 m (4,400 ft)*
700: A 1,418 m (4,650 ft)
B 1,433 m (4,700 ft)*
800: A 1,646 m (5,400 ft)
B 1,646 m (5,400 ft)
900: A, B 1,662 m (5,450 ft)

Design range:
600 with 110 passengers:
A 1,340 n miles (2,481 km; 1,542 miles)
B 3,050 n miles (5,648 km; 3,509 miles)
700 with 126 passengers:
A 1,540 n miles (2,852 km; 1,772 miles)
B† 3,260 n miles (6,037 km; 3,751 miles)
800 with 162 passengers:
A 1,990 n miles (3,685 km; 2,290 miles)
B† 2,940 n miles (5,444 km; 3,383 miles)
900 with 177 passengers:
A 2,060 n miles (3,815 km; 2,370 miles)
B† 2,745 n miles (5,083 km; 3,158 miles)

** Category D Honeywell brakes*
† with optional blended winglets

UPDATED

Boeing 737-800 of low-cost operator Ryanair *(Paul Jackson)* ***NEW***/0561726

BOEING 747-400

TYPE: Wide-bodied airliner.

PROGRAMME (original): Announced 13 April 1966 (first ever wide-body jet airliner), with Pan American order for 25; official programme launch 25 July 1966; first flight 9 February 1969; FAA certification 30 December 1969; first delivery (to Pan Am) 12 December 1969; first route service New York-London flown 21 January 1970. 747-400 announced October 1985. In May 1990, Boeing decided to market only the -400; last -200 (a -200F Freighter for Nippon Cargo Air Lines) delivered 19 November 1991.

For all variants before 747-400, see *Jane's Aircraft Upgrades*. Production of earlier variants totalled 724 (205 -100, 45 SP, 393 -200 and 81 -300). Nineteen Pan American 747s modified as passenger/cargo **C-19A**s by Boeing Military Airplanes for Civil Reserve Air Fleet (see 1990-91 edition). Boeing board approved launch of 747-400IGW in December 1997. By 31 July 2002, 1,308 Boeing 747s (including 584 -400s) had been delivered, of which 1,100 remained in service. The worldwide fleet of 747s (all models) had flown more than 35 billion miles in 12 million flights, carrying 3.6 billion passengers, by January 2002.

PROGRAMME (current): Series 400 announced October 1985 as 747 development with extended capacity and range; design go-ahead July 1985; first order 22 October 1985; roll-out 26 January 1988; first flight 29 April 1988; certified with P&W PW4056 on 10 January 1989; first delivery 26 January 1989; entered service with Northwest Airlines 9 February 1989; certified with GE CF6-80C2B1F on 8 May 1989; R-R RB211-524G on 8 June 1989; R-R RB211-524H on 11 May 1990. Since May 1990, -400 is the only 747 marketed. 1,200th 747 delivered to British Airways on 17 February 1999.

CURRENT VERSIONS: **747-400:** Basic passenger version; standard and three optional gross weights (see below).

Detailed description applies to -400, except where indicated.

747-400M Combi: Passenger/freight version; initial order 9 April 1986; rolled out 23 March 1989; first flight 30 June 1989; certified 1 October 1989; first delivery 1 September 1989 to KLM. Maximum 266 three-class passengers with freight, 413 without; port-side rear freight door; main deck limit is seven pallets at 27,215 kg (60,000 lb); underfloor and fuel capacities as for passenger 747; 49 delivered by 31 December 1996. For all gross weights, maximum landing weight 285,763 kg (630,000 lb) and maximum zero-fuel weight 256,280 kg (565,000 lb). All three engine options available.

747-400F: All-freight version. Described separately.

747-400 Domestic: Special high-density two-class 568-passenger version; first order 18 December 1988; rolled out 18 February 1991; first flown 18 March 1991; certified 10 October 1991 and delivered same day to Japan Air Lines (first of six) and later to All Nippon (six) and Japan Air System (one). Maximum T-O weight 272,155 kg (600,000 lb) but can be certified to 394,625 kg (870,000 lb). Structurally reinforced; no winglets; lower engine thrust; five more upper deck windows; revised avionics software and cabin pressure schedule; brake cooling fans; five pallets, 14 LD-1 containers and bulk cargo under floor; GE or P&W engines.

747-400 Performance Improvement Package (PIP): Announced April 1993, and first stage implemented in July 1993. Included gross weight increase of 2,268 kg (5,000 lb). Second stage, implemented in December 1993, included longer-chord dorsal fin made of CFRP, and wing spoilers held down more tightly to reduce profile drag and leakage. These improvements were immediately applied to production aircraft and are retrofittable; PIP flight tested in leased United Airlines 747-400 May 1993.

747-400ER: Offered (as 747-400IGW) from December 1997 in response to Qantas requirement, for which the carrier has placed an order for six, with first delivery then scheduled for October 2002. One or two additional fuel tanks in hold. Range 7,500 n miles (13,890 km; 8,630 miles) with one additional tank; 7,700 n miles (14,260 km; 8,861 miles) with two. Structural strengthening around centrebody, wing/fuselage joint, flaps and landing gear.

Prototype N747ER (1,308th B747) rolled out 10 June 2002 (official ceremony on 17th); maiden flight 31 July 2002; became VH-OEE of Qantas.

747-400 ERF: See following entry.

747-400X QLR: Study, since superseded, for developed, Quiet Longer Range version, initially designated 747-400X. Based on 747-400 airframe, but with revised (B777-style) flight deck, crew rest/passenger sleeping area in upper aft fuselage, increased provision for carry-on baggage in cabin, 747-400F's thicker gauge outboard wing with B767-400ER-style raked wingtips (span 68.66 m; 225 ft 3 in) instead of winglets, MD-11-type trailing-edge wedges (of which flight tests began in October 1998), strengthened fuselage sections and landing gear, and modifications to cargo and fuel systems to permit installation of additional fuselage tank forward of centre wing tank, with second additional tank of same capacity optional. Max ramp weight 418,665 kg (923,000 lb); max T-O weight 417,760 kg (921,000 lb); operating weight empty 186,425 kg (411,000 lb), max structural payload 65,315 kg (144,000 lb); fuel load 248,714 litres (65,705 US gallons; 54,710 Imp gallons), giving max range, with 416 passengers in three classes, of 7,980 n miles (14,779 km; 9,183 miles); alternative 396,900 kg (875,000 lb) MTOW and 7,500 n mile (13,890 km; 8,630 mile) range to comply with QC2 noise regulations. Alternative seating up to 524 (including 42 first class). Cruising Mach No is 0.86. By late 2002, QLR had generated little airline interest and Boeing had developed the proposal with greater range and payload, provisionally designating it **747-800X**.

Initial engine planned to be GE CF6-80C2B9F of 282 kN (63,300 lb st). New 'chevron' engine nacelles with serrated rear edges on core and fan nozzles promote mixing of bypass and core flows, and mixing of bypass flow and ambient air; combined with acoustic engine liners, these make QLR some 6 dB quieter (20 per cent on T-O; 40 per cent on approach), enabling it to meet QC2 noise standards.

QLR announced at Asian Aerospace, Singapore, 26 February 2002 (when 'chevron' design revealed). Studies replaced by 747 Advanced.

747-400XF QLR: Study for cargo version of Quiet Longer Range, with simplified and lightened handling system. Launched (then as Longer-Range 747-400 Freighter) April 2001 with order from ILFC. MTOW 417,760 kg (921,000 lb); range 5,150 n miles (9,537 km; 5,926 miles) with 112,810 kg (248,700 lb) payload. Cargo volumes (upper, lower and bulk) as for 747-400F. No extra

BOEING 747-400 ORDER BOOK
(at 1 January 2004)

Customer	Variant	First order	First delivery	Engine	400	400D	400ER	400ERF	400F	400M
Air Canada	400M	20 Jan 89	4 Jun 91	PW4056						3
Air China	400	31 May 90	20 Mar 92	PW4056	6					
	400M	16 May 86	13 Oct 89	PW4056						8
Air France	400	16 Dec 87	28 Feb 91	CF6-80	7					
	400ERF	24 Apr 01	31 Oct 02					2		
	400M	16 Dec 87	17 Sep 91	CF6-80						5
Air India	400	14 Aug 91	4 Aug 93	PW4056	6					
Air Namibia	400M	21 Apr 99	21 Oct 99	CF6-80						1
Air New Zealand	400	30 Jul 84	14 Dec 89	RB211-524	3					
	400	1 Mar 91	31 Oct 98	CF6-80	1					
All Nippon Airways	400	21 Oct 86	28 Aug 90	CF6-80	12					
	400D	21 Jan 86	13 Jan 92	CF6-80		11				
Amiri Flight	400	30 Nov 99	30 Nov 99	CF6-80	1					
Asiana Airlines	400	12 Jun 89	24 Jun 93	CF6-80	2					
	400F	3 Sep 90	4 Nov 94	CF6-80					6	
	400M	12 Jun 89	1 Nov 91	CF6-80						6
Atlas Air	400F	9 Jun 97	29 Jul 98	CF6-80					16	
British Airways	400	15 Aug 86	30 Jun 89	RB211-524	57					
Canadian Airlines Intnl	400	28 Jul 88	11 Dec 90	CF6-80	4					
Cargolux Airlines	400F	6 Dec 90	17 Nov 93	CF6-80					5	
	400F	13 Jun 95	8 Dec 98	RB211-524					8	
Cathay Pacific Airways	400	3 Jun 86	8 Jun 89	RB211-524	17					
	400F	28 Feb 90	1 Jun 94	RB211-524					6	
China Airlines	400	21 Jul 87	8 Feb 90	PW4056	13					
	400	28 Nov 02	none	CF6-80	4					
	400F	11 Aug 99	6 Jul 00	PW4056					19	
China Southern	400F	13 Feb 01	19 Jun 02	PW4062					2	
El Al	400	11 Dec 90	27 Apr 94	PW4056	4					
EVA Air	400	6 Oct 89	2 Nov 92	CF6-80	7					
	400F	6 May 99	20 Jul 00	CF6-80					3	
	400M	6 Oct 89	16 Sep 93	CF6-80						8
Garuda Indonesia	400	15 Nov 90	14 Jan 94	CF6-80	2					
GE Capital	400	22 Dec 95	18 Jun 99	CF6-80	1					
	400F	15 Dec 99	16 Oct 00	CF6-80					5	
ILFC	400	16 May 88	31 May 91	CF6-80	11					
	400	16 May 88	25 Sep 91	RB211-524	2					
	400F	30 Jan 90	14 Apr 99	CF6-80					1	
	400ERF	17 Apr 01	17 Oct 02	CF6-80				3		
Japan Airlines	400	21 Sep 87	25 Jan 90	CF6-80	37					
	400D	30 Jun 88	10 Oct 91	CF6-80		8				
	400F	7 Oct 02	none	CF6-80					2	
Japan Air SDF	400	23 Dec 87	17 Sep 91	CF6-80	2					
KLM	400	9 Apr 86	18 May 89	CF6-80	5					
	400ERF	1 Mar 99	31 Mar 03	CF6-80				3		
	400M	9 Apr 86	1 Sep 89	CF6-80						17
Korean Air Lines	400	29 Aug 86	13 Jun 89	PW4056	27					
	400F	11 Jun 90	6 Sep 96	PW4056					10	
	400ERF	31 Dec 01	13 Jun 03	PW4056				5		
	400M	14 Apr 88	27 Jun 90	PW4056						1
Kuwait Airways	400M	12 Apr 92	29 Nov 94	CF6-80						1
Lufthansa	400	21 May 86	23 May 89	CF6-80	24					
	400M	21 May 86	19 Sep 89	CF6-80						7
Malaysia Airlines	400	19 Oct 88	27 Sep 90	CF6-80	2					
	400	12 Jan 89	27 Aug 92	PW4056	19					
	400M	30 Oct 87	6 Oct 89	CF6-80						2
Mandarin Airlines	400	15 Sep 94	14 Jun 95	PW4056	1					
Northwest Airlines	400	22 Oct 85	26 Jan 89	PW4056	16					
Omani Royal Flight	400	31 Jul 00	14 Dec 01	CF6-80	1					
Philippine Airlines	400	29 Oct 92	19 Nov 93	CF6-80	7					
	400M	18 Jan 96	29 Mar 96	CF6-80						1
Qantas Airways	400	2 Mar 87	11 Aug 89	RB211-524	21					
	400ER	19 Dec 00	31 Oct 02	CF6-80			6			
Saudia	400	18 Jun 95	24 Dec 97	CF6-80	5					
Singapore Airlines	400	27 Mar 86	18 Mar 89	PW4056	42					
	400F	16 Jan 90	5 Aug 94	PW4056					17	
South African Airways	400	6 May 89	19 Jan 91	RB211-524	6					
	400	30 Dec 98	30 Dec 98	CF6-80	2					
Thai Airways Intnl	400	16 Jun 87	21 Feb 90	CF6-80	18					
United Airlines	400	7 Nov 85	30 Jun 89	PW4056	44					
US Air Force (AL-1A)	400F	30 Jan 98	21 Jan 00	CF6-80					1	
UTA	400	3 Jul 86	22 Sep 90	CF6-80	1					
	400M	3 Jul 86	26 Jul 91	CF6-80						1
Virgin Atlantic Airways	400	20 Dec 96	17 Jun 97	CF6-80	9					
undisclosed	400	2 Apr 02		CF6-80	1					
		16 Oct 02		CF6-80	1					
Subtotals					**451**	**19**	**6**	**13**	**101**	**61**
Total								**651**		

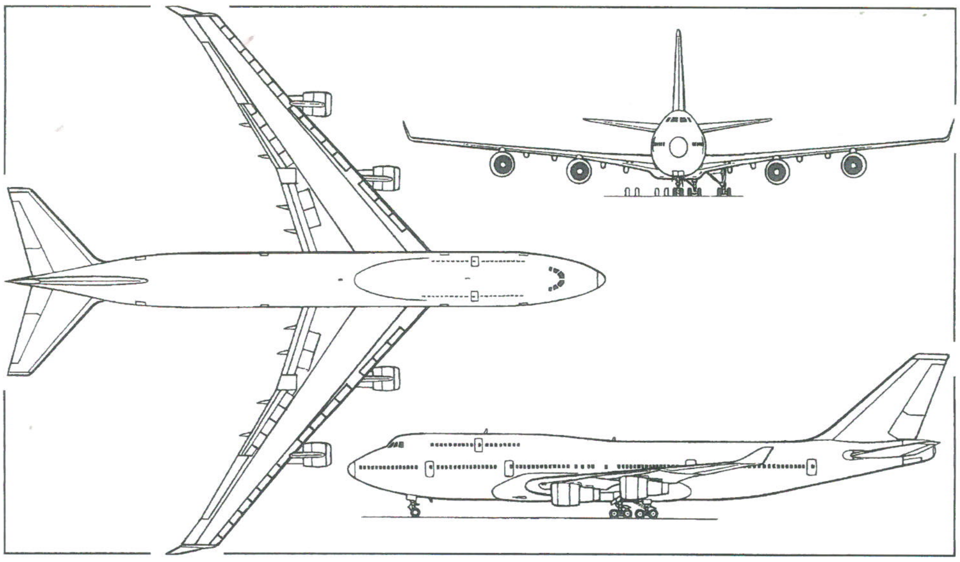
Note: For deliveries see Group Orders and Deliveries table

fuel; capacity as for basic 747-400, GE-engined variant (203,325 litres; 53,765 US gallons; 44,769 Imp gallons). Typical cruising speed M0.845 on GE CF6-80C2B9F engines.

747X and 747X Stretch: Boeing cancelled development of its proposed 747X and 747X Stretch in March 2001.

747-800X: Under consideration by late 2002. Evolved from 747-400X QLR, with 1.98 m (6 ft 6 in) forward fuselage stretch; some 3,785 litres (1,000 US gallons; 833 Imp gallons) of additional fuel in tailplane tanks; between 20 and 40 more seats; and range increased to 8,000 n miles (14,816 km; 9,206 miles). Candidate engines in 276 to 285 kN (62,000 to 64,000 lb st) class. Developed into 747 Advanced.

747 Advanced: Revealed mid-2003 as further development of 747X QLR (and 747XF QLR) theme, drawing on Boeing 7E7 Dreamliner technology, including new engines. Service entry possible in 2009. Raked wingtips with overall span of 68.66 m (225 ft 3 in); trailing-edge wedge and fuselage plugs carried forward from previous studies, although last-mentioned to comprise 2.03 m (6 ft 8 in) ahead of wing and 1.52 m (5 ft 0 in) behind. Length 74.22 m (243 ft 6 in), height overall 19.38 m (63 ft 7 in). Weight empty 198,660 kg (437,975 lb), max T-O 421,840 kg (930,000 lb), zero-fuel 269,430 kg (594,000 lb), max structural payload



Boeing 747-400 advanced long-range airliner (General Electric CF6-80C2 engines) *(Jane's/Dennis Punnett)*
0526900

70,770 kg (156,020 lb). Fuel capacity 225,705 litres (59,625 US gallons; 49, 648 Imp gallons); max operating speed M0.86 with 448 passengers (24/85/339) over 8,090 n miles (14,982 km; 9,309 miles).

CUSTOMERS: As per table. Launch customer Northwest Orient Airlines ordered 10 -400s with PW4000s and 420-passenger interior October 1985; first delivery 26 January 1989.

COSTS: US$185 million to US$211 million (2002); Combi version US$196 million to US$215 million (2002). Prices unchanged by mid-2003.

DESIGN FEATURES: Wide-bodied extrapolation of Boeing intercontinental jet configuration of low wing and four podded engines, optimised for greater passenger numbers and increased efficiency. Twin-deck forward fuselage; four mainwheel bogies for weight distribution.

According to engine type, fuel burn per seat over 3,000 n mile (5,556 km; 3,452 mile) sector varies between 135.8 kg (299.3 lb) and 138.5 kg (305.4 lb).

Sweepback at quarter-chord 37° 30′; thickness/chord ratio 13.44 per cent inboard, 7.8 per cent at mid-span, 8 per cent outboard; dihedral at rest 7°; incidence 2°; winglets, canted 22° outward and swept 60°, increase range by 3 per cent; upper deck extended rearward by 7.11 m (23 ft 4 in).

FLYING CONTROLS: Conventional and powered.

Elevators: Four elevator sections mechanically linked with breakable shear devices; each elevator has dual hydraulic-powered control units; control feel and three individual autopilot input servos mounted on central elevator quadrant; all surfaces have position transmitters; feel computer-operated by pitot pressure and tailplane angle.

Rudder: Upper rudder surface operated by three hydraulic actuators served by two hydraulic systems, lower surface by two actuators fed by remaining two hydraulic systems; no balance weights; each rudder has separate yaw damper module; left and right digital air data computers provide signals for controlling rudder ratio changer on each rudder surface according to air data and tailplane angle; combined feel actuator, rudder centring and trim actuator in rear servo area; mechanical cable linkage between rudder pedals and aft actuator area; rudder trim control switches on centre console. Maximum rudder deflection ±30°.

Tailplane: Tailplane angle set by hydraulic motor-driven shaft and ball screw with primary and secondary hydraulic brakes; flight control unit and air data computer signals sent to tailplane through dual stabiliser, trim and rudder ratio modules, which automatically apply Mach trim, and by dual-stabiliser control modules; tailplane trim limits computed according to flap positions.

Lateral control: Pilot and co-pilot aileron linkage can be physically separated if necessary; all four ailerons operate at low speeds; outboard ailerons are locked out at cruising speed; the inboard spoiler panel on each wing used on ground only; remainder have variable ratio response and spoiler mixer units; there are trim, centring and feel units.

Leading-edge and trailing-edge devices: Three-section Krueger flaps inboard of engines; variable camber slats between (five-section) and outboard (six-section) of engines lie flat when retracted and adopt camber curvature when extended. Two flap assemblies on each wing, one inboard of engines and the other between engines; three sections, fore flap, mid-flap and aft flap, move rearwards as single flat panel up to 5° deflection; thereafter, three sections separate progressively to form three slots, and camber angles relative to each other increase progressively.

Automatic flight control system: Combines autopilot, flight director and automatic tailplane trim and sends commands through triple independent flight control computers; system automates all flight phases except take-off; dual digital air data computers; pilots' primary flight and navigation displays are large-size cathode-ray tubes; two engine indicating and crew alerting screens, one on main panels, one on console; three multifunction control and display panels control flight management system, navigation and communications; flight control computers (autopilot) and inertial reference units are triplicated; new features include full-time autothrottle and dual-thrust management system included in flight management computer; integrated radio control panels and automatic start and shutdown of APU.

STRUCTURE: Wing and tail surfaces are aluminium alloy dual-path fail-safe structures; advanced aluminium alloys in wing torsion box save 2,721 kg (6,000 lb); advanced aluminium honeycomb spoiler panels; CFRP winglets and main deck floor panels; advanced graphite/phenolic and Kevlar/graphite in cabin fittings and engine nacelles; frame/stringer/stressed skin fuselage with some bonding. Improved corrosion protection and further coverage with compound introduced from 1993.

LANDING GEAR: Twin-wheel nose unit retracts forward; main gear consists of four four-wheel bogies; two, mounted side by side under fuselage at wing trailing-edge, retract forward; two, mounted under wings, retract inward; nosewheel steerable up to 70° left or right from tillers; full rudder pedal travel gives up to 7° for use at high speed; two centre main legs steer up to 13° when nosewheels are steered more than 20° and speed is less than 20 kt (37 km/h; 23 mph); carbon disc brakes on all mainwheels, with individually controlled digital anti-skid units; one of three brake pressure supplies automatically selected; main and nose tyres H49×19.0-20 or -22 (32 ply). Minimum ground turning radius, with body gear steering, is 48.46 m (159 ft 0 in) at wingtip and 27.73 m (91 ft 0 in) at nosewheels.

POWER PLANT: Four turbofans for baseline 747-400, these comprise: 252 kN (56,750 lb st) Pratt & Whitney PW4056: 258 kN (57,900 lb st) General Electric CF6-80C2B1F or 276 kN (62,100 lb st) CF6-80C2B5F; or 258 kN (58,000 lb st) Rolls-Royce RB211-524G or 270 kN (60,600 lb st) RB211-524H. Further optional engines (subject to certification) are 267 kN (60,000 lb st) PW4060, 276 kN (62,000 lb st) PW4062 and 274 kN (61,500 lb st) CF6-80C2B1F1. For 747-400ER, initial engine choices are CF6-80C2B5F, PW4062 and RB211-524H8T.

Boeing 747-400 of the Qantas *Longreach* class *(Paul Jackson)* ***NEW***/0561725

Fuel in four main tanks in wings can feed to any engine; in addition there are a centre-wing tank and reserve tanks in outer wing; optional tailplane tank; vent and surge tanks in outer wings and starboard tailplane; jettison pumps in inner main tanks; APU fed from port inner tank; automatic refuelling through two receptacles under each wing leading-edge between engines; automatic condensate scavenging and flame arresters in vent outlets.

Basic fuel capacity 204,355 litres (53,985 US gallons; 44,952 Imp gallons) with P&W and R-R engines; 203,523 litres (53,765 US gallons; 44,769 Imp gallons) with GE engines. At alternative higher T-O weights above 394,625 kg (870,000 lb) use of 12,492 litre (3,300 US gallon; 2,748 Imp gallon) tailplane/centre section tank is mandatory; fuel capacity including tailplane tank is therefore 216,846 litres (57,285 US gallons; 47,700 Imp gallons) with P&W and R-R engines and 216,013 litres (57,065 US gallons; 47,516 Imp gallons) with GE engines.

Usable fuel in 747-400ER comprises 239,389 litres (63,240 US gallons; 52,658 Imp gallons) with GE engines; 240,222 litres (63,460 US gallons; 52,841 Imp gallons) with P&W and R-R engines. Volumes include two tanks in cargo hold each of 11,583 litres (3,060 US gallons; 2,548 Imp gallons).

Nitrogen-based flammability reduction system (FRS) trials with 747-400 tanks undertaken in 2003 with Honeywell/Parker Aerospace OBNGS; available from late 2006 or early 2007.

ACCOMMODATION: Two-crew flight deck, with seats for two observers; two-bunk crew rest cabin accessible from flight deck. Optional (but currently available on 90 per cent of B747-400 fleet) overhead cabin crew rest compartments above rear of main deck cabin (four bunks, four seats; eight bunks, two seats; two bunks, two seats, five sleeper seats). Typical 416-seat, three-class, long-range configuration accommodates 40 business class on upper deck; 23 first class in front cabin, 38 business class in middle cabin and 315 economy class in rear cabin on main deck. Maximum upper deck capacity 69 economy class. First class seating six abreast with two 86 cm (34 in) aisles, each twin-seat unit 1.45 m (4 ft 9 in) wide. Business passengers four abreast with 72 cm (281/2 in) aisle and 1.37 m (4 ft 6 in) wide seat pairs on upper deck or two-three-two on lower deck with two 63 cm (243/4 in) aisles and 2.08 m (6 ft 10 in) triple seat. Economy seating three-four-three, with 49.5 cm (191/2 in) aisles, two 1.51 m (4 ft 111/2 in) triple seats and 2.07 m (6 ft 91/2 in) quad seat. Five passenger doors on each side; upper deck emergency door each side. 747-400ER accommodates, typically, 500 in two-class arrangement (42 first, 458 economy or 416 three-class (as above).

Centre overhead stowage bins 0.16 m^3 (5.7 cu ft) volume per 1.02 m (40 in) long bin; outboard bins 0.45 m^3 (15.9 cu ft) volume per 1.52 m (60 in) long bin; 0.083 m^3 (2.95 cu ft) bin volume per passenger (three-class). Two modular upper deck lavatories, 14 on main deck, relocatable (six upper deck optional locations; 33 on lower deck) and vacuum-drained into four waste tanks with combined volume of 1,136 litres (300 US gallons; 250 Imp gallons). Single-point drainage. Basic galley configuration, one on upper deck, seven centreline and two sidewall on main deck; lavatories and galleys can be

Model of Boeing 747-400X QLR, showing extended wingtips and 'chevron' engine pod modifications *(Paul Jackson)* 0131952

quickly relocated if required fittings are installed; advanced integrated audio/video/announcement system.

Underfloor freight: forward compartment, five 2.44 m (96 in) × 3.18 m (125 in) pallets (totalling 58.8 m³, 2,075 cu ft) or 16 LD-1 containers (totalling 78.4 m³; 2,768 cu ft); aft compartment, 14 LD-1 containers (totalling 68.6 m³; 2,422 cu ft) or four pallets (totalling 47.0 m³; 1,660 cu ft); and bulk storage behind aft compartment 23.6 m³ (835 cu ft). Max capacity of 747-400 (16 LD-1s forward, 14 LD-1s aft and bulk storage in extreme rear) 170.6 m³ (6,025 cu ft). Door to each of three areas, all starboard side. Optional cargo door, port rear, on Combi version. 747-400ER lower deck accommodates 129 m³ (4,550 cu ft) within LD-1 containers, plus 22.3 m³ (789 cu ft) of bulk cargo, when two fuel tanks fitted. Capacity of 747-400X QLR reduced by up to six containers when both additional fuel tanks fitted; capacity 158.5 m³ (5,599 cu ft) with basic fuel; 137.0 m³ (4,837 cu ft) with max fuel.

SYSTEMS: Each engine drives a hydraulic pump feeding an independent system; services are connected to supplies in such a way that loss of one supply cannot disable one system; two hydraulic systems also have air-driven pumps to maintain pressure and two have electric pumps; one electric pump can be run to provide braking when the aircraft is being towed on the ground; all four hydraulic reservoirs can be filled from a single location in the port main landing gear bay.

Hot air bled from the low-pressure and high-pressure compressors of all four engines is precooled by fan exit air and fed via a manifold to the cabin pressurisation and air conditioning system and to provide de-icing of wing leading-edge and engine nose cowling and to pressurise hydraulic tanks. Three conditioning packs in wing/fuselage fairing provide cabin air; five cabin zones, each with digital temperature control.

Each engine drives an integrated drive generator supplying 90 kVA power to respective AC busses; three generators are a dispatch item, but one will supply essential loads; APU drives two further generators; automatic start-up, load transfers and load shedding reduce crew workload; power systems may be isolated from each other for triple-channel Cat. III autoland.

Completely self-contained 1,081 kW (1,450 shp) P&WC PW901A APU, mounted clear of all flight-critical structure and flight controls in the extreme tail, drives two 90 kVA generators that can supply electrical power for whole aircraft; also supplies compressed air to operate pneumatic components; can run at up to 6,100 m (20,000 ft) and supply compressed air below 4,575 m (15,000 ft). Capabilities include maintenance of 24°C (75°F) ground cabin temperature in 38°C (100°F) ambient conditions.

Forward underfloor cargo compartment heated to 5°C by hot air exhausted from flight deck cooling equipment and avionics in main equipment centre, boosted as necessary by two electrical heaters; rear underfloor hold heated to minimum 5°C or 18°C (selected by crew) by engine bleed.

Overheat detection and automatic extinguishing provided in all lavatories; APU automatically shut down and fire extinguisher bottles initiated on detection of fire; each engine has three dual fire detectors in series and a fourth detector for overheating. Underfloor freight compartments and upper deck hold of Combi have smoke detectors and extinguisher systems; wheel wells have overheat detectors.

AVIONICS: Boeing launched development of new Flight Management Computer software in January 1993 to match existing aircraft to international Future Air Navigation System (FANS-1) during 1995. Standard avionics fit as follows:

Comms: Dual VHF and HF transceivers with Selcal; dual transponders; flight intercom with air-to-ground facility, connectable also to satcom system; cabin entertainment and passenger address and service units.

Radar: Colour weather radar transmitting in I- and G-bands.

Flight: Dual VOR; triple ILS receivers with single marker beacon receiver; dual ADF; dual DME; all nav radios automatically tuned by flight management computer system (FMCS). Automatic flight control system (AFCS) integrates autopilot, flight director and automatic stabiliser trim functions; dual digital air data computers with dual selectable pressure sensors, angle of attack sensors and total air temperature probes; FMCS allows crew to preselect flight plan using standard air traffic control language; FMCS incorporates database, updated every 28 days, which includes data on waypoints, airports, standard instrument departures (SIDs), standard terminal arrival routes (STARs), airline routes and information on specific geographic areas; triple ring laser gyro inertial reference units provide navigation input on EFIS, flight management displays or radio magnetic indicators; other systems include ground proximity warning, triple low-range radio altimeters and TCAS.

Central maintenance computer monitors over 75 electrical and electromechanical systems, performs tests and centralises maintenance data; failures are indicated in EICAS displays and stored for future reference for in-flight use or line or hangar maintenance. Satcom datalink allows ground crews to interrogate system for additional information while aircraft in flight.

Instrumentation: Electronic flight instrument system (EFIS) comprising six (left/right inboard/outboard and central upper/lower) 20.3 × 20.3 cm (8 × 8 in) integrated display units (IDU), two each for primary flight display (PFD), navigation display (ND) and engine indicating and crew alerting (EICAS) functions; all IDUs receive data from all three EFIS/EICAS interface units (EIU), updated via software data loader; PFD and EICAS primary formats automatically switch to inboard and lower IDUs respectively, with facility for manual selection of formats on different IDUs as required. B747-400 has 181 switches, 171 lights and 13 gauges, compared with 284, 555 and 132 of earlier variants; total 365 is below average 450 for typical two-crew jet transport.

DIMENSIONS, EXTERNAL:

Wing span: normal	64.44 m (211 ft 5 in)
with winglets	64.92 m (213 ft 0 in)
Wing span, fully fuelled	64.92 m (213 ft 0 in)
Wing chord: at root	14.63 m (48 ft 0 in)
at tip	4.06 m (13 ft 4 in)
Winglet height	0.89 m (2 ft 11 in)
Wing aspect ratio	7.7
Length: overall	70.67 m (231 ft 101/4 in)
fuselage	68.63 m (225 ft 2 in)
Max width of fuselage	6.50 m (21 ft 4 in)
Height overall:	
at OWE: -400	19.51 m (64 ft 0 in)
-400ER	19.58 m (64 ft 3 in)
at MTOW: -400	18.77 m (61 ft 7 in)
-400ER	19.05 m (62 ft 6 in)
Tailplane span	22.17 m (72 ft 9 in)
Wheel track (c/l shock-struts):	
outer pair	11.00 m (36 ft 1 in)
inner pair	3.84 m (12 ft 7 in)
Wheelbase: mean	25.60 m (84 ft 0 in)
to forward main bogie	24.07 m (78 ft 11½ in)
to rear main bogie	27.14 m (89 ft 0½ in)
Distance between engine centrelines:	
outboard	41.66 m (136 ft 8 in)
inboard	23.37 m (76 ft 8 in)
Passenger doors (10, each):	
Height: door, clear access	1.93 m (6 ft 4 in)
Width: door	1.19 m (3 ft 11 in)
clear access	1.07 m (3 ft 6 in)
Height to sill:	
at OWE:	
front: -400	5.16 m (16 ft 11 in)
-400ER	5.21 m (17 ft 1 in)
rear: -400	5.31 m (17 ft 5 in)
-400ER	5.38 m (17 ft 8 in)
at MTOW:	
front: -400	4.72 m (15 ft 6 in)
-400ER	4.75 m (15 ft 7 in)
rear: 400	4.80 m (15 ft 9 in)
-400ER	4.98 m (16 ft 4 in)
Upper deck emergency door (two):	
Height: door	2.01 m (6 ft 7¼ in)
clear access	1.83 m (6 ft 0 in)
Width	1.07 m (3 ft 6 in)
Height to sill:	
at OWE: -400	7.90 m (25 ft 11 in)
-400ER	7.95 m (26 ft 1 in)
at MTOW: -400	7.52 m (24 ft 8 in)
-400ER	7.54 m (24 ft 9 in)
Baggage door (front hold): Height	1.68 m (5 ft 6 in)
Width	2.64 m (8 ft 8 in)
Height to sill: at OWE	3.10 m (10 ft 2 in)
at MTOW	2.69 m (8 ft 10 in)
Baggage door (rear hold): Height	1.68 m (5 ft 6 in)
Width	2.64 m (8 ft 8 in)
Height to sill: at OWE	3.17 m (10 ft 5 in)
at MTOW	2.82 m (9 ft 3 in)
Bulk loading door:	
Height: max (front)	1.42 m (4 ft 8 in)
min (rear)	1.24 m (4 ft 1 in)
Width	1.12 m (3 ft 8 in)
Mean height to sill: at OWE	3.40 m (11 ft 2 in)
at MTOW	3.00 m (9 ft 10 in)
Combi cargo door (port):	
Height (clear access)	3.05 m (10 ft 0 in)
Width	3.40 m (11 ft 2 in)
Height to sill: at OWE	5.26 m (17 ft 3 in)
at MTOW	4.87 m (16 ft 0 in)

747-400ER baggage door heights to sill: add 50 to 75 mm (2 to 3 in)

DIMENSIONS, INTERNAL:

Cabin (main): Max height	2.41 m (7 ft 11 in)
Passenger cabin volume	885.9 m³ (31,285 cu ft)

AREAS:

Wings, gross	541.16 m² (5,825.0 sq ft)
Ailerons (total)	20.90 m² (225.00 sq ft)
Trailing-edge flaps (total)	78.69 m² (847.00 sq ft)
Leading-edge flaps (total)	43.85 m² (472.00 sq ft)
Inboard spoilers (total)	12.78 m² (137.60 sq ft)
Outboard spoilers (total)	15.46 m² (166.40 sq ft)
Fin	77.11 m² (830.00 sq ft)
Rudder	21.37 m² (230.00 sq ft)
Tailplane	136.57 m² (1,470.00 sq ft)
Elevators (total, incl tabs)	30.38 m² (327.00 sq ft)

WEIGHTS AND LOADINGS (747-400: GB: CF6-80C2B1F, GM: CF6-80C2B5F, PB: PW4056, PM: PW4062, RB: RB211-524G, RM: 211-524M engines; all 416 passengers, five cargo pallets and 14 containers, 747-400ER: ER GM CF6-80C2B5F, ER PM: PW4062, ER RM: RB211-524H-8T with passengers/cargo as above):

Operating weight empty: GB	180,485 kg (397,900 lb)
GM	180,895 kg (398,800 lb)
PB	180,845 kg (398,700 lb)
PM	181,255 kg (399,600 lb)
RB	181,435 kg (400,000 lb)
RM	181,845 kg (400,900 lb)
ER GM/PM/RM	184,565 kg (406,900 lb)
Baggage/freight capacity, all:	
forward compartment	26,490 kg (58,400 lb)
aft compartment	22,938 kg (50,570 lb)
bulk compartment	6,749 kg (14,880 lb)
Max structural payload:	
ER GM, PM, RM	67,175 kg (148,100 lb)
Max fuel weight: GB	162,580 kg (358,425 lb)
GM	172,560 kg (380,425 lb)
PB, RB	163,250 kg (359,900 lb)
PM, RM	173,225 kg (381,900 lb)
ER, GM	192,190 kg (423,700 lb)
ER, PM, ER, RM	192,855 kg (425,175 lb)
Max T-O weight:	
GB, PB, RB	362,875 kg (800,000 lb)
GM, PM, RM	396,895 kg (875,000 lb)
ER GM, PM, RM	412,770 kg (910,000 lb)
Max ramp weight:	
GB, PB, RB	364,235 kg (803,000 lb)
GM, PM, RM	398,255 kg (878,000 lb)
ER, GM, PM, RM	414,130 kg (913,000 lb)
Max landing weight:	
GB, PB, RB	260,360 kg (574,000 lb)
GM, PM, RM	295,745 kg (652,000 lb)
ER, GM, PM, RM	295,745 kg (652,000 lb)
Max zero-fuel weight:	
GB, PB, RB	242,670 kg (535,000 lb)
GM, PM, RM	251,745 kg (555,000 lb)
ER, GM, PM, RM	251,745 kg (555,000 lb)
Max wing loading:	
GB, PB, RB	670.5 kg/m² (137.34 lb/sq ft)
GM, PM, RM	733.4 kg/m² (150.21 lb/sq ft)

Max power loading:	
GB, RB	352 kg/kN (3.45 lb/lb st)
GM, PB	359 kg/kN (3.52 lb/lb st)
PM	360 kg/kN (3.53 lb/lb st)
RM	368 kg/kN (3.61 lb/lb st)

PERFORMANCE (as above; landing at MLW):

Cruising Mach No.	0.85
Approach speed:	
GB, PB, RB	146 kt (270 km/h; 168 mph)
GM, PM, RM	157 kt (291 km/h; 181 mph)
Initial cruising altitude:	
GB, PB, RB	10,575 m (34,700 ft)
GM, PM, RM	10,000 m (32,800 ft)
T-O field length, 30°C (86°F): GB	2,820 m (9,250 ft)
GM	3,033 m (9,950 ft)
PB	2,820 m (9,250 ft)
PM	2,990 m (9,800 ft)
RB	2,850 m (9,350 ft)
RM	3,215 m (10,550 ft)
Landing field length:	
GB, PB, RB	1,905 m (6,250 ft)
GM, PM, RM	2,180 m (7,150 ft)
Design range:	
GB	6,185 n miles (11,454 km; 7,117 miles)
GM	7,260 n miles (13,445 km; 8,354 miles)*
PB	6,195 n miles (11,473 km; 7,129 miles)
PM	7,325 n miles (13,565 km; 8,429 miles)*
RB	6,040 n miles (11,186 km; 6,950 miles)
RM	7,170 n miles (13,278 km; 8,251 miles)*

**Fuel volume limited*

UPDATED

BOEING 747-400F

USAF designation: AL-1A

TYPE: Four-jet freighter.

PROGRAMME: Initial order 13 September 1989; rolled out 8 March 1993; first flight (N6005C) 4 May 1993; FAA certification 22 October 1993; JAR certification followed; first delivery (Cargolux) 17 November 1993. During 2000, Boeing began design of a freighter conversion of passenger 747-400s as an eventual partner to the first 747-300F conversion, begun in that year. However, this would differ from new-production -400F in several respects.

CURRENT VERSIONS: **747-400F:** *As described.*

747-400ERF: Freighter version of 747-400ER, described in previous entry; first order placed 30 April 2001. Deliveries to Air France (two), ILFC (three) and KLM (three, beginning 31 March 2003). Others for undisclosed customer(s).

Differences from 747-400ER include 302,090 kg (666,000 lb) max landing weight; 277,145 kg (611,000 lb) zero-fuel weight; 164,380 kg (362,400 lb) empty operating weight; 112,765 kg (248,600 lb) structural max payload; 530 m³ (18,720 cu ft) containerised volume on main deck; 159 m³ (5,600 cu ft) lower deck containerised volume and 14.7 m³ (520 cu ft) bulk cargo volume. Usable fuel is 203,523 litres (53,765 US gallons; 44,769 Imp gallons) for GE-engined version and 204,355 litres (53,985 US gallons; 44,952 Imp gallons) for P&W and R-R-engined versions.

747-400XF: Variant of projected 747-400X QLR, now replaced by 747F Advanced.

747F Advanced: Counterpart of 747 Advanced, announced mid-2003, for possible service entry in 2009. Shorter upper deck (as -400F) and other Advanced features, but forward plug of 3.56 m (11 ft 8 in), giving length overall of 75.74 m (248 ft 6 in). Weight empty 182,800 kg (403,000 lb), max T-O 332,940 kg (734,000 lb), zero-fuel 314,790 kg (694,000 lb), max structural payload 132,000 kg (291,000 lb). Fuel capacity 204,366 litres (53,988 US gallons; 44,954 Imp gallons).

AL-1A: Anti-missile defence aircraft. Described separately.

CUSTOMERS: See table with main 747-400 entry. First 747-400F delivered to Cargolux 17 November 1993; total of 34 delivered by October 1999. Production of 16 envisaged in 2000. Recent customers include China Airlines, which ordered 13 on 11 August 1999, for delivery between 2000 and 2007 (first on 6 July 2000); EVA Air, three for delivery from 2000 (first on 20 July); and Cathay Pacific Airways, which ordered two in October 1999 (first delivered on 12 September 2000), subsequently increasing its order to five.

COSTS: List price US$187.5 million to US$214.5 million (2002 and 2003).

DESIGN FEATURES: 747-200F fuselage (short upper deck) with additional changes combined with stronger and larger 747-400 wing; strengthened floor of short upper deck, as offered for -200F, also integrated into 747-400F; further developed freight handling system; total cargo volume 777.8 m³ (27,467 cu ft), of which 604.5 m³ (21,347 cu ft) on main deck, 158.6 m³ (5,600 cu ft) in lower hold and 48.3 m³ (520 cu ft) available for bulk cargo. Compared to -200F, empty weight saving of 2,000 kg (4,409 lb) has raised maximum revenue freight load to about 113,000 kg (249,125 lb), at which range is 4,400 n miles (8,149 km; 5,063 miles); fuel consumption more than 15 per cent lower than 747-200F. Same gross weights as passenger 747-400; maximum landing weight at optional T-O weight, 302,090 kg (666,000 lb); maximum zero-fuel weight, 276,690 kg (610,000 lb), can be increased on condition T-O weight is decreased.

ACCOMMODATION: Two-pilot crew, as 747-400. Upward-opening nose cargo door and optional port-side rear cargo door; underfloor cargo doors fore and aft of wing and bulk cargo door aft of rear underfloor door; two crew doors to port. Capacity for 30 pallets on main deck and 32 LD-1 containers plus bulk cargo under floor.

UPDATED

Boeing 747-400F freighter of Singapore Airlines ***(Paul Jackson)*** 0526931

BOEING 757-200

US Air Force designations: C-32A and C-32B

TYPE: Twin-jet airliner.

PROGRAMME: Announced early 1978; has 707/727/737 fuselage cross-section and two large turbofans; Eastern Air Lines and British Airways ordered 21 firm and 24 optioned and 19 + 18 respectively 13 August 1978; first flight (N757A) 19 February 1982 powered by 166.4 kN (37,400 lb st) Rolls-Royce RB535Cs and designated 757-200; first Boeing airliner launched with foreign engine.

FAA certification 21 December 1982; CAA certification 14 January 1983; revenue services began 1 January 1983 (EAL) and 9 February 1983 (BA). First flight of 757 powered by P&W PW2037s, 14 March 1984; certified October 1984 and delivered to Delta; first 757 with RB535E4s delivered to EAL 10 October 1984; first extended-range model delivered to Royal Brunei Airlines May 1986; 757 with RB535E4 engines approved FAA ETOPS December 1986 (extended to 180 minutes July 1990); 757 with PW2037/2040 ETOPS approved April 1990 (180 minutes for PW2037 April 1992); Boeing windshear guidance and detection system approved by FAA January 1987. Certified for operation in the Russian Federation and Associated States (CIS) September 1993. On 14 February 2002, 1,000th Boeing 757 was delivered, being 148th for American Airlines.

Boeing announced on 16 October 2002 that manufacture of the 757 will be terminated in late 2004.

CURRENT VERSIONS: **757-200:** Initial production passenger airliner; extended range available.

Main description applies to -200 version, except where indicated.

757-200PF Package Freighter: Developed for United Parcel Service. Large freight door forward, single crew door and no windows; up to 15 standard 2.24 × 3.18 m (88 × 125 in) cargo pallets on main deck; operating weight empty 51,710 kg (114,000 lb), MTOW 115,665 kg (255,000 lb), MZFW 90,719 kg (200,000 lb), max structural payload 39,009 kg (86,000 lb). Cargo capacity 187 m³ (6,600 cu ft) on main deck plus 51.8 m³ (1,830 cu ft) on lower deck. UPS ordered 20 on 31 December 1985; deliveries began 17 September 1987.

757-200M Combi: Boeing's mixed cargo/passenger configuration with windows; upward-opening cargo door to port (forward) 3.40 × 2.18 m (134 × 86 in); carries up to three 2.24 × 2.74 m (88 × 108 in) cargo containers and 150 passengers; one delivered to Royal Nepal Airlines on 15 September 1988.

757-200 Freighter: Developed by Pemco Aeroplex in 1992 as conversions of existing 757s; all-freight, combi and quick-change versions available; same weights as Boeing 757-200PF Package Freighter; choice of more powerful engines; large freight door forward on port side.

757SF: Under an agreement announced 5 October 1999, Boeing Airplane Services will purchase a total of 44 757-200s from British Airways and other operators and modify them, in conjunction with Israel Aircraft Industries and Singapore Technologies Aerospace, to 757SF Special Freighter configuration for lease to DHL Worldwide Express. The modification, which is also available to other customers, provides 226.5 m³ (8,000 cu ft) of cargo space with payload of 27,215 kg (60,000 lb) and range of over 2,000 n miles (3,704 km; 2,301 miles). Eventual DHL fleet will be 44, of which first two are 757-200PFs bought from Ansett on 15 November 1999. First converted 757SF, a former BA aircraft, entered service with DHL on 19 March 2001 and passed to EAT in Belgium on 28 March 2001 as OO-DLN. In 2002 a rival freighter conversion was offered by Precision Conversions of Goodyear, Arizona.

757-200 'Catfish': Boeing's own 757-200 prototype (N757A) fitted with radar nose in Lockheed Martin F-22A profile and representative F-22A swept wing section above flight deck containing conformal radar antennas for advanced radar trials; first flight in this configuration 11 March 1999. See also Lockheed Martin entry.

757-200ER: Projected extended-range version under study in 2001; would combine fuselage of 757-200 with strengthened wing structure of 757-300; up to four auxiliary fuel tanks in aft cargo hold; range 4,600 n miles; (8,519 km; 5,293 miles).

757-300: Stretched version. Described separately.

C-32A: Boeing 757-2G4. Four, with PW2040 engines, ordered 8 August 1996 as replacements for VC-137s of USAF's 89th Airlift Wing at Andrews AFB, Maryland; thus loosely described as 'VC-32s'. First aircraft (98-0001) flew 11 February 1998 and was delivered to 89th AW on 19 June. Further three followed on 23 June, 20 November and 25 November 1998. Post-production modifications, performed at Boeing's Wichita facility and completed on first aircraft on 2 April 1999, include installation of auxiliary fuel tanks, capacity 6,984 litres (1,845 US gallons; 1,536 Imp gallons) in forward and aft cargo holds, increasing range to 5,000 n miles (9,260 km; 5,753 miles); self-deploying forward airstair; crew ladder; satcom upgrade; and 378 litre (100 US gallon; 83.0 Imp gallon) potable water tank.

C-32B: One second-hand aircraft (86006) initially designated U-757, obtained for USAF's Foreign Emergency Support Team (FEST) by early 2000 at cost of US$45 million. Purchase of further FEST aircraft funded in FY02.

CUSTOMERS: As per table.

COSTS: US$73.5 million to US$80.5 million 757-200; US$72.5 million to US$75.0 million 757-200F (2002 and 2003).

DESIGN FEATURES: Low-wing, single-aisle airliner, with two podded turbofans below wings. Common design philosophy – including flight deck – with Boeing 767. Design goals also included multimarket performance, fuel efficiency, low noise and emissions, employment of advanced, digital avionics and 'dark' flight deck.

All flying surfaces sweptback and tapered; Boeing aerofoils; wing sweepback at quarter-chord 25°; dihedral 5°; incidence 3° 12′.

FLYING CONTROLS: Conventional and hydraulically powered. All-speed outboard ailerons assisted by five flight spoilers on each wing also acting variously as airbrakes and ground spoilers; one additional ground spoiler inboard on each wing; elevators and rudder; double-slotted trailing-edge flaps; full-span leading-edge slats, five sections each wing; variable incidence tailplane.

STRUCTURE: Aluminium alloy two-spar fail-safe wing box; centre-section continuous through fuselage; ailerons, flaps and spoilers extensively of honeycomb, graphite composites and laminates; tailplane has full-span light alloy torque boxes; fin has three-spar, dual-cell light alloy torque box; elevators and rudder have graphite/epoxy honeycomb skins supported by honeycomb and laminated spar and rib assemblies; CFRP wing/fuselage and flap track fairings. All landing gear doors of CFRP/Kevlar.

Subcontractors include Hawker de Havilland (wing in-spar ribs), Shorts (inboard flaps), CASA (outboard flaps), various Boeing divisions (leading-edge slats, main cabin sections, fixed leading-edges and flight deck), Northrop Grumman (fin and tailplane, extreme rear fuselage, overwing spoiler panels), Heath Tecna (wing/fuselage and flap track fairings), Schweizer (wingtips), Rohr Industries (engine support struts), IAI (dorsal fin) and Fleet Industries (APU access doors).

LANDING GEAR: Retractable tricycle type, with main and nose units manufactured by Menasco. Each main unit carries a four-wheel bogie, fitted with Dunlop or Goodrich wheels, carbon brakes and tyres. Twin-wheel nose unit, also with Dunlop or Goodrich tyres. Nose tyres H31×13.0-12 (20 ply); main tyres either H42×14.5-19 (24/26 ply) or, for higher weight options H42×16.0-19 (24 ply). Minimum ground turning radius 21.64 m (71 ft) at nosewheels, 29.87 m (98 ft) at wingtip.

POWER PLANT: Two 162.8 kN (36,600 lb st) Pratt & Whitney PW2037, 178.4 kN (40,100 lb st) PW2040, 178.8 kN (40,200 lb st) Rolls-Royce RB211-535E4, 189.5 kN (42,600 lb st) PW2043 or 193.5 kN (43,500 lb st) RB211-

535E4-B turbofans, mounted in underwing pods. Standard fuel capacity 42,684 litres (11,276 US gallons; 9,389 Imp gallons), optional 43,489 litres (11,489 US gallons; 9,566 Imp gallons).

ACCOMMODATION: Crew of two on flight deck, with provision for an observer; common crew qualification with Boeing 767. Five to seven cabin attendants. Standard interior arrangements for 200 (12 first class/188 economy) when overwing emergency exits fitted, or 194 (12 first class/183 economy) mixed-class passengers when in four-door configuration, or 221 (overwing exit) or 228 (four-door) all-economy passengers. First class seats are four-abreast, at 91 cm (36 in) pitch; business class five-abreast; economy seat pitch is 81 cm (32 in) in mixed class or 76 cm (30 in) in all-economy, mainly six-abreast. New cabin interior includes twin-door overhead luggage bins of 203 cm (80 in) width, replacing single-door, 152 cm (60 in) type; optional ceiling-mounted stowage compartments and video screens; aesthetic improvements; and (typically, five) vacuum lavatories, as in 757-300.

Provision for four doors each side of passenger deck: No. 1 (LH) passenger and No. 1 (RH) service doors immediately to rear of flight deck; Nos. 2 (LH) and 2 (RH) passenger doors; optional Nos. 3 (LH) and 3 (RH) emergency exit doors; and Nos. 4 (LH) passenger and 4 (RH) service doors; two overwing emergency exits each side if No. 3 doors not installed. Up to nine galleys at forward, mid-cabin and aft locations on starboard side; nine lavatory position options in typical three-door configuration, or up to 12 in four-door configuration. Movable class dividers. Cargo hold doors forward and aft on starboard side; optional bulk cargo hold door, starboard, extreme rear.

SYSTEMS: Honeywell ECS; General Electric engine thrust management system; Honeywell-Vickers engine-driven hydraulic pumps; four Abex electric hydraulic pumps. Hydraulic system maximum flow rate 140 litres (37.0 US gallons; 30.8 Imp gallons)/min at T-O power on engine-driven pumps; 25.4 to 34.8 litres (6.7 to 9.2 US gallons; 5.6 to 7.7 Imp gallons)/min on electric motor pumps; 42.8 litres (11.3 US gallons; 9.4 Imp gallons)/min on ram air turbine. Independent reservoirs, pressurised by air from pneumatic system, maximum pressure 207 bar (3,000 lb/sq in) on primary pumps. Hamilton Sundstrand electrical power generating system and ram air turbine; and Honeywell GTCP331-200 APU. Wing thermally anti-iced.

AVIONICS: *Flight:* Honeywell inertial reference system (IRS) (first commercial application of laser gyros); IRS provides position, velocity and attitude information to flight deck displays, and the flight management computer system (FMCS) and digital air data computer (DADC) supplied by Honeywell; FMCS provides automatic en route and terminal navigation capability, and also computes and commands both lateral and vertical flight profiles for optimum fuel efficiency, maximised by electronic linkage of the FMCS with automatic flight control and thrust management systems; CAT. IIIb instrument landing capability; Boeing windshear detection and guidance system is optional. Future Air Navigation System (FANS) FMS.

Instrumentation: Rockwell Collins EFIS-700 six-tube display with engine indication and crew alerting system (EICAS), EADI and EHSI functions; Rockwell Collins FCS-700 autopilot flight director system (AFDS).

DIMENSIONS, EXTERNAL:

Wing span	38.05 m (124 ft 10 in)
Wing chord: at root	8.20 m (26 ft 11 in)
at tip	1.73 m (5 ft 8 in)
Wing aspect ratio	7.8
Length: overall	47.32 m (155 ft 3 in)
fuselage	46.96 m (154 ft 10 in)
Fuselage max width	3.76 m (12 ft 4 in)
Height overall: at OWE	13.74 m (45 ft 1 in)
at MTOW	13.49 m (44 ft 3 in)
Tailplane span	15.21 m (49 ft 11 in)
Wheel track	7.32 m (24 ft 0 in)
Wheelbase	18.29 m (60 ft 0 in)
Distance between engine centrelines	12.95 m (42 ft 6 in)
Passenger doors (two, fwd, port and No. 2 starboard):	
Height	1.83 m (6 ft 0 in)
Width	0.84 m (2 ft 9 in)
Height to sill: at OWE	4.01 m (13 ft 2 in)
at MTOW	3.78 m (12 ft 5 in)
Passenger door (rear, port): Height	1.83 m (6 ft 0 in)
Width	0.76 m (2 ft 6 in)
Height to sill: at OWE	4.14 m (13 ft 7 in)
at MTOW	3.89 m (12 ft 9 in)
Service door (fwd, stbd): Height	1.65 m (5 ft 5 in)
Width	0.76 m (2 ft 6 in)
Service door (rear, stbd): Height	1.83 m (6 ft 0 in)
Width	0.76 m (2 ft 6 in)
Bulk cargo door (optional, starboard, extreme rear):	
Max height	0.81 m (2 ft 8 in)
Max width	1.22 m (4 ft 0 in)
Height to sill: at OWE	2.77 m (9 ft 1 in)
at MTOW	2.59 m (8 ft 6 in)
Emergency exits (four, overwing):	
Height	0.97 m (3 ft 2 in)
Width	0.51 m (1 ft 8 in)

BOEING 757 ORDER BOOK
(at 1 January 2004)

Customer	First order	First Delivery	Variant	Engine	Qty
Air 2000	12 Dec 86	27 Apr 97	757-200	RB211	5
Air Europe	2 Jul 82	30 Mar 83	757-200	RB211	15
Air Holland	25 Jun 87	9 Mar 88	757-200	RB211	3
Airtours International	17 May 96	20 Mar 97	757-200	RB211	1
America West	6 Feb 87	10 Dec 87	757-200	RB211	4
American Airlines	25 May 88	17 Jul 89	757-200	RB211	126
American Trans Air	7 Sep 94	26 Sep 95	757-200	RB211	13
	30 Jun 00	4 Aug 01	757-300	RB211	12
Ansett Worldwide	7 Oct 87	15 Feb 89	757-200	RB211	18
	16 Nov 88	2 Dec 92	757-200	PW2037	3
	7 Oct 87	26 Jul 89	757-200PF	RB211	4
Arkia Israeli Airlines	31 Jul 98	31 Jan 00	757-300	RB211	2
Azerbaijan Airlines	30 Dec 97	27 Sep 00	757-200	RB211	2
Britannia Airways	20 Dec 91	10 Apr 92	757-200	RB211	11
British Airways	31 Aug 78	25 Jan 83	757-200	RB211	50
China Southern	1 Mar 88	22 Nov 88	757-200	RB211	19
China Southwest	31 May 90	5 Aug 92	757-200	RB211	12
China Xinjiang Airlines	30 Oct 97	30 Apr 98	757-200	RB211	6
Condor Flugdienst	29 Sep 88	19 Mar 90	757-200	PW2040	17
	9 Dec 96	10 Mar 99	757-300	RB211	13
Continental Airlines	8 Oct 90	12 May 94	757-200	RB211	41
	2 Jan 01	20 Dec 01	757-300	RB211	9
Delta Air Lines	12 Nov 80	5 Nov 84	757-200	PW2037	110
	14 Nov 89	9 Jan 92	757-200	PW2040	6
Eastern Air Lines	31 Aug 78	22 Dec 82	757-200	RB211	25
El Al	1 Oct 86	25 Nov 87	757-200	RB211	7
Ethiopian Airlines	9 Jun 89	25 Feb 91	757-200	PW2040	4
	9 Jun 89	24 Aug 90	757-200PF	PW2040	1
Far Eastern Air Transport	8 Nov 94	8 Nov 94	757-200	PW2037	7
GATX Capital Corp	31 Jul 96	25 Apr 97	757-200	RB211	3
GE Capital	13 Jun 00	5 Feb 01	757-200	RB211	4
GPA Group Ltd	22 Apr 88	30 Aug 91	757-200	RB211	12
Iberia Airlines	25 May 90	7 Jun 93	757-200	RB211	24
Icelandair	19 Oct 88	4 Apr 90	757-200	RB211	7
	16 Jun 97	18 Mar 02	757-300	RB211	1
ILFC	18 Jun 86	1 Apr 87	757-200	RB211	43
	25 Apr 88	25 Feb 92	757-200	PW2037	13
	25 Apr 88	28 May 91	757-200	PW2040	25
JMC Airline	3 May 00	24 Apr 01	757-300	RB211	2
Kawasaki Leasing	25 Apr 88	13 May 92	757-200	RB211	2
LTE	25 Apr 88	15 Apr 92	757-200	RB211	1
LTU	25 Aug 83	25 May 84	757-200	RB211	12
Mexican Government	16 Nov 87	16 Nov 87	757-200	RB211	1
Mid East Jet	27 Jan 97	27 Jan 97	757-200	PW2040	1
Monarch Airlines	19 Feb 81	21 Mar 83	757-200	RB211	7
Northwest Airlines	29 Nov 83	28 Feb 85	757-200	PW2037	56
	16 Jan 01	20 Jul 02	757-300	PW2037/40	16
Republic Airlines	1 Oct 85	6 Dec 85	757-200	RB211	6
R-R Aircraft Mgmt	1 Aug 98	21 May 99	757-200	RB211	4
Royal Air Maroc	5 Feb 86	15 Jul 86	757-200	PW2037	2
Royal Brunei Airlines	30 May 85	6 May 86	757-200	RB211	3
Royal Nepal Airlines	17 Feb 86	9 Sep 87	757-200	RB211	1
	17 Feb 86	15 Sep 88	757-200M	RB211	1
Shanghai Airlines	14 Dec 88	4 Aug 89	757-200	PW2037	13
Singapore Airlines	31 May 83	12 Nov 84	757-200	PW2037	4
Starflite Corp	15 Dec 99	17 Dec 99	757-200	RB211	1
Sterling European	13 Jan 89	2 Aug 90	757-200	RB211	3
Sunrock Aircraft	25 Apr 88	19 Jun 91	757-200	RB211	2
Transavia Airlines	23 May 89	22 Feb 93	757-200	RB211	3
Trans World Airlines	5 Feb 96	10 Feb 97	757-200	PW2037	14
Turkmenistan Airlines	20 Oct 95	29 Aug 96	757-200	RB211	3
United Airlines	26 May 88	24 Aug 89	757-200	PW2037	47
	26 May 88	17 Aug 90	757-200	PW2040	51
UPS	6 Nov 90	2 Jul 94	757-200PF	RB211	40
	31 Dec 85	17 Sep 87	757-200PF	PW2040	35
US Airways	25 Apr 89	26 Feb 93	757-200	RB211	23
USAF	8 Aug 96	29 May 98	757-200	PW2040	4
Uzbekistan Airways	20 Oct 95	19 Oct 96	757-200	PW2037	3
Xiamen Airlines	27 Oct 89	12 Aug 92	757-200	RB211	9
Total					**1,048**

Note: For deliveries see Group Orders and Deliveries table

Boeing 757-200 of UK operator Airtours *(Paul Jackson)* ***NEW***/0561645

Boeing 757-200, one of two second-hand aircraft supplied to 40 Squadron, Royal New Zealand Air Force, in 2003 *(Paul Jackson)* ***NEW***/0561724

Boeing 757-200 flown by LTU of Germany *(Paul Jackson)* ***NEW***/0561649

Emergency exits, optional (two, aft of wings):
- Height 1.12 m (3 ft 8 in)
- Width 0.61 m (2 ft 0 in)

Cargo door (fwd, port): Height 1.08 m (3 ft 6½ in)
- Width 1.40 m (4 ft 7 in)
- Height to sill: at OWE 2.67 m (8 ft 9 in)
- at MTOW 2.46 m (8 ft 1 in)

Cargo door (aft, port): Height 1.12 m (3 ft 8 in)
- Width 1.40 m (4 ft 7 in)
- Height to sill: at OWE 2.51 m (8 ft 3 in)
- at MTOW 2.36 m (7 ft 9 in)

Cargo door (-200PF):
- Max width 3.40 m (11 ft 2 in)
- Max height 2.18 m (7 ft 2 in)
- Height to sill: at OWE 4.01 m (13 ft 2 in)
- at MTOW 3.81 m (12 ft 6 in)

Crew door (-200PF):
- Max width 0.56 m (1 ft 10 in)
- Max height 1.22 m (4 ft 0 in)
- Height to sill as cargo door

DIMENSIONS, INTERNAL:

Cabin, aft of flight deck to rear pressure bulkhead:
- Length 36.09 m (118 ft 5 in)
- Max width 3.53 m (11 ft 7 in)
- Height: max 2.13 m (7 ft 0 in)
- to ceiling video screen 1.85 m (6 ft 1 in)
- to baggage lockers 1.66 m (5 ft 5½ in)
- Floor area 116.0 m^2 (1,249 sq ft)
- Passenger section volume 230.5 m^3 (8,140 cu ft)

Underfloor baggage hold:
- Length: fwd 8.57 m (28 ft 1¼ in)
- rear 11.17 m (36 ft 7¾ in)
- Width at floor 1.26 m (4 ft 1¾ in)
- Max height: fwd 1.12 m (3 ft 8 in)
- rear 1.37 m (4 ft 6 in)
- Volume (bulk loading): fwd 19.8 m^3 (699 cu ft)
- rear 27.5 m^3 (971 cu ft)

AREAS:
- Wings, gross 185.25 m^2 (1,994.0 sq ft)
- Ailerons (total) 4.46 m^2 (48.00 sq ft)
- Trailing-edge flaps (total) 30.38 m^2 (327.00 sq ft)
- Leading-edge slats (total) 18.39 m^2 (198.00 sq ft)
- Flight spoilers (total) 10.96 m^2 (118.00 sq ft)
- Ground spoilers (total) 12.82 m^2 (138.00 sq ft)
- Fin 34.37 m^2 (370.00 sq ft)
- Rudder 11.61 m^2 (125.00 sq ft)
- Tailplane 50.35 m^2 (542.00 sq ft)
- Elevators (total) 12.54 m^2 (135.00 sq ft)

WEIGHTS AND LOADINGS (with 200 passengers. A: PW2037 engines, B: PW2040s, C: RB211-535E4s, D: RB211-535E4-Bs):
- Operating weight empty: A, B 59,170 kg (130,440 lb)
- C, D 59,300 kg (130,730 lb)
- Baggage capacity, underfloor:
- fwd hold 4,672 kg (10,300 lb)
- aft hold 7,394 kg (16,300 lb)
- Max structural payload: A, B 25,229 kg (55,620 lb)
- C, D 26,712 kg (58,890 lb)
- Max fuel weight 34,269 kg (75,550 lb)
- Max T-O weight: A, C 99,790 kg (220,000 lb)
- B, D 115,665 kg (255,000 lb)
- Max landing weight: A, C 89,815 kg (198,000 lb)
- B, D 95,255 kg (210,000 lb)
- Max ramp weight: A, C 100,245 kg (221,000 lb)
- B, D 116,120 kg (256, 000 lb)
- Max zero-fuel weight: A, C 83,460 kg (184,000 lb)
- B 84,370 kg (186,000 lb)
- D 85,275 kg (188,000 lb)
- Max wing loading: A, C 538.7 kg/m^2 (110.33 lb/sq ft)
- B, D 624.4 kg/m^2 (127.88 lb/sq ft)
- Max power loading: A 306 kg/kN (3.01 lb/lb st)
- B 324 kg/kN (3.18 lb/lb st)
- C 279 kg/kN (2.74 lb/lb st)
- D 299 kg/kN (2.93 lb/lb st)

PERFORMANCE (with 200 passengers; at max basic T-O weight except where indicated):
- Max operating Mach No. (MMO): A, B, C, D 0.86
- Cruising speed: A, B, C, D M0.80
- Approach speed at S/L, flaps down, max landing weight:
- A, C 132 kt (245 km/h; 152 mph) EAS
- B, D 137 kt (254 km/h; 158 mph)
- Initial cruising height: A 11,675 m (38,300 ft)
- B 10,790 m (35,400 ft)
- C 11,795 m (38,700 ft)
- D 10,880 m (35,700 ft)
- Runway LCN at ramp weight of 100,244 kg (221,000 lb), optimum tyre pressure and subgrade C flexible pavement: H40×14.5-19.0 tyres 36
- T-O field length (S/L, 29°C):
- A 1,814 m (5,950 ft)
- B 2,347 m (7,700 ft)
- C 1,677 m (5,500 ft)
- D 2,104 m (6,900 ft)
- Landing field length at max landing weight:
- A 1,463 m (4,800 ft)
- B 1,555 m (5,100 ft)
- C 1,418 m (4,650 ft)
- D 1,494 m (4,900 ft)
- Range with 200 passengers:
- A 2,570 n miles (4,759 km; 2,957 miles)
- B 3,900 n miles (7,222 km; 4,488 miles)*
- C 2,260 n miles (4,185 km; 2,600 miles)
- D 3,655 n miles (6,769 km; 4,206 miles)*

OPERATIONAL NOISE LEVELS (FAR Pt 36 Stage 3):
- T-O, at max basic T-O weight, cutback power:
- A 82.2 EPNdB
- B 86.2 EPNdB
- C (estimated) 84.7 EPNdB
- Approach at max landing weight, 30° flap:
- A 95.0 EPNdB
- B, C 97.7 EPNdB
- Sideline: A 93.3 EPNdB
- B 94.0 EPNdB
- C (estimated) 94.6 EPNdB

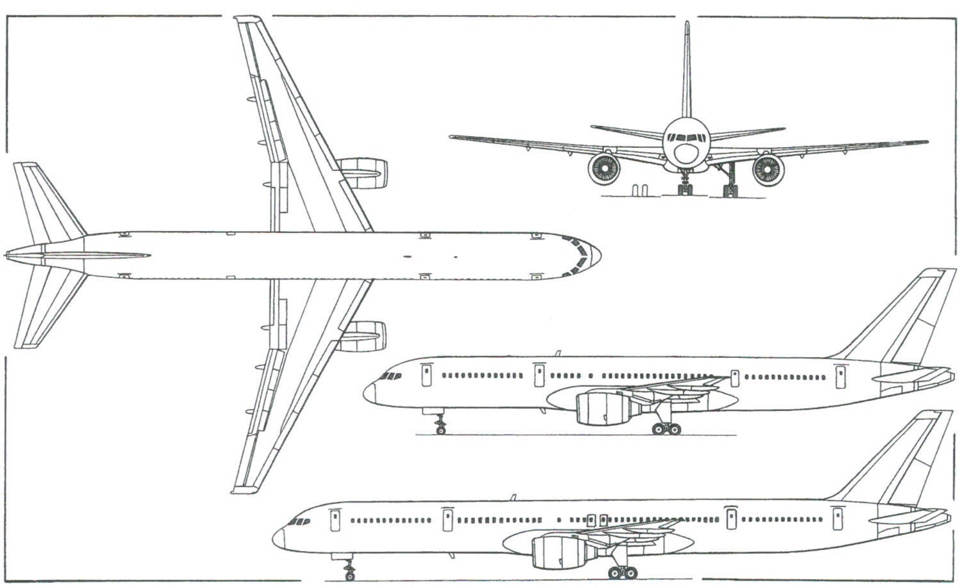
** Fuel volume limited*

UPDATED

BOEING 757-300

TYPE: Twin-jet airliner.

PROGRAMME: Stretched 757-200. Launched 2 September 1996; major assembly began 9 August 1997; prototype (N757X; 804th B757; earmarked for Condor Flugdienst as D-ABOA) rolled out at Renton on 19 May 1998 (officially 31 May); first flight (transmitted live on the Internet) 2 August 1998. 912-hour, 356-sortie flight test programme undertaken by three aircraft. N757X/NU701, employed on



Boeing 757-200 twin-turbofan medium-range transport, with additional side view of stretched -300 *(Jane's/Dennis Punnett)* 0093862

Stretched Boeing 757-300 of launch customer, Condor *(Paul Jackson)* ***NEW***/0561646

initial airworthiness and basic controllability tests; D-ABOB/NU721, first flown 4 September 1998, for ground effect, autoland and fuel consumption tests; and D-ABOC/NU722, first flown 2 October 1998, initially for HERF testing, before installation of standard interior for a four-day period of simulated airline operations with launch customer Condor Flugdienst. FAA certification with 180-minute ETOPS approval 27 January 1999, followed by first delivery (D-ABOE) to Condor on 10 March 1999 and first revenue-earning service 19 March 1999. Achieved 8.7 hours daily utilisation and 99.64 per cent reliability rate in first 12 months of operation. All early aircraft with Rolls-Royce engines; first with PW2040 power (N753JM) was flown 20 February 2002, before delivery to Northwest Airlines.

CUSTOMERS: See table accompanying Boeing 757-200 entry. Launch customer Condor Flugdienst ordered 12 firm, with 12 options, on 2 September 1996; Icelandair ordered two, with Rolls-Royce engines, in June 1997, for delivery in second quarter 2001 and second quarter 2002. Boeing 757 production terminated in 2004.

COSTS: US$82.0 million to US$89.5 million (2002 and 2003). Seat-mile operating costs estimated at 10 per cent lower than those of 757-200.

Description generally as for 757-200, except that below.

DESIGN FEATURES: Fuselage stretched by 7.11 m (23 ft 4 in) – 4.06 m (13 ft 4 in) ahead of the wing and 3.05 m (10 ft 0 in) aft – to provide 20 per cent more passenger accommodation and nearly 50 per cent more cargo volume than 757-200; typical accommodation 243 passengers in two-class configuration or up to 280 in single class with pitch of between 71 and 74 cm (28 and 29 in). Other features include strengthened wings, engine pylons, high-lift devices and landing gear; strengthened overwing exit body section; new wheels, 26-ply tyres and brakes; nosewheel spray deflector; retractable tailskid, similar to those of 767-300 and 777-300, with 'body contact' indicator on flight deck; redesigned cabin interior based on 'Next-Generation' 737s, with upgraded environmental control system, larger precooler, more powerful fans, and vacuum lavatories with single-point drainage. Flight deck and operating systems generally as for 757-200, but with Pegasus FMS (including software options for GPS, FANS and satcom) and enhanced EICAS with improved BITE functions.

POWER PLANT: As for 757-200. Total fuel capacity 43,491 litres (11,490 US gallons; 9,567 Imp gallons) for all options.

ACCOMMODATION: Four doors each side, standard as for 757-200; two overwing emergency exists each side. Typical cabin arrangements provide for 243 passengers (12 first class, 231 economy) in mixed class configuration, four-abreast in first class, at 91 cm (36 in) seat pitch, six-abreast in economy at 81 cm (32 in) seat pitch; or 280 passengers in inclusive tour configuration, six-abreast at 71/74 cm (28/29 in) seat pitch.

DIMENSIONS, EXTERNAL: As for 757-200 except:

Length: overall	54.43 m (178 ft 7 in)
fuselage	54.08 m (177 ft 5 in)
Height overall: at OWE	13.64 m (44 ft 9 in)
at MTOW	13.56 m (44 ft 6 in)
Wheelbase	22.35 m (73 ft 4 in)
Passenger door, height to sill:	
No. 1: at OWE	4.01 m (13 ft 2 in)
at MTOW	3.78 m (12 ft 5 in)
No. 2: at OWE	as No. 1
No. 3 emergency exit: at OWE	4.06 m (13 ft 4 in)
at MTOW	3.94 m (12 ft 11 in)
No. 4: at OWE	4.06 m (13 ft 4 in)
at MTOW	3.96 m (13 ft 0 in)
Cargo door, height to sill:	
fwd: at OWE	2.67 m (8 ft 9 in)
at MTOW	2.44 m (8 ft 0 in)
rear: at OWE	2.39 m (7 ft 10 in)
at MTOW	2.29 m (7 ft 6 in)

DIMENSIONS, INTERNAL:

Cabin (rear of flight deck to rear pressure bulkhead):	
Length	43.21 m (141 ft 9 in)
Underfloor cargo hold:	
Length: fwd	12.80 m (42 ft 0 in)
rear	14.22 m (46 ft 7¾ in)
Width, height	as 757-200
Volume (bulk loading): fwd	30.3 m³ (1,071 cu ft)
rear	37.2 m³ (1,312 cu ft)

WEIGHTS AND LOADINGS (with 243 passengers: A: PW2040 engines, B: PW2043s, C: RB211-535E4s, D: RB211-535E4-Bs):

Operating weight empty: A, B	64,270 kg (141,690 lb)
C, D	64,475 kg (142,140 lb)
Max structural payload: A, B	30,935 kg (68,200 lb)
C, D	30,686 kg (67,650 lb)
Baggage capacity, underfloor:	
fwd hold	7,303 kg (16,100 lb)
aft hold	8,845 kg (19,500 lb)
Max fuel weight: A, B, C, D	34,918 kg (76,980 lb)
Max T-O weight: A, B, C, D	122,470 kg (270,000 lb)
Max landing weight: A, B, C, D	101,605 kg (224,000 lb)
Max ramp weight: A, B, C, D	122,925 kg (271,000 lb)
Max zero-fuel weight: A, B, C, D	95,255 kg (210,000 lb)
Max wing loading: A, B, C, D	661.1 kg/m² (135.41 lb/sq ft)
Max power loading: A	343 kg/kN (3.37 lb/lb st)
B	323 kg/kN (3.17 lb/lb st)
C	342 kg/kN (3.36 lb/lb st)
D	316 kg/kN (3.10 lb/lb st)

PERFORMANCE (243 passengers):

Max operating Mach No. (MMO): A, B, C, D	0.86
Cruising speed: A, B, C, D	M0.80
Approach speed, S/L, flaps down, at max landing weight:	
A, B, C, D	143 kt (265 km/h; 165 mph)
Initial cruising height: A	11,005 m (36,100 ft)
B	10,400 m (34,120 ft)
C	11,200 m (36,740 ft)
D	10,420 m (34,180 ft)
T-O field length, S/L, 86°F: A	2,088 m (6,850 ft)
B	2,637 m (8,650 ft)
C	2,119 m (6,950 ft)
D	2,622 m (8,600 ft)
Landing field length at max landing weight:	
A, B	1,753 m (5,750 ft)
C, D	1,738 m (5,700 ft)
Range: A	2,120 n miles (3,1926 km; 2,439 miles)
B	3,395 n miles (6,287 km; 3,906 miles)*
C	1,955 n miles (3,620 km; 2,249 miles)
D	3,180 n miles (5,889 km ; 3,659 miles)*

* *Fuel volume limited*

UPDATED

BOEING 767

TYPE: Wide-bodied airliner.

PROGRAMME: Launched on receipt of United Air Lines order for 30 on 14 July 1978; construction of basic 220-passenger 767-200 began 6 July 1979; first flight (N767BA) 26 September 1981 with P&W JT9D turbofans: first flight fifth aircraft with GE CF6-80A 19 February 1982; 767 with JT9D-7R4D certified 30 July 1982; with CF6-80A 30 September 1982.

First delivery with JT9D (United Air Lines) 19 August 1982 (initial service 8 September); first delivery with CF6 (Delta) 25 October 1982. ETOPS approval for 767-200 with JT9D-7R4 or CF6-80A or -80A2 granted January 1987; ETOPS approval for 767-200 and -300 with PW4000 obtained April 1990; 180-minute ETOPS approval with PW4000 engines obtained August 1993. Joint 757/767 crew rating approved 22 July 1983. Boeing windshear detection and guidance system FAA approved for 767-200 and -300 February 1987.

Boeing 767-400 first flew 9 October 1999; FAA certification and 180-minute ETOPS granted 20 July 2000: JAA certification 24 July 2000; FAA common type rating with 767-200/300 and 757-200/300 issued 21 August 2000.

CURRENT VERSIONS: **767-200:** Basic model; no longer available. Medium-range variant (MTOW 136,080 kg; 300,000 lb) has reduced fuel; higher gross weight variant (142,880 kg; 315,000 lb) certified June 1983.

767-200ER: Extended-range version; announced January 1983; first flight 6 March 1984; basic -200ER with centre-section tankage and gross weight increased; first delivered to El Al 26 March 1984.

767-300: Stretched 269-passenger version, with 3.07 m (10 ft 1 in) plug forward of wing and 3.35 m (11 ft) plug aft, and same gross weight as 767-200; strengthened landing gear and thicker metal in parts of fuselage and underwing skin; same flight deck and systems as other 767s; same engine options as 767-200ER; first ordered (by Japan Airlines) 29 September 1983. First flight with JT9D-7R4D engines 30 January 1986; certified with JT9D-7R4D and CF6-80A2 22 September 1986. First delivery (Japan Airlines) 25 September 1986. British Airways ordered 11 in August 1987, later increased to total 25, with Rolls-Royce RB211-524H engines; delivered from 8 February 1990. No longer available.

767-300ER: Extended-range, higher gross weight version; development began January 1985; optional gross weights 172,365 kg (380,000 lb) and, from 1992, 186,880 kg (412,000 lb); further increased centre-section tankage. Engine choice CF6-80C2, PW4000, RB211-524H; structural reinforcement; certified late 1987. Launch customer American Airlines (15), delivered from 19 February 1988. New interior introduced late 2000; based on Boeing 777; first recipient Lauda Air.

767-300ERX: Further range extension, under study from 1998 to 2002, but not proceeded with; addition of tailplane fuel tank, capacity 7,571 litres (2,000 US gallons: 1,665 Imp gallons) would have increased range to 6,695 n miles (12,400 km; 7,705 miles).

767-300X: Proposed early 2002. Main feature would be rapidly changeable 767-400-type wingtip, allowing airlines to customise aircraft to individual routes, according to distance, reverting to standard tips for long range.

Boeing 767-300 of Delta Airlines *(Paul Jackson)* ***NEW***/0561647

767-300 General Market Freighter: See separate entry.

767-400ER: Stretched version with 10 to 15 per cent increase in passenger accommodation, seating 245 passengers in three-class configuration and 304 in two-class. Features include strengthened wing with thicker ribs, spars and skin; updated flight deck based on Boeing 777; fuselage lengthened 6.43 m (21 ft 1 in) by means of plugs forward (3.36 m; 11 ft 0¼ in) and aft (3.07 m; 10 ft 0¾ in) of centre-section; stringerless window belt with elliptical 777-type cabin windows; wing span increased by 4.42 m (14 ft 6 in) with highly sweptback (9° 50′) wingtips of composites construction which reduce take-off distance, increase climb rate and improve fuel consumption; redesigned interior; cargo volume 129.7 m³ (4,580 cu ft); new landing gear with 46 cm (18 in) longer main legs, Boeing 777 brakes and 127 cm (50 in) tyres and revised, hydraulically actuated tail skid; 120 kVA AC generators and more powerful Honeywell 331-400 APU also of 120 kVA. Engine choice 276 kN (62,100 lb st) CF6-80C2B7F1 or 282 kN (63,500 lb st) CF6-80C2B8, with PW4000 series as option; fuel capacity as currently offered on 767-300ER. Maximum T-O weight increase to 204,115 kg (450,000 lb) together with aerodynamic improvements to provide maximum range of approximately 5,695 n miles (10,547 km; 6,553 miles), enabling 767-400ER to operate most existing 767-300ER routes.

Offered from January 1997; launch customer Delta Air Lines announced intention to order 21 on 20 March 1997; confirmed 28 April 1997; Continental ordered 26 on 10 October 1997. Assembly of first aircraft began at Everett on 9 February 1999; roll-out 26 August 1999; first flight (N76400 No. 1) 9 October 1999. Four aircraft took part in test programme, comprising 1,150 flight hours and 1,200 ground testing hours: prototype used primarily to test and certify basic handling qualities; N76401 served as aerodynamics and avionics certification article; N87402, with full cabin interior used for systems development and certification; N47403 (first flown June 2000) for cabin entertainment and related evaluation. World tour (by N76400 No. 2) in July-August 2000. First delivery (N828MH), to launch customer Delta Airlines, 11 August 2000; deliveries to Continental Airlines began 30 August 2000 with refurbished second prototype (N76401/N66051). Also on 30 August 2000, Delta received first 767-400ER with Rockwell Collins Large Format Display System, comprising six 203 × 203 mm (8 × 8 in) LCDs.

767-400ER Shrink: Under study in 1999 as alternative to 767-300ERX. Not proceeded with.

Longer Range 767-400ER: Extended-range version; launched (as 767-400ERX) 13 September 2000, but discontinued by 2002.

767 AWACS: Military version. Described separately. Also under consideration are a tanker version for boom and hose-reel refuelling systems and a carrier for ground surveillance radar, designated **Northrop Grumman E-10.**

767 AST: Boeing contracted by US Army on 11 October 1994 to supply company-owned 767 as Airborne Sensor Testbed for long wavelength infra-red surveillance system; operating contract was extended for 12 months in September 1998 at cost of US$4.1 million.

767 SF: Special Freighter conversion of 767-200 airliner; available from 2000; payload 39,010 kg (86,000 lb); freight door as 767-300F; strengthened floor, main landing gear and forward fuselage.

CUSTOMERS: As per table. Original prototype became 767 Airborne Surveillance Testbed (formerly AOA) for US Army. One reconfigured by E-Systems as medevac aircraft for Civil Reserve Air Fleet.

COSTS: US$101 million to US$112 million 767-200ER; US$115.5 million to US$127.5 million 767-300ER; US$126.5 million to US$138.5 million 767-400ER (all 2002 and 2003).

DESIGN FEATURES: Low-wing, wide-bodied airliner with twin, podded turbofans underwing. Boeing aerofoils; quarter-chord sweepback 31° 30′; thickness/chord ratio 15.1 per cent at root, 10.3 per cent at tip; dihedral 6°; incidence 4° 15′.

FLYING CONTROLS: Conventional and hydraulically powered. Inboard, all-speed (between inner and outer flaps) and outboard low-speed ailerons supplemented by flight spoilers (four-section outboard; two-section inboard) also acting as airbrakes and lift dumpers; single-slotted, linkage-supported outboard trailing-edge flaps, double-slotted inboard; track-mounted leading-edge slats; variable incidence tailplane driven by hydraulic screwjack; two-piece elevators each side; no trim tabs; roll and yaw trim through spring feel system; triple digital flight control computers and EFIS; Boeing windshear detection and guidance system optional. Control surface deflections: outboard ailerons +30/−15°, inboard ailerons ±20°, inboard flaps 61° (first element 36°), outboard flaps 36°, spoilers +60°, elevators +28/−20°, rudder ±26°; tailplane incidence +2/−12°.

STRUCTURE: Fail-safe structure. Conventional aluminium structure augmented by graphite ailerons, spoilers, elevators, rudder and floor panels; advanced aluminium alloy keel beam chords and wing skins; composites engine cowlings, wing/fuselage fairing and rear wing panels; CFRP landing gear doors; and aramid flaps and engine pylon fairings.

Subcontractors include Boeing Military Aircraft (wing fixed leading-edges); Northrop Grumman (wing centre-section and adjacent lower fuselage section; fuselage bulkheads); Vought Aircraft (horizontal tail); Canadair (rear fuselage); Alenia (wing control surfaces, flaps and leading-edge slats, wingtips, elevators, fin and rudder, nose radome); Fuji (wing/body fairings and main landing gear doors); Kawasaki (forward and centre fuselage; exit hatches; wing in-spar ribs); Mitsubishi (rear fuselage body panels and rear fuselage doors).

LANDING GEAR: Hydraulically retractable tricycle type; Menasco twin-wheel nose unit retracts forward; Cleveland Pneumatic main gear, with two four-wheel bogies, retracts inward; oleo-pneumatic shock-absorbers; Honeywell wheels and brakes; mainwheel tyres of current production versions H46×18.0-20 (26/28 ply for -200/300; 32 ply for -200ER/300ER); nosewheel tyres size H37×14.0-15 (22/24 ply) for all; steel disc brakes on all mainwheels; electronically controlled anti-skid units. Nosewheel steerable ±16°; ±65° for towing.

POWER PLANT: Two high-bypass turbofans in pods, pylon-mounted on the wing leading-edges.

General Electric options: 225 kN (50,600 lb st) CF6-80C2B2F, 251 kN (56,500 lb st) CF6-80C2B4F, 268 kN (60,200 lb st) CF6-80C2B6F, 276 kN (62,100 lb st) CF6-80C2B7F and 282 kN (63,500 lb st) CF6-80C2B8F.

Pratt & Whitney options: 233 kN (52,300 lb st) PW4052, 254 kN (57,100 lb st) PW4056, 268 kN (60,200 lb st) PW4060 and 282 kN (63,300 lb st) PW4062. P&W JT9D-7R4D of 213.5 kN (48,000 lb st) no longer offered.

Rolls-Royce options: 251 kN (56,400 lb st) RB211-524G4-T and 265 kN (59,500 lb st) RB211-524H2-T.

Fuel in one integral tank in each wing, and in centre tank, with total capacity of 63,216 litres (16,700 US gallons; 13,905 Imp gallons) in 200/300; 767-200ER and -300ER and -400ER have additional 27,558 litres (7,280 US gallons; 6,062 Imp gallons) in second centre-section tank, raising total capacity to 90,774 litres (23,980 US gallons; 19,967 Imp gallons). Refuelling point in port outer wing.

ACCOMMODATION: Operating crew of two on flight deck; observer's seat and optional second observer's seat. Basic accommodation in -200 models for 224 passengers, made up of 18 first class passengers forward in six-abreast seating at 96.5 cm (38 in) pitch, and 206 tourist class in seven-abreast seating at 81 cm (32 in) pitch. Window or aisle seats comprise 86 per cent of total. Type A inward-opening plug doors provided at both front and rear of cabin on each side of fuselage, with options of Type A, I or III emergency exits at various mid-cabin locations on each side. Total of five lavatories installed, two centrally in main cabin, two aft in main cabin, and one forward in first class section. Galleys situated at forward and aft ends of cabin. Alternative single-class layouts provide for 255 tourist passengers seven-abreast (two-three-two) at 81 cm (32 in) pitch (one overwing exit each side) and maximum (requiring two additional overwing emergency exits) 290, mainly eight-abreast (two-four-two), at 76 cm (30 in) pitch. Three-class layout for 181 passengers: 15 first class (two-one-two) at 152 cm (60 in) pitch; 40 business class (two-two-two) at 91 cm (36 in); and 126 tourist class (two-three-two) at 81 cm (32 in).

Basic accommodation in -300 models for 269 passengers, made up of 24 first class passengers forward in six-abreast seating at 96.5 cm (38 in) pitch, 245 tourist class in seven-abreast at 78.7 cm (31 in) pitch, six lavatories and five galleys. Alternatives include 286 in two-three-two seating at 81 cm (32 in) pitch and 218 in three-class layout comprising 18 first, 46 business and 154 tourist class passengers arranged as in -200. Maximum seating capacity in -300 models is 350 passengers at 71 cm (28 in), six lavatories and four galleys; capacities from 291 upwards require standard -300 door configuration (each side) of Type A front and rear and two Type Is overwing to be replaced by two Type As, plus third Type A ahead of wing and Type I adjacent to trailing-edge.

Underfloor cargo holds (forward and rear, combined) of -200 versions can accommodate, typically, up to 22 LD2 or 11 LD1 containers; 767-300 underfloor cargo holds can accommodate 30 LD2 or 15 LD1 containers. Starboard side forward and rear cargo doors of equal size on 767-200 and 767-300, but larger forward door standard on 767-200ER and 767-300ER and optional on 767-200 and 767-300. Bulk cargo door at rear on port side. Overhead stowage for carry-on baggage is 0.08 m³ (3.0 cu ft) per passenger. Cabin air conditioned, cargo holds heated.

SYSTEMS: Honeywell dual air cycle air conditioning system. Pressure differential 0.59 bar (8.6 lb/sq in). Electrical supply from two engine-driven 90 kVA three-phase 400 Hz constant frequency AC generators, 115/200 V output. 90 kVA generator mounted on APU for ground operation or for emergency use in flight. Three hydraulic systems at 207 bar (3,000 lb/sq in), for flight control and utility functions, supplied from engine-driven pumps and a Honeywell bleed air-powered hydraulic pump or from APU. Maximum generating capacity of port and starboard systems is 163 litres (43 US gallons; 35.8 Imp gallons)/min; centre system 185.5 litres (49.0 US gallons; 40.8 Imp gallons)/min, at 196.5 bar (2,850 lb/sq in). Reservoirs pressurised by engine bleed air via pressure regulation module. Reservoir relief valve pressure nominally 4.48 bar (65 lb/sq in). Additional hydraulic motor-driven generator, to provide essential functions for extended-range operations, standard on 767-200ER and 767-300ER and optional on 767-200 and 767-300. Nitrogen chlorate oxygen generators in passenger cabin, plus gaseous oxygen for flight crew. APU in tailcone to provide ground and in-flight electrical power and pressurisation. Anti-icing for outboard wing leading-edges (none on tail surfaces), engine air inlets, air data sensors and windscreen.

AVIONICS: *Radar:* Honeywell RDR-4A colour weather radar in aircraft for All-Nippon, Britannia and Transbrasil.

Flight: Standard ARINC 700 series equipment, including Honeywell VOR/ILS/marker beacon receivers, ADF, DME, RMI-743 radio magnetic indicator and radio altimeter. Honeywell IRS, FMCS and DADC, as described in Boeing 757 entry; dual digital flight management systems, and triple flight control computers, including

Boeing 767-300 operated by Alitalia ***(Paul Jackson)*** ***NEW***/0561650

BOEING 767 ORDER BOOK
(at 1 January 2004)

Customer	Variant	Engine	First order	First delivery	Qty
Aeromaritime	200ER	PW	17 Jan 89	26 Jul 90	2
	300ER	PW	17 Jan 89	22 Aug 91	1
Air Algérie	300ER	GE	1 May 89	28 Jun 90	3
Air Canada	200	PW	11 Jul 79	30 Oct 82	10
	200ER	PW	11 Jul 79	18 Oct 84	9
	300ER	PW	31 Aug 89	10 Aug 93	6
Air China	200ER	PW	23 May 85	9 Oct 85	6
	300	PW	31 May 90	20 May 92	4
Air France	300ER	PW	7 Feb 92	14 May 93	3
Air Mauritius	200ER	GE	19 Jan 87	5 Apr 88	2
Air New Zealand	200ER	GE	30 Jul 84	3 Sep 85	3
	300ER	GE	1 Mar 91	11 Aug 93	5
Airtours International/					3
My Travel	300ER	GE	17 Aug 93	16 Mar 94	
Air Zimbabwe	200ER	PW	20 Jul 88	28 Nov 89	2
All Nippon Airways	200	GE	1 Oct 79	25 Apr 83	25
	300	GE	26 Dec 85	30 Jun 87	34
	300ER	GE	26 Dec 85	26 Jun 89	26
	300F		7 Aug 01	28 Aug 02	1
American Airlines	200	GE	15 Nov 78	4 Nov 82	13
	200ER	GE	15 Nov 78	18 Nov 85	17
	300ER	GE	3 Mar 87	19 Feb 88	58
Amiri Flight	300ER	GE	30 Nov 99	15 Dec 99	1
Ansett Australia	200	GE	17 Mar 80	7 Jun 83	5
Ansett Worldwide	200ER	PW	8 Sep 88	1 May 90	3
	200ER	GE	28 Sep 93	28 Sep 93	1
	300ER	PW	16 Nov 88	13 Dec 91	21
	300ER	GE	24 Jun 94	24 Jun 94	8
Asiana Airlines	300	GE	23 Dec 88	27 Sep 90	9
	300ER	GE	3 Sep 90	7 Nov 91	2
	300F	GE	3 Sep 90	23 Aug 96	1
Avianca	200ER	PW	24 Dec 80	26 Feb 90	2
BCC Leasing	300ER	PW	25 Sep 01	24 Oct 02	3
Braathens	200	PW	28 Apr 80	23 Mar 94	2
Britannia Airways	200	GE	31 Mar 80	6 Feb 84	11
	300ER	GE	23 Nov 94	15 May 96	7
British Airways	300ER	RR	14 Aug 87	8 Feb 90	28
Canadian Airlines Int'l	300ER	GE	7 Apr 87	15 Apr 88	14
China Airlines	200	PW	20 Mar 80	20 Dec 82	2
China Yunnan	300ER	RR	10 Jan 95	26 Jul 96	3
Condor Flugdienst	300ER	PW	16 Nov 88	13 Jul 91	11
Continental Airlines	200ER	GE	23 Nov 98	9 Nov 00	10
	400ER	GE	10 Oct 97	30 Aug 00	16
Delta Airlines	200	GE	15 Nov 78	25 Oct 82	15
	300	GE	15 Nov 78	7 Nov 86	24
	300	PW	20 Dec 90	17 Jun 93	4
	300ER	PW	22 Sep 88	9 Jun 90	31
	300ER	GE	10 Jun 97	18 Jun 98	22
	400ER	GE	10 Jun 97	11 Aug 00	21
Egyptair	200ER	PW	12 Jan 84	20 Jul 84	3
	300ER	PW	25 Oct 88	15 Aug 89	2
El Al Israel Airlines	200	PW	18 Mar 81	12 Jul 83	2
	200ER	PW	18 Mar 81	26 Mar 84	2
Ethiopian Airlines	200ER	PW	16 Dec 82	23 May 84	3
	300ER	PW	28 Nov 02	24 Nov 03	3
Eva Airways	200	GE	10 Jun 93	13 Jan 94	4
	300ER	GE	6 Oct 89	30 May 91	4
Flightlease	300ER	PW	15 Dec 99	4 Apr 00	4
GATX Capital Corp	200ER	GE	24 May 89	25 Jan 91	1
GECAS	300ER	GE	30 Aug 95	30 Aug 95	29
	300F	GE	15 Dec 99	28 Nov 01	1
GPA Ltd	200ER	PW	18 Apr 89	14 Jan 92	1
	300ER	GE	18 Apr 89	3 May 93	2
	300ER	PW	18 Apr 89	28 Feb 01	11
Gulf Air	300ER	GE	27 Apr 88	14 Jun 88	20
Hainan Airlines	300ER	PW	21 Aug 02	31 Oct 02	3
ILFC	200	GE	27 Aug 86	25 Aug 87	1
	200ER	GE	18 Feb 86	29 May 86	4
	300ER	GE	16 May 88	14 Jun 91	36
	300ER	PW	16 May 88	21 Mar 91	16
Itochu Air Lease Corp	300ER	GE	15 Apr 91	14 Aug 92	3
Itochu Corp	200ER	GE	4 Nov 93	1 Dec 94	4
Japan Airlines	200	PW	29 Sep 83	22 Jul 85	3
	300	PW	29 Sep 83	25 Sep 86	13
	300	GE	10 Jun 93	1 Aug 94	9
	300ER	GE	27 Nov 00	19 May 02	14
Kazakstan Airlines	200ER	GE	29 Dec 00	8 Feb 02	1
Kuwait Airlines	200ER	PW	18 Sep 84	20 Mar 86	3
LAM Mozambique	200ER	PW	1 Aug 90	24 Aug 93	1
LAN Chile	300ER	GE	28 May 97	29 Apr 98	3
	300F	GE	17 Nov 97	23 Sep 98	5
Lauda Air	300ER	PW	21 Apr 97	29 Apr 88	7
LOT Polish Airlines	200ER	GE	4 Nov 88	21 Apr 89	2
	300ER	GE	4 Nov 88	21 Aug 90	3
LTU	300ER	PW	21 Jan 88	2 Feb 89	5
Malev Hungarian Airlines	200ER	PW	21 Feb 91	30 Apr 93	2
Martinair Holland	300ER	PW	11 Mar 88	21 Sep 89	6
Mid East Jet	200ER	GE	4 Oct 96	4 Oct 96	1
Pacific Western	200	PW	21 Dec 78	4 Mar 83	2
Piedmont	200ER	GE	25 Jul 86	21 May 87	6
Qantas Airways	200ER	PW	7 Sep 83	3 Jul 85	7
	300ER	GE	24 Apr 87	30 Aug 88	22
Royal Brunei Airways	300ER	GE	8 Mar 96	8 Mar 96	2
SAS	200ER	PW	18 Jan 88	11 May 90	2
	300ER	PW	18 Jan 88	29 Mar 89	14
Shanghai Airlines	300	PW	14 May 93	22 Jul 94	4
Singapore Lease	300ER	GE	8 Aug 95	4 Aug 95	3
TACA Int'l Airlines	200	GE	22 May 86	22 May 86	1
	300ER	GE	27 Aug 91	26 Aug 91	2
Transbrasil	200	GE	30 Jul 81	23 Jun 83	3
TWA	200	PW	5 Dec 79	22 Nov 82	10
Turkmenistan Airlines	300ER	GE	11 Aug 03	none	1
unidentified	200ER	GE	15 Apr 02	27 Mar 03	6
	300ER	GE	15 Nov 01	none	1
United Airlines	200	PW	14 Jul 78	19 Aug 82	19
	300ER	PW	19 May 89	18 Apr 91	37
United Parcel Service	300F	GE	15 Jan 93	12 Oct 95	32
US Airways	200ER	GE	4 Apr 89	22 May 90	6
Uzbekistan	300ER	PW	20 Oct 89	27 Nov 96	4
Varig	200ER	GE	18 Mar 86	2 Jul 87	6
	300ER	GE	8 Sep 98	21 Dec 89	4
Total					**941**

Note: For deliveries see Group Orders and Deliveries table

FCS-700 flight control system; certified for Cat. IIIb landings; options include Boeing's windshear protection and guidance system.

Instrumentation: Honeywell EFIS-700 electronic flight instrument system.

DIMENSIONS, EXTERNAL:
- Wing span: except 400ER — 47.57 m (156 ft 1 in)
  - 400ER — 51.99 m (170 ft 7 in)
- Wing chord: at root — 8.57 m (28 ft 1¼ in)
  - at tip — 2.29 m (7 ft 6 in)
- Wing aspect ratio: except 400ER — 8.0
  - 400ER — 9.3
- Length:
  - overall: 200/200ER — 48.51 m (159 ft 2 in)
    - 300/300ER — 54.94 m (180 ft 3 in)
    - 400ER — 61.37 m (201 ft 4 in)
  - fuselage: 200/200ER — 47.24 m (155 ft 0 in)
    - 300/300ER — 53.67 m (176 ft 1 in)
- Fuselage max width — 5.03 m (16 ft 6 in)
- Height overall: 200ER/300 ER — 15.85 m (52 ft 0 in)
  - 400 ER — 16.87 m (55 ft 4 in)
- Tailplane span — 18.62 m (61 ft 1 in)
- Wheel track — 9.30 m (30 ft 6 in)
- Wheelbase: 200/200ER — 19.69 m (64 ft 7 in)
  - 300/300ER — 22.76 m (74 ft 8 in)
- Passenger doors (two, fwd and rear, port):
  - Height — 1.88 m (6 ft 2 in)
  - Width — 1.07 m (3 ft 6 in)
- Galley service door (two, fwd and rear, stbd):
  - Height — 1.88 m (6 ft 2 in)
  - Width — 1.07 m (3 ft 6 in)
- Emergency exits (two, each): Height — 0.97 m (3 ft 2 in)
  - Width — 0.51 m (1 ft 8 in)
- Cargo door (rear, stbd; fwd, stbd 200/300):
  - Height — 1.75 m (5 ft 9 in)
  - Width — 1.78 m (5 ft 10 in)
- Cargo door (fwd, stbd, 200ER/300ER):
  - Height — 1.75 m (5 ft 9 in)
  - Width — 3.40 m (11 ft 2 in)
- Bulk cargo door (port,rear): Height — 1.22 m (4 ft 0 in)
  - Width — 0.97 m (3 ft 2 in)

DIMENSIONS, INTERNAL:
- Cabin, excl flight deck:
  - Length: 200/200ER — 33.93 m (111 ft 4 in)
    - 300/300ER — 40.36 m (132 ft 5 in)
  - Max width — 4.72 m (15 ft 6 in)
  - Max height — 2.87 m (9 ft 5 in)
  - Floor area: 200/200ER — 155.5 m² (1,674 sq ft)
    - 300/300ER — 184.7 m² (1,988 sq ft)
    - 400ER — 213.8 m² (2,301 sq ft)
  - Volume: 200/200ER — 428.2 m³ (15,121 cu ft)
    - 300/300ER — 483.9 m³ (17,088 cu ft)
- Volume, flight deck — 13.5 m³ (478 cu ft)
- Baggage holds (containerised), volume:
  - 200/200ER: fwd — 40.8 m³ (1,440 cu ft)
    - rear — 34.0 m³ (1,200 cu ft)
  - 300/300ER: fwd — 54.4 m³ (1,920 cu ft)
    - rear — 47.6 m³ (1,680 cu ft)
  - 400ER: fwd — 68.0 m³ (2,400 cu ft)
    - rear — 61.2 m³ (2,160 cu ft)
- Bulk cargo hold volume:
  - 200ER/300ER — 12.2 m³ (430 cu ft)
  - 400ER — 9.8 m³ (345 cu ft)
- Combined baggage hold/bulk cargo hold volume:
  - 200/200ER — 87.0 m³ (3,070 cu ft)
  - 300/300ER — 114.1 m³ (4,030 cu ft)
- Total cargo hold volume:
  - 200/200ER — 111.3 m³ (3,930 cu ft)
  - 300/300ER — 147.0 m³ (5,190 cu ft)

AREAS:
- Wings, gross: except 400ER — 283.3 m² (3,050.0 sq ft)
  - 400ER — 290.70 m² (3,129.0 sq ft)
- Ailerons (total) — 11.58 m² (124.60 sq ft)
- Trailing-edge flaps (total) — 36.88 m² (397.00 sq ft)
- Leading-edge slats (total) — 28.30 m² (304.60 sq ft)
- Spoilers (total) — 15.83 m² (170.40 sq ft)
- Fin — 30.19 m² (325.00 sq ft)
- Rudder — 15.95 m² (171.70 sq ft)
- Tailplane — 59.88 m² (644.50 sq ft)
- Elevators (total) — 17.81 m² (191.70 sq ft)

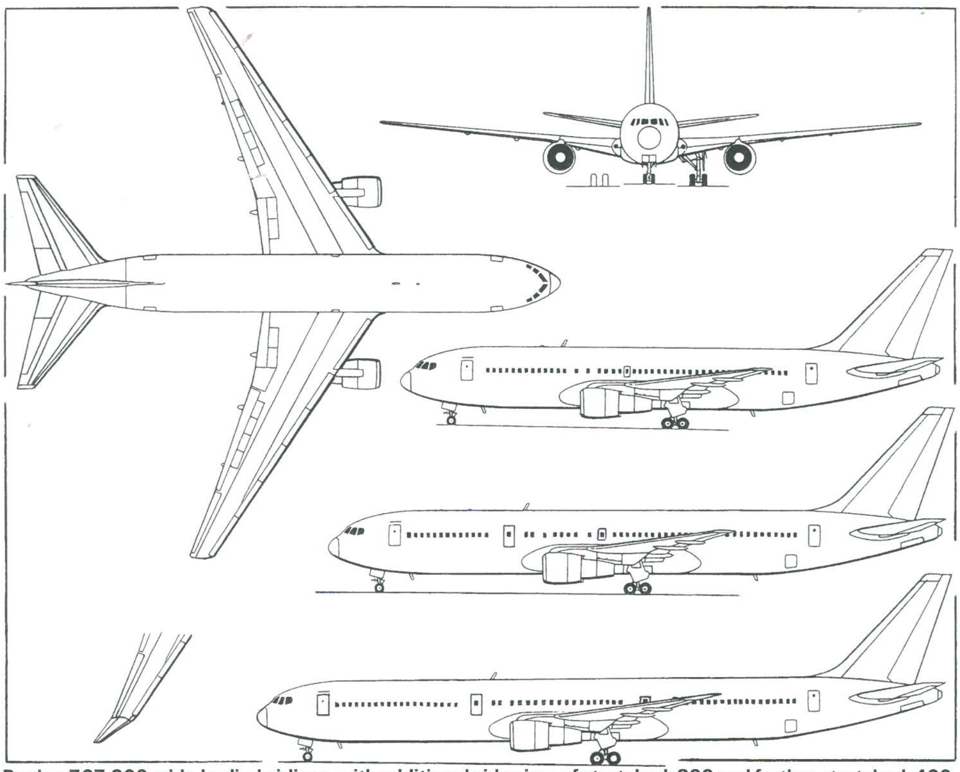
WEIGHTS AND LOADINGS (2GB: 767-200ER basic with CF6-80C2B2F engines, 2GM: 767-200ER max optional T-O weight and CF6-80C2B7Fs, 2PB: 767-200ER basic PW4052, 2PM: 767-200ER max PW4062, 3GB: 767-300ER basic CF6-80C2B4F, 3GM: 767-300ER max CF6-80C2B7F, 3PB: 767-300ER basic PW4056, 3PM: 767-300ER max PW4062, 3RB: 767-300ER basic RB211-524G4, 3RM: 767-300ER max RB211-524H; all -200 with 181 or 224 passengers, all -300ER with 218 or 269 passengers as indicated, where different):
- Operating weight empty:
  - 2GB (181), 2GM (181) — 84,960 kg (187,300 lb)
  - 2GB (224), 2GM (224) — 84,280 kg (185,800 lb)
  - 2PB (181), 2PM (181) — 85,005 kg (187,400 lb)
  - 2PB (224), 2PM (224) — 84,325 kg (185,900 lb)
  - 3GB (218), 3GM (218) — 90,810 kg (200,200 lb)
  - 3GB (269), 3GM (269) — 90,130 kg (198,700 lb)
  - 3PB (218), 3PM (218) — 90,855 kg (200,300 lb)
  - 3PB (269), 3PM (269) — 90,175 kg (198,800 lb)

3RB (218), 3RM (218)	91,625 kg (202,000 lb)
3RB (269), 3RM (269)	90,945 kg (200,500 lb)
Baggage capacity, underfloor:	
200ER:	
fwd: standard	9,798 kg (21,600 lb)
alternate	15,309 kg (33,750 lb)
rear: standard	8,165 kg (18,000 lb)
alternate	12,247 kg (27,000 lb)
300ER:	
fwd: standard	13,063 kg (28,800 lb)
alternate	20,412 kg (45,000 lb)
rear: standard	11,431 kg (25,200 lb)
alternate	17,574 kg (38,745 lb)
Bulk hold capacity (all versions)	2,926 kg (6,450 lb)
Max fuel weight: 200, 300	51,130 kg (112,725 lb)
200ER, 300ER	73,635 kg (162,340 lb)
Max T-O weight: 2GB, 2PB	156,490 kg (345,000 lb)
2GM, 2PM	179,170 kg (395,000 lb)
3GB, 3PB, 3RB	172,365 kg (380,000 lb)
3GM, 3PM, 3RM	186,880 kg (412,000 lb)
Max ramp weight: 2GB, 2PB	156,945 kg (346,000 lb)
2GM, 2PM	179,625 kg (396,000 lb)
3GB, 3PB, 3RB	172,820 kg (381,000 lb)
3GM, 3PM, 3RM	187,335 kg (413,000 lb)
Max landing weight: 2GB, 2PB	126,100 kg (278,000 lb)
2GM, 2PM	136,080 kg (300,000 lb)
3GB, 3GM, 3PB, 3PM, 3RB, 3RM	145,150 kg (320,000 lb)
Max zero-fuel weight:	
2GB, 2PB	114,755 kg (253,000 lb)
2GM, 2PM	117,935 kg (260,000 lb)
3GB, 3GM, 3PB, 3PM, 3RB, 3RM	133,810 kg (295,000 lb)
Max wing loading:	
2GB, 2PB	552.3 kg/m² (113.11 lb/sq ft)
2GM, 2PM	632.3 kg/m² (129.51 lb/sq ft)
3GB, 3PB, 3RB	608.3 kg/m² (124.59 lb/sq ft)
3GM, 3PM, 3RM	659.5 kg/m² (135.08 lb/sq ft)
Max power loading: 2GB	348 kg/kN (3.41 lb/lb st)
2GM	324 kg/kN (3.18 lb/lb st)
2PB	336 kg/kN (3.30 lb/lb st)
2PM	318 kg/kN (3.12 lb/lb st)
3GB	343 kg/kN (3.36 lb/lb st)
3GM	338 kg/kN (3.32 lb/lb st)
3PB	339 kg/kN (3.33 lb/lb st)
3PM	332 kg/kN (3.25 lb/lb st)
3RB	344 kg/kN (3.37 lb/lb st)
3RM	353 kg/kN (3.46 lb/lb st)

PERFORMANCE:

Normal cruising speed, all versions	M0.80
Approach speed at MLW:	
2GB, 2PB	137 kt (254 km/h; 158 mph)
2GM, 2PM	142 kt (263 km/h; 163 mph)
3GB, 3GM, 3PB, 3PM	145 kt (269 km/h; 167 mph)
3RB, 3RM	148 kt (275 km/h; 171 mph)
Initial cruising altitude at max T-O weight:	
2GB	11,550 m (37,900 ft)
2GM, 2PM	10,670 m (35,000 ft)
2PB	11,310 m (37,100 ft)
3GB	10,700 m (35,100 ft)
3GM, 3PM	10,180 m (33,400 ft)
3PB	10,730 m (35,200 ft)
3RB	10,730 m (35,200 ft)
3RM	10,210 m (33,500 ft)
Service ceiling, OEI: 2GB	5,090 m (16,700 ft)
2GM	4,205 m (13,800 ft)
2PB	5,395 m (17,700 ft)
2PM	4,845 m (15,900 ft)
3GB	4,510 m (14,800 ft)
3GM	3,930 m (12,900 ft)
3PB	4,785 m (15,700 ft)
3PM	4,085 m (13,400 ft)
3RB	3,900 m (12,800 ft)
3RM	3,505 m (11,500 ft)
T-O field length S/L, 86°F: 2GB	2,301 m (7,550 ft)
2GM, 3PB	2,485 m (8,150 ft)
2PB	2,180 m (7,150 ft)
2PM	2,439 m (8,000 ft)
3GB	2,530 m (8,300 ft)
3GM	2,713 m (8,900 ft)
3PM	2,652 m (8,700 ft)
3RB	2,500 m (8,200 ft)
3RM	2,896 m (9,500 ft)
Landing field length at MLW: 2GB	1,524 m (5,000 ft)
2GM	1,555 m (5,100 ft)
2PB	1,509 m (4,950 ft)
2PM	1,540 m (5,050 ft)
3GB, 3GM, 3PB, 3PM	1,677 m (5,500 ft)
3RB, 3RM	1,707 m (5,600 ft)
3RM	2,896 m (9,500 ft)
Design range:	
2GB (181)	5,125 n miles (9,491 km; 5,897 miles)
2GB (224)	4,830 n miles (8,945 km; 5,558 miles)
2GM (181)	6,655 n miles (12,325 km; 7,658 miles)
2GM (224)	6,545 n miles (12,121 km; 7,531 miles)
2PB (181)	5,030 n miles (9,315 km; 5,788 miles)
2PB (224)	4,740 n miles (8,778 km; 5,454 miles)
2PM (181)	6,555 n miles (12,139 km; 7,543 miles)
2PM (224)	6,450 n miles (11,945 km; 7,422 miles)
3GB (218)	5,230 n miles (9,686 km; 6,018 miles)
3GB (269)	4,890 n miles (9,056 km; 5,627 miles)
3GM (218)	6,150 n miles (11,389 km; 7,077 miles)
3GM (269)	5,990 n miles (11,093 km; 6,893 miles)
3PB (218)	5,155 n miles (9,547 km; 5,932 miles)
3PB (269)	4,820 n miles (8,926 km; 5,546 miles)
3PM (218)	6,075 n miles (11,250 km; 6,991 miles)
3PM (269)	5,915 n miles (10,954 km; 6,806 miles)
3RB (218)	4,880 n miles (9,037 km; 5,615 miles)
3RB (269)	4,555 n miles (8,435 km; 5,241 miles)
3RM (218)	5,850 n miles (10,834 km; 6,732 miles)
3RM (269)	5,620 n miles (10,408 km; 6,467 miles)

UPDATED



Boeing 767-200 wide-bodied airliner, with additional side view of stretched -300 and further stretched -400, including last mentioned's revised wingtips *(Jane's/Dennis Punnett)* 0085775

BOEING 767-300 GENERAL MARKET FREIGHTER

TYPE: Twin-jet freighter.

PROGRAMME: First 767 specialised package freighter launched January 1993 by United Parcel Service order; mockup completed early 1994; first flight (N301UP) 20 June 1995. The 767-300F for general operation was ordered by Asiana in November 1993 and differs from UPS version in having mechanical freight handling on main and lower decks, air conditioning for animals and perishables on main and forward lower decks and more elaborate crew facilities.

CUSTOMERS: UPS ordered 30 parcel freighters 15 January 1993; first delivery 12 October 1995; last on 9 September 1999; two of further 30 options taken up and delivered in October and November 2001. Asiana ordered two 767-300Fs in November 1993; contract reduced to one, which was delivered 23 August 1996. Five to LAN Chile between 23 September 1998 and 9 October 2001. One ordered by GECAS; one by undisclosed customer. Total 40.

COSTS: US$122.5 million to US$134.0 million (2002 and 2003).

DESIGN FEATURES: Modifications include reinforced landing gear and internal wing structure; main deck floor strengthened to take 24 containers, each 2.24 × 3.18 m (88 × 125 in); no passenger windows; 2.67 × 3.40 m (8 ft 9 in × 11 ft 1¾ in) freight door forward to port; pilot-type rating and extensive component commonality with 757 Freighter.

POWER PLANT: Two General Electric CF6-80C2B6F/B7F, Pratt & Whitney PW4060/4062 or Rolls-Royce RB211-524/H turbofans; 267 kN (60,000 lb st) each.

DIMENSIONS, INTERNAL:

Cabin: Length	39.80 m (130 ft 7 in)
Main deck container capacity	339.5 m³ (11,990 cu ft)
Lower deck cargo capacity	92.9 m³ (3,282 cu ft)

WEIGHTS AND LOADINGS:

Max T-O weight: standard	185,065 kg (408,000 lb)
optional	186,880 kg (412,000 lb)
Max ramp weight	187,335 kg (413,000 lb)
Max zero-fuel weight	140,160 kg (309,000 lb)
Max landing weight	147,871 kg (326,000 lb)
Max wing loading	659.5 kg/m² (135.08 lb/sq ft)
Max power loading	350 kg/kW (3.43 lb/lb st)

PERFORMANCE:

Range: with 40,823 kg (90,000 lb) payload
4,000 n miles (7,408 km; 4,603 miles)
with 50,800 kg (112,000 lb) payload
3,000 n miles (5,556 km; 3,452 miles)

UPDATED

BOEING 777

TYPE: Wide-bodied airliner.

PROGRAMME: Formerly known as 767-X, initial variant now 777-200; Boeing board authorised firm offer for sale 8 December 1989; launch order by United Airlines 15 October 1990 (see Customers); Boeing launched production programme of initial market and Increased Gross Weight 777s and formed 777 Division 29 October 1990; configuration frozen March 1991; Boeing signed final agreement with Mitsubishi, Kawasaki and Fuji, making them risk-sharing programme partners for about 20 per cent of the 777 structure, on 21 May 1991; roll-out occurred 9 April 1994.

First flight (line no. WA001/N7771 with PW4084 engines), 12 June 1994, WA002 15 July, WA003 2 August, WA004 28 October, WA005 11 November; WA006/G-ZZZA (first with GE90, for British Airways) 2 February 1995, same day as FAA granted engine approval; PW-engined aircraft accumulated some 3,235 hours in 2,340 cycles in test programme, leading to joint FAA/JAA certification on 19 April 1995; FAA awarded 180-minute ETOPS approval 30 May 1995; first delivery, to United Airlines, on 15 May 1995; service entry with United on 7 June 1995 with inaugural revenue flight (by N777NA) from London to Washington, DC. Second GE90 aircraft for British Airways (WA010/G-ZZZB) joined WA006 in 1,750 hour, 1,260 cycle test programme; certification with GE engine 9 November 1995, with deliveries to BA commencing two days later.

Flight testing of Rolls-Royce Trent 800 on Boeing 747-100 testbed began late March 1995, with first flight of Trent-powered 777 (Boeing test aircraft) 26 May; certification and first delivery (to Thai International) on 3 April 1996 (formal hand-over 31 March), with ETOPS clearance following in October. The US National Aeronautic Association awarded Boeing and the 777 its 1995 Robert J. Collier Trophy for aeronautical achievement. On 2 April 1997, a Trent-powered 777 landed at Boeing Field having captured the eastbound world circumnavigation record in 41 hours 59 minutes with a single stop at Kuala Lumpur, Malaysia, its arrival at the latter also having secured the non-stop great circle distance record of 10,266.9 n miles (19,014.3 km; 11,814.9 miles).

Two new derivatives launched 29 February 2000 as 777-200LR and 777-300ER, both as extended-range versions of current production types. Anticipated market of 500 for these derivatives, 45 per cent of which with Asian operators.

CURRENT VERSIONS: **777-100X:** Under study in 2000 to meet Singapore Airlines requirements for shortened, 250-seat version. Not proceeded with.

777-200: Initial production version. Maximum T-O weight 247,210 kg (545,000 lb); up to 440 passengers at maximum density.

777-200ER: Formerly -200-IGW (Increased Gross Weight). Maximum T-O weight initially 286,895 kg (632,500 lb); increased to 293,930 kg (648,000 lb) in March 1998 and 297,555 kg (656,000 lb) in January 1999; additional 53,828 litres (14,220 US gallons; 11,840 Imp gallons) of fuel in centre-section tank; same passenger capacity as basic aircraft; configuration frozen January

1994, including strengthened wing, fuselage, empennage, landing gear and engine pylons. First flew (G-VIIA, one of two for British Airways) 7 October 1996 (GE engines); FAA/JAA ETOPS certification 5 February 1997; delivery 6 February. First Trent-powered -200ER (A6-EMI, for Emirates) flew 21 November 1996. January 1999 MTOW increase resulted from fitting 777-300 main landing gear and restricting CG travel to 4 per cent, for increased taxying weight. First flight with GE90-94B engines 12 June 2000; FAA certification 14 November 2000, followed immediately by first delivery (to Air France).

First 777 for private use is a -200ER (N777AS) first flown 3 November 1998 and delivered to Raytheon Systems at Waco, Texas, for outfitting; customer delivery to Middle East Jet due late 2000.

777-200LR: Ultra-long-range version (previously 777-200X) powered by two General Electric GE90-110B engines, each rated at 489 kN (110,000 lb/st); launched 29 February 2000. Maximum T-O weight 340,200 kg (750,000 lb); fuel capacity 202,292 litres (53,440 US gallons; 44,498 Imp gallons), with addition of tanks in rear cargo hold; range 9,100 n miles (16,853 km; 10,472 miles) with 301 passengers. Raked wingtips extend total span by 3.96 m (13 ft 0 in). Firm launch order from EVA Airlines, 27 June 2000, for three. On 1 October 2001, Boeing announced suspension of development programme for up to 18 months this being resumed in March 2003; roll out due January 2005; deliveries to Pakistan International Airlines scheduled to begin in January 2006.

777-250ERX: Under consideration by late 2002; length 68.6 m (225 ft); range 7,500 n miles (13,890 km; 8,630 miles) with up to 330 passengers.

777-300: Initially known as 777 Stretch; revealed at Paris Air Show, 14 June 1995; launched by Boeing board 26 June 1995 when 36 commitments held; configuration frozen October 1995; major assembly started 7 April 1997; roll-out 8 September 1997; first flight (Rolls-Royce engines) 16 October 1997 (N5014K); first with P&W engines (HL-7534 of Korean Air) 4 February 1998; FAA certification achieved 4 May 1998 with 180-minute ETOPS approval; first delivery (B-HNH, 136th 777) to Cathay Pacific 22 May 1998.

Compared with first-generation 747s, 777-300 carries same number of passengers, but at two-thirds of fuel cost and with 40 per cent less maintenance. Features strengthened airframe, inboard wing and landing gear, ground-manoeuvring cameras on horizontal tail surfaces and wing/fuselage fairing; tailskid; Type A emergency door over each wing; and fuselage stretched by 19 frames, 10.13 m (33 ft 3 in) longer (5.33 m; 17 ft 6 in ahead of wing and 4.80 m; 15 ft 9 in aft of wing) than that of 777-200 to increase passenger capacity to 550 in single-class high-density configuration.

777-300ER: Extended range version of 777-300 (previously 777-300X); launched 29 February 2000; launch customer Japan Airlines ordered eight on 31 March 2000 for delivery from October 2003, but first recipient now ILFC/Air France in April 2004 (beginning F-GSQA). Assembly started 20 June 2002; rolled out 14 November 2002; first flight (WD501/N5017V) 24 February 2003; second prototype (WD502) flew 6 April 2003; WD501 set twin-jet MTOW record of 351,350 kg (774,600 lb) at Edwards AFB, 19 May 2003 and subsequently exhibited at Paris Air Show, 15 to 22 June 2003.

GE90-115B engines each rated at 512 kN (115,000 lb st); height 18.57 m (60 ft 11 in). Maximum T-O weight as for 777-200LR; fuel capacity 181,283 litres (47,890 US gallons; 39,877 Imp gallons); range 7,200 n miles (13,334 km; 8,285 miles) with 359 passengers. Both -200LR and -300ER have strengthened horizontal and vertical tail surfaces, strengthened wings with new tips which increase span to 64.80 m (212 ft 7 in) and strengthened landing gear, including semi-levered main gear and extendable (up to 25 cm; 9¾ in) nosewheel leg on -300ER. Modified landing gear permits steeper rotation, and thus operations from shorter runways; anti-tail strike system automatically moves elevator when runway contact is imminent.

777-300ER Stretch: Under study in 1999 as possible replacement for 747-400 with Asian carrier on routes to Europe; fuselage stretch of about 7.9 m (26 ft) to accommodate an additional 60 passengers, but airframe otherwise unchanged; range as for 777-300ER. Also referred to as **777-400X**. Not proceeded with.

CUSTOMERS: As per table.

COSTS: Estimated development cost US$4 billion (1990). US$153.5 million to US$171 million 777-200; US$162 million to US$182 million 777-200ER; US$188 million to US$213.5 million 777-200LR; US$178.5 million to US$203.5 million 777-300; US$203.5 million to US$231.5 million to US$231.5 million 777-300ER (all 2002 and unchanged by mid-2003). 777-300 estimated to burn 33 per cent less fuel and have 40 per cent lower maintenance cost than 747-100/200, resulting in direct operating cost savings of around 30 to 35 per cent.

DESIGN FEATURES: Objectives of design included replacement of McDonnell Douglas DC-10 Srs 10 and Lockheed TriStar in regional market, as well as DC-10 Srs 30 and Boeing 747SP in intercontinental service; also is replacement for early 747s. All features required for 180-minute ETOPS incorporated and tested in basic aircraft

BOEING 777 ORDER BOOK
(at 1 January 2004)

Customer	Variant	Engine	First Order	First Delivery	Qty
Air China	777-200	PW4000	24 Mar 97	26 Oct 98	10
Air France	777-200	GE90	20 Nov 96	27 Mar 98	18
	777-300ER	GE90	13 Nov 00	none	10
Alitalia	777-200ER	GE90	9 Nov 00	23 Aug 02	6
All Nippon Airways	777-200	PW4000	19 Dec 90	4 Oct 95	20
	777-200ER	PW4000	19 Dec 90	6 Oct 99	4
	777-300	PW4000	12 Sep 95	30 Jun 98	10
	777-300ER	GE90	18 Jul 00	none	6
American Airlines	777-200ER	Trent 800	21 Nov 96	21 Jan 99	54
Asiana Airlines	777-200ER	PW4000	20 Dec 96	24 May 02	7
British Airways	777-200	GE90	21 Aug 91	11 Nov 95	5
	777-200ER	GE90	21 Aug 91	6 Feb 97	24
	777-200ER	Trent 800	1 Aug 98	7 Jun 00	16
Cathay Pacific Airways	777-200	Trent 800	6 May 92	9 May 96	5
	777-300	Trent 800	6 May 92	22 May 98	10
China Southern Airlines	777-200	GE90	17 Dec 92	28 Dec 95	4
	777-200ER	GE90	17 Dec 92	28 Feb 97	2
Continental Airlines	777-200ER	GE90	12 May 93	28 Sep 98	16
Delta Air Lines	777-200ER	Trent 800	13 Nov 97	23 Mar 99	13
Egyptair	777-200ER	PW4090	23 Aug 95	23 May 97	5
El Al Israel Airlines	777-200ER	Trent 800	14 Dec 99	29 Jan 01	4
Emirates	777-200	Trent 800	4 Jun 92	5 Jun 96	3
	777-200ER	Trent 800	4 Jun 92	11 Apr 97	6
EVA Airways	777-200LR	GE90	27 Jun 00	none	3
	777-300ER	GE90	27 Jun 00	none	4
Garuda Indonesian	777-200ER	GE90	25 Jun 96	none	6
GECAS	777-200ER	GE90	26 Sep 00	10 Oct 03	4
	777-300ER	GE90	26 Sep 00	none	14
ILFC	777-200ER	GE90	15 Dec 92	8 Jan 98	28
	777-200ER	PW4000	15 Dec 92	16 Jul 98	6
	777-200ER	Trent 800	2 Sep 97	none	7
	777-300	Trent 800	6 Mar 96	26 Sep 00	8
	777-300ER	GE90	28 Nov 00	none	18
Japan Air System	777-200	PW4000	29 Jun 93	3 Dec 86	7
Japan Airlines	777-200	PW4000	24 Jan 92	15 Feb 96	7
	777-200ER	GE90	27 Nov 00	11 Jul 02	11
	777-300	PW4000	22 Dec 95	28 Jul 98	8
	777-300ER	GE90	31 Mar 00	none	8
Kenya Airways	777-200ER	n/k	22 Mar 02	none	3
KLM	777-200ER	n/k	26 Aug 02	23 Oct 03	4
Korean Air Lines	777-200ER	PW4000	16 Dec 93	21 Mar 97	18
	777-300	PW4000	16 Dec 93	12 Aug 99	4
Kuwait Airways	777-200	GE90	10 Jul 96	30 Mar 98	2
Lauda Air	777-200ER	GE90	13 Dec 91	24 Sep 97	3
Malaysia Airlines	777-200ER	Trent 800	8 Jan 96	23 Apr 97	15
Mid East Jet	777-200ER	GE90	1 Oct 97	24 Nov 98	1
Pakistan International Airlines	777-200ER	GE90	14 Nov 02	none	3
	777-200LR	GE90	14 Nov 02	none	2
	777-300ER	GE90	14 Nov 02	none	3
Saudia	777-200ER	GE90	18 Jun 95	26 Dec 97	23
Saudi Oger	777-200ER	GE90	30 Nov 98	22 Oct 99	1
Singapore Aircraft Leasing	777-200ER	Trent 800	22 Dec 95	20 Mar 01	2
	777-300	Trent 800	22 Dec 95	12 Nov 99	4
Singapore Airlines	777-200ER	Trent 800	22 Dec 95	5 May 97	47
	777-300	Trent 800	22 Dec 95	10 Dec 98	12
Thai Airways International	777-200	Trent 800	20 Jun 91	31 Mar 96	8
	777-300	Trent 800	22 Dec 95	23 Dec 98	6
unidentified	777-300ER	GE90	31 Dec 02	none	8
United Airlines	777-200	PW4000	15 Oct 90	15 May 95	22
	777-200ER	PW4000	15 Oct 90	7 Mar 97	39
Vietnam Airlines	777-200ER	PW4000	31 Jan 02	none	4
Total					**631**

Note: For delivery totals see Group Orders and Deliveries table

design. Cylindrical fuselage wider than 767 to allow twin aisle seating for from six- to 10-abreast; lavatories and overhead baggage bins designed to allow rapid change of layout.

Wing, of 31° 30′ sweepback at quarter-chord, incorporates new technology to allow minimum M0.83 cruise in combination with high thickness for economical structure and large internal volume, long span for improved take-off and payload/range and large area for high cruise altitude and low approach speed; no winglets. Design included provision for outer 6.48 m (21 ft 3 in) of each wing to be folded to vertical to reduce gate width requirement at airports; this option not proceeded with.

FLYING CONTROLS: Fly-by-wire. Hydraulically actuated, with trim tab in rudder. Six-segment slats in each wing leading-edge. Single-slotted flaps mid-wing, double-slotted flaps inboard; flaperon between inboard and outboard flaps. Five-segment spoilers ahead of single-slotted flaps; two-segment spoilers ahead of double-slotted flaps.

Boeing's first airliner fly-by-wire system; fully powered control surface actuators (31 by Teijin Seiki America) electrically signalled from full FBW system; this signals slats, flaps, spoilers and control feel unit as well as inboard flaperons, outboard ailerons, elevators and rudder; system provides flight envelope protection as well as stabilisation and autopilot inputs, but the normal control columns and rudder pedals in cockpit are back-driven by the system to give the pilots direct appreciation of the activity of the automatic system.

In normal mode, flight guidance commands are generated by Rockwell Collins triple redundant digital autopilot/flight directors and the control laws and envelope protection commands are shaped by the Marconi Avionics triple digital primary flight computers; each of the three primary flight computers contains three 32-bit microprocessors (a Motorola 68040, an Intel 80486 and an AMD 29050), all three programmed in Ada to perform all FBW functions; with power supply and ARINC 629 modules, each microprocessor module constitutes a lane and the three lanes constitute a channel; each lane is compared with the others in its channel; the system not only has high fault tolerance, but allows deferred maintenance, by which failures can be carried over until the next scheduled maintenance.

Commands to the powered control units are produced by three BAE Systems and Teijin Seiki actuator control electronics units, which have a fourth analogue channel directly signalled from the sticks and pedals in the cockpit; normal operating mode is for the aircraft to be flown through autopilots, primary flight computers and actuator control electronics, which simultaneously back-drive the sticks and pedals in the cockpit; first degraded (secondary) mode is used if inertial units and standby attitude sensors all become disabled and the pilots take manual control through the digital primary flight computers; second degraded (direct) mode bypasses the main FBW system with the direct analogue link between cockpit and actuator control electronics; ultimate standby is mechanical control

Prototype Boeing 777-300ER displayed at Paris in June 2003 *(Paul Jackson)* ***NEW***/0561723

of tailplane incidence for the pitch axis and two wing spoiler panels for lateral control. Some powered control units produced by Parker-Bertea and Moog; tailplane trim module and hydraulic brake by Raytheon Systems.

Pitch axis control law is C* U, effectively tending to make the aircraft hold an airspeed and to respond in pitch attitude to a departure from that airspeed; trim changes due to configuration changes are suppressed; the system returns the bank angle to 35° if that angle is exceeded by the pilots and the controls then released; the system prevents exceeding the limiting airspeed and stalling; asymmetric thrust is automatically countered; the variable feel system adjusts control forces to warn of approach to flight envelope limits in manual flight; the FBW system is linked to the ARINC 629 dual triplex digital databusses (see also aircraft information management system under Avionics heading).

STRUCTURE: Composites of carbon and toughened resin used in skins of tailplane and fin torsion boxes and cabin floor beams; CFRP used for rudder, elevators, ailerons, flaps, engine nacelles and landing gear doors; hybrid composites in wingroot fairing; GFRP in fixed-wing leading-edge, tailplane and fin fore and aft panels, wing aft panels, engine pylon fairings and radome. Toughened materials have high damage resistance and allow simple low-temperature bolted repairs. Metal structure includes thick skins without need for tear straps; no bonding; single-piece fuselage frames; fuselage skin of advanced 2000-series aluminium alloy; wing, empennage and engine nacelle leading edges of 2000-series; wing top skin and stringers made in advanced 7055 aluminium alloy with greater compression strength; tailcone in standard 7000-series; 10 per cent of structure weight is composites.

Fully digital product definition with all parts created by Dassault/IBM CATIA CAD/CAM and communicated to manufacturing and publications; structure and systems integration, tube and cable run design completed before design release; 238 design/build teams have ensured that design, fabrication and test have proceeded concurrently for structure and systems. Whole aircraft defined in computer system; no mockup built.

Centre and rear fuselage barrel sections, tailcone, doors, wingroot fairing and landing gear doors made in Japan. Wing and tail leading-edges and moving wing parts, landing gear, floor beams, nose landing gear doors, wingtips, dorsal fin and nose radome made by Northrop Grumman, Kaman, Alenia (Italy), Embraer (Brazil), Short Brothers (UK), Singapore Aerospace Manufacturing, HDH and ASTA (Australia), Korean Air and other subcontractors. Boeing manufactures flight deck and forward cabin, basic wing and tail structures and engine nacelles; assembles and tests completed aircraft.

LANDING GEAR: Retractable tricycle type (Menasco/Messier-Bugatti joint design for main gear); two main legs carrying six-wheel bogies with steering rear axles automatically engaged by nose gear steering angle; six-wheel bogies avoid need for third leg in fuselage and simplify braking system; twin-wheel steerable nose gear; mainwheel tyres H49×19.0-22 or 50×20.0R22 (32 ply); nosewheel tyres 42×17.0R18 (26 ply). Honeywell Carbenix 4000 mainwheel brakes arranged so that initial toe-pedal pressure used during taxying applies brakes to alternate sets of three wheels to save brake wear; full toe-pedal pressure applies all six brakes together.

POWER PLANT: Two turbofans.

777-200: 343 kN (77,000 lb st) General Electric GE90-77B, 331 kN (74,500 lb st) Pratt & Whitney PW4074 or 343 kN (77,200 lb st) PW4077, or 327 kN (73,400 lb st) Rolls-Royce Trent 875 or 338 kN (76,000 lb st) Trent 877.

777-200ER: 377 kN (84,700 lb st) GE90-85B, 400 kN (90,000 lb st) GE90-90B, 417 kN (93,700 lb st) GE90-94B, 376 kN (84,600 lb st) PW4084, 401 kN (90,200 lb st) PW4090, 436 kN (98,000 lb st), PW4098, 372 kN (83,600 lb st) Trent 884, 400 kN (90,000 lb st) Trent 892 or 415 kN (93,400 lb st) Trent 895.

777-300: PW4090, PW4098 or Trent 884, 892, as above.

All fuel of baseline version contained in integral tanks in wing torsion box, with reserve tank, surge tank and fuel vent and jettison pipes all inboard of wing fold; combined capacity of main, centre and reserve tanks in 777-200 is 117,348 litres (31,000 US gallons; 25,813 Imp gallons); 777-200ER and 777-300 fuel capacity increased by centre-section tank of 53,829 litres (14,220 US gallons; 11,841 Imp gallons) to maximum of 171,176 litres (45,220 US gallons; 37,653 Imp gallons).

ACCOMMODATION: Two-pilot crew; cabin cross-section, which is between that of 747 and 767, chosen to allow widest selection of twin-aisle class and seating layouts ranging from six- to 10-abreast; galleys and lavatories can be located at a selection of fixed points in front and rear cabins or freely positioned within large footprints in which they can be moved in 2.5 cm (1 in) increments and attached to prepositioned mounting, plumbing and electric fittings; overhead bins open downward and provide each passenger with 0.08 m³ (3 cu ft) volume; bins can be removed without disturbing ceiling panels, ducts or support structure; advanced cabin management system simplifies cabin management and includes digital sound system of hi-fi quality.

Typical configurations for 200/200ER include 305 passengers in three-class layout: 24 first class (two-two-two-abreast), 54 business class (two-three-two) and 227 economy class (three-three-three); 367 in two classes: 14 business (two-three-two) and 353 economy (three-three-three); 375 in two classes: 30 first class (two-two-two at 97 cm; 38 in pitch) and 345 economy (two-five-two at 79 cm; 31 in or 81 cm; 32 in pitch); 400 in two classes: 30 first class, as immediately previously and 370 economy (three-four-three, pitches as previously); and 440 passengers in single class (three-four-three).

For 777-300, options include 368 in three classes: 30 first (two-two-two at 152 cm; 60 in), 84 business (two-three-two at 97 cm; 38 in) and 254 economy (two-five-two at 79 cm; 31 in or 81 cm; 32 in); 386 in first (30), business (77) and economy (279) classes, as previously, except last-mentioned at three-four-three, with only four seats at minimum pitch; 451 passengers in two classes: 40 first, as above, and 411 economy (two-five-two, at usual pitches); 479, in first (44) and economy (435) classes, the former with 97 cm; 38 in pitch and latter three-four-three at usual pitches; and ultimate 550 single-class passengers, mostly two-four-two. Underfloor cargo compartments have mechanical handling system and can accommodate all LD formats and 88 in or 96 in width pallets; up to 32 LD-3 containers plus 17.0 m³ (600 cu ft) bulk cargo can be loaded in 777-200, or 44 LD-3s and some bulk cargo in 777-300.

Flight crew rest module on flight deck, port, contains two bunks. Optional underfloor crew rest modules available with six, eight or 10 bunks, and stowage space and require only electrical connection and hatch in passenger cabin floor, level with wing trailing-edge. Roof-mounted rest modules optional for ER and LR versions, occupying unused space between rows of baggage bins; first delivery May 2003.

SYSTEMS: Honeywell air drive unit, using bleed air from engines, APU or ground supply, drives central hydraulic system; cabin air supply and pressure control by Honeywell; Hamilton Sundstrand variable-speed, constant frequency AC electrical power generating system, with two 120 kVA integrated drive generators, one APU-driven generator and Honeywell ram air turbine system. Honeywell GTCP331-500 APU; Hamilton Sundstrand air conditioning; Smiths Industries ultrasonic fuel quantity gauging system and electrical load management system; optional wingtip folding by Raytheon Montek Division and Frisby Airborne Hydraulics.

AVIONICS: *Radar:* Honeywell weather radar standard.

Flight: Main navigation system is Honeywell air data and inertial reference (ADIRS) containing the Hexad skewed axis arrangement of six ring laser gyros; standby system is the secondary attitude and air data reference unit (SAARU) containing interferometric fibre optic gyros (using light transmitted in two directions along fibre optic paths), which produces a secondary flight director attitude display, airspeed and altimeter; both are linked to the ARINC 629 digital databus (777 being first aircraft thus equipped); Honeywell TCAS; Honeywell/BAE Systems Canada global navigation satellite sensor with 12-channel receiver; Honeywell/Racal multichannel satcom system optional. New, smaller flight computers installed from October 2003 onwards.

Dual Honeywell aircraft information management system (AIMS) contains the processing equipment required to collect, format and distribute onboard avionic information, including the flight management system (FMS), engine thrust control, digital communications management, operation of flight deck displays and monitoring of aircraft condition; both pilots and ground engineers can assess the condition of all onboard avionics systems.

Instrumentation: Based on five-screen EFIS using Honeywell 203 mm (18 in) ARINC D-size colour liquid crystal flat panel displays (two primary flight displays, two navigation displays and EICAS display); three multipurpose control and colour display units on centre console provide interface with integrated aircraft information management system, which handles flight management, thrust control and communications control as well as all systems information.

Mission: Flight crew's 'electronic flight bag' (EFB) software installed from October 2003 (KLM Royal Dutch Airlines first) as option.

EQUIPMENT: Boeing 777-300 has Ground Maneuver Camera System with TV cameras in leading-edges of both horizontal stabilisers and underside of fuselage.

DIMENSIONS, EXTERNAL:

Wing span	60.93 m (199 ft 11 in)
Wing aspect ratio	8.7
Length overall: 200	63.73 m (209 ft 1 in)
300	73.86 m (242 ft 4 in)
Fuselage: Length	62.74 m (205 ft 10 in)
Max diameter	6.20 m (20 ft 4 in)
Max height overall: 200	18.51 m (60 ft 9 in)
300	18.49 m (60 ft 8 in)
Tailplane span	21.52 m (70 ft 7½ in)
Wheel track	10.97 m (36 ft 0 in)
Wheelbase	25.88 m (84 ft 11 in)
Passenger doors (four port, four stbd, each):	
Height	1.88 m (6 ft 2 in)
Width	1.07 m (3 ft 6 in)
Max height to sill	5.51 m (18 ft 1 in)
Forward cargo door, stbd: Height	1.70 m (5 ft 7 in)
Width	2.69 m (8 ft 10 in)
Max height to sill	3.05 m (10 ft 0 in)
Rear cargo door, stbd:	
Height	1.70 m (5 ft 7 in)
Width: standard	1.78 m (5 ft 10 in)
optional	2.69 m (8 ft 10 in)
Max height to sill	3.40 m (11 ft 2 in)
Bulk cargo door, stbd: Height	0.91 m (3 ft 0 in)
Width	1.14 m (3 ft 9 in)
Max height to sill	3.48 m (11 ft 5 in)

DIMENSIONS, INTERNAL:

Cabin: Length	49.10 m (161 ft 1 in)
Max width	5.87 m (19 ft 3 in)
Floor area: 200, 200ER	279.1 m² (3,004 sq ft)
Max underfloor cargo hold volume:	
200, 200ER: forward	80.5 m³ (2,844 cu ft)
aft	62.6 m³ (2,212 cu ft)
bulk	17.0 m³ (600 cu ft)
total	160.2 m³ (5,656 cu ft)
300: forward	107.4 m³ (3,792 cu ft)
aft	89.5 m³ (3,160 cu ft)
bulk	17.0 m³ (600 cu ft)
total	213.8 m³ (7,552 cu ft)

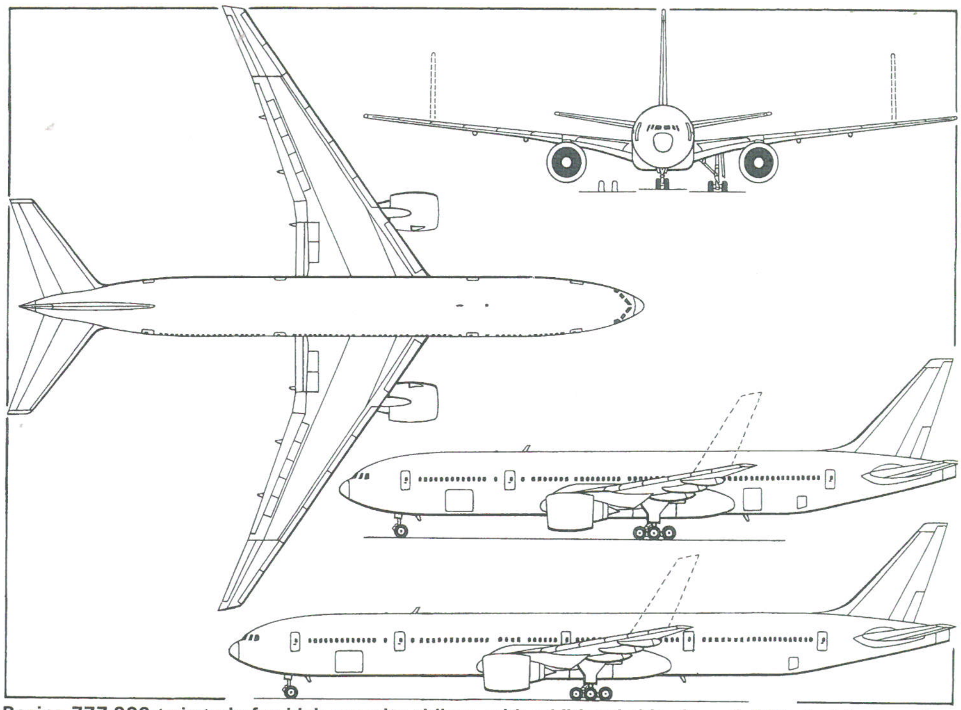
AREAS:

Wings, projected	427.8 m² (4,605.0 sq ft)
Ailerons (total)	7.11 m² (76.50 sq ft)
Trailing-edge flaps (total)	67.13 m² (722.60 sq ft)

Slats (total)	36.84 m² (396.50 sq ft)
Inboard spoilers (total)	8.67 m² (93.30 sq ft)
Outboard spoilers (total)	14.34 m² (154.40 sq ft)
Flaperons	6.69 m² (72.00 sq ft)
Horizontal tail surfaces, projected	101.26 m² (1,090.0 sq ft)
Vertical tail surfaces, projected	53.23 m² (573.00 sq ft)
Elevators, incl tabs (total)	25.48 m² (274.30 sq ft)
Rudder, incl tab	18.16 m² (195.50 sq ft)

WEIGHTS AND LOADINGS (777-200 with 305 passengers, 24/54/227, 2GB: GE90-77B engines at basic MTOW, 2GM: GE90-77B maximum, 2PB: PW4074 basic, 2PM: PW4077 maximum, 2RB: Trent 875 basic, 2RM: Trent 877 maximum; 777-200ER with 301 passengers, 16/58/227, 2ERGB: GE90-85B basic, 2ERGM: GE90-94 maximum, 2ERPB: PW4084 basic, 2ERPM: PW4090 maximum, 2ERRB: Trent 884 basic, 2ERRM: Trent 895 maximum; 777-300 with 368 passengers, 30/84/254, 3PB: PW4090 basic, 3PM: PW4098 maximum, 3RB: Trent 892 basic, 3RM: Trent 892 maximum):

Operating weight empty: 2GB	140,660 kg (310,100 lb)
2GM	140,795 kg (310,400 lb)
2PB	138,890 kg (306,200 lb)
2PM	139,025 kg (306,500 lb)
2RB	141,205 kg (311,300 lb)
2RM	141,385 kg (311,700 lb)
2ERGB	144,830 kg (319,300 lb)
2ERGM	145,015 kg (319,700 lb)
2ERPB	143,065 kg (315,400 lb)
2ERPM	143,835 kg (317,100 lb)
2ERRB	141,205 kg (311,300 lb)
2ERRM	141,385 kg (311,700 lb)
3PB	158,030 kg (348,400 lb)
3PM	158,485 kg (349,400 lb)
3RB, 3RM	155,540 kg (342,900 lb)
Max fuel weight: 200	94,210 kg (207,700 lb)
200ER/300	135,845 kg (299,490 lb)
Max T-O weight:	
2GB, 2PB, 2RB	229,575 kg (506,000 lb)
2GM, 2PM, 2RM	247,205 kg (545,000 lb)
2ERGB, 2ERPB, 2ERRB, 3PB, 3RB	263,080 kg (580,000 lb)
2ERGM, 2ERPM, 2ERRM	297,555 kg (656,000 lb)
3PM, 3RM	299,370 kg (660,000 lb)
Max ramp weight allowance:	
200, 200ERB, 300	907 kg (2,000 lb)
200ERM	454 kg (1,000 lb)
Max landing weight: 200	201,845 kg (445,000 lb)
200ER	213,190 kg (470,000 lb)
300	237,680 kg (524,000 lb)
Max zero-fuel weight: 200	190,510 kg (420,000 lb)
200ER	199,580 kg (440,000 lb)
300	224,525 kg (495,000 lb)
Max wing loading:	
2GB, 3PB, 2RB	536.5 kg/m² (109.88 lb/sq ft)
2GM, 3PM, 2RM	577.8 kg/m² (118.35 lb/sq ft)
2ERGB, 2ERPB, 2ERRB, 3PB, 3RB	614.9 kg/m² (125.95 lb/sq ft)
2ERGM, 2ERPM, 2ERRM	695.5 kg/m² (142.45 lb/sq ft)
3PM, 3RM	699.8 kg/m² (143.32 lb/sq ft)
Max power loading: 2GB	335 kg/kN (3.29 lb/lb st)
2GM	361 kg/kN (3.54 lb/lb st)
2PB	346 kg/kN (3.40 lb/lb st)
2PM	360 kg/kN (3.53 lb/lb st)
2RB	351 kg/kN (3.45 lb/lb st)
2RM	366 kg/kN (3.59 lb/lb st)
2ERGB	349 kg/kN (3.42 lb/lb st)
2ERGM	357 kg/kN (3.50 lb/lb st)
2ERPB	350 kg/kN (3.43 lb/lb st)
2ERPM	371 kg/kN (3.64 lb/lb st)
2ERRB	354 kg/kN (3.47 lb/lb st)
2ERRM	358 kg/kN (3.51 lb/lb st)
3PB, 3RB	328 kg/kN (3.22 lb/lb st)
3PM	343 kg/kN (3.37 lb/lb st)
3RM	374 kg/kN (3.67 lb/lb st)



Boeing 777-200 twin-turbofan high-capacity airliner, with additional side view of -300 stretched version; planned, but not incorporated, optional folding wing shown by broken lines ***(Jane's/Mike Keep)*** 0015648

PERFORMANCE:

Cruising speed: all	M0.84
Approach speed: 200	136 kt (252 km/h; 157 mph)
200ER	138 kt (256 km/h; 159 mph)
300	149 kt (276 km/h; 171 mph)
Initial cruising altitude (ISA + 10°C):	
2GB	12,010 m (39,400 ft)
2GM, 2PB	11,550 m (37,900 ft)
2PM, 2ERGB	11,155 m (36,600 ft)
2RB	11,645 m (38,200 ft)
2RM	11,370 m (37,300 ft)
2ERGM	10,575 m (34,700 ft)
2ERPB	10,820 m (35,500 ft)
2ERPM	10,270 m (33,700 ft)
2ERRB	11,005 m (36,100 ft)
2ERRM	10,455 m (34,300 ft)
3PB	10,975 m (36,000 ft)
3PM	10,425 m (34,200 ft)
3RB	11,245 m (36,900 ft)
3RM	10,395 m (34,100 ft)
Service ceiling, OEI (ISA +10°C):	
2GB	5,515 m (18,100 ft)
2GM	4,724 m (15,500 ft)
2PB	4,940 m (16,200 ft)
2PM	4,877 m (16,000 ft)
2RB	4,816 m (15,800 ft)
2RM	5,365 m (17,600 ft)
2ERGB	3,995 m (13,100 ft)
2ERGM	3,719 m (12,200 ft)
2ERPB	4,359 m (14,300 ft)
2ERPM	3,660 m (12,000 ft)
2ERRB	4,755 m (15,600 ft)
2ERRM	3,749 m (12,300 ft)
3PB	4,572 m (15,000 ft)
3PM	3,719 m (12,200 ft)
3RB	4,816 m (15,800 ft)
3RM	3,505 m (11,500 ft)
T-O field length (30° C): 2GB	2,073 m (6,800 ft)
2GM	2,530 m (8,300 ft)
2PB, 2RB	2,164 m (7,100 ft)
2PM, 2RM	2,576 m (8,450 ft)
2ERGB	2,515 m (8,250 ft)
2ERGM	3,033 m (9,950 ft)
2ERPB	2,591 m (8,500 ft)
2ERPM	3,582 m (11,750 ft)
2ERRB	2,545 m (8,350 ft)
2ERRM	3,140 m (10,300 ft)
3PB	2,759 m (9,050 ft)
3PM	3,292 m (10,800 ft)
3RB	2,667 m (8,750 ft)
3RM	3,734 m (12,250 ft)
Landing field length: 2GB, 2GM	1,570 m (5,150 ft)
2PB, 2PM, 2RB, 2RM	1,555 m (5,100 ft)
2ERGB, 2ERGM	1,616 m (5,300 ft)
2ERPB, 2ERPM, 2ERRB, 2ERRM	1,601 m (5,250 ft)
300	1,844 m (6,050 ft)
Design range:	
2GB	3,985 n miles (7,380 km; 4,585 miles)
2GM	5,145 n miles (9,528 km; 5,920 miles)
2PB	3,955 n miles (7,324 km; 4,551 miles)
2PM	5,070 n miles (9,389 km; 5,834 miles)
2RB	4,100 n miles (7,593 km; 4,718 miles)
2RM	5,210 n miles (9,648 km; 5,995 miles)
2ERGB	5,810 n miles (10,760 km; 6,686 miles)
2ERGM	7,730 n miles (14,315 km; 8,895 miles)
2ERPB	5,695 n miles (10,547 km; 6,553 miles)
2ERPM	7,410 n miles (13,723 km; 8,527 miles)
2ERRB	5,840 n miles (10,815 km; 6,720 miles)
2ERRM	7,665 n miles (14,195 km; 8,820 miles)
3PB	3,880 n miles (7,185 km; 4,465 miles)
3PM	5,710 n miles (10,574 km; 6,570 miles)
3RB	4,050 n miles (7,500 km; 4,660 miles)
3RM	5,955 n miles (11,028 km; 6,852 miles)

UPDATED

Emirates Boeing 777-200 taking off from Dubai ***(Paul Jackson)*** 0526958

BOEING 7E7 DREAMLINER

TYPE: Wide-bodied airliner.

PROGRAMME: Originated in Super Efficient Airliner studies undertaken in 2001-02 in parallel with (then) higher-profile Sonic Cruiser; assumed prominence when latter abandoned in December 2002. Working designation of 7E7 to indicate 'Efficient'; named Dreamliner on 15 June 2003, following public Internet vote. Programme headquarters at Everett.

Airline commitments sought from early 2004 onwards and launch in latter part of that year; configuration freeze in second quarter of 2005; first flight 2007; service entry 2008.

On 15 December 2003, Boeing's Board of Directors approved the start of marketing of the 7E7 in the expectation of receiving sufficient proposals by airlines to warrant a formal launch to the programme during 2004. World market for airliners in the 7E7 class was then estimated as between 2,000 and 3,000 over the following 20 years.

CURRENT VERSIONS: **7E7:** Baseline version; length 56.0 m (184 ft); spam 58.8 m (193 ft); height 17.4 m (57 ft); 200 passengers in three-class layout. Range up to 7,800 n miles (14,445 km; 6,778 miles). MTOW 205,400 kg (452,500 lb).

7E7 SR: Short range. Length and height as 7E7, but span reduced to 51.5 m (169 ft). Total 300 passengers in two classes. Range 3,500 n miles (6,480 km; 3,040 miles). MTOW 136,075 kg (300,000 lb), with variant-specific weight-saving measures employed.

7E7 STR: Stretched; length 62.0 m (203 ft); span and height as 7E7. Some 250 passengers in two-class layout. Range up to 8,300 n miles (15,370 km; 9,550 miles). MTOW 223,000 kg (491,625 lb).

CUSTOMERS: Boeing studies show 20-year market for between 2,000 and 3,000 mid-size airliners of 7E7 class.

DESIGN FEATURES: Intended to replace Boeing 767 and reduce seat/mile costs while providing increased versatility by enabling direct operations into smaller airports, thereby obviating the inconvenience of passenger transfers at hubs.

Efficiency gains of 15 to 20 per cent, compared to Boeing 767, to be achieved by 17 per cent reduction in fuel burn, aerodynamic improvements and airframe weight reduction. Cruising Mach No 0.85.

Low wing configuration with two pylon-mounted turbofans underwing. Sweptback wing with increased sweep at tips, latter partly upturned. Pronounced sweep on fin leading- and trailing-edges.

FLYING CONTROLS: Outboard and inboard ailerons; two-section elevator; single-piece rudder. Three-section spoilers/airbrakes ahead of outboard flaps; two section spoilers/airbrakes ahead of inboard flaps.

STRUCTURE: Up to 65 per cent of airframe built by external suppliers. Some 35 per cent produced in Japan, with Mitsubishi contributing composites wingbox; Kawasaki the intermediate forward fuselage, main landing gear well and wing fixed trailing edge; Fuji responsible for centre wing box and integration of wheelwells. Vought and Alenia team producing 26 per cent, principally centre and rear fuselage sections and tailplane; Boeing producing 35 per cent at Australian, Canadian and US sites (forward fuselage and flight deck at Wichita, wing/fuselage fairings at Winnipeg, wing moving leading– and trailing-edges at Tulsa and Australia, and fin at Frederickson); with 4 per cent unallocated at end of 2003. Composites for ''majority'' of fuselage and wing, predominantly carbon fibre/epoxy but with titanium-graphite (TiGr) laminate in wings. Possible use of new aluminium alloys for smaller structural pieces. Airframe 50 per cent composites by weight; 20 per cent aluminium; 15 per cent titanium; and 10 per cent steel.

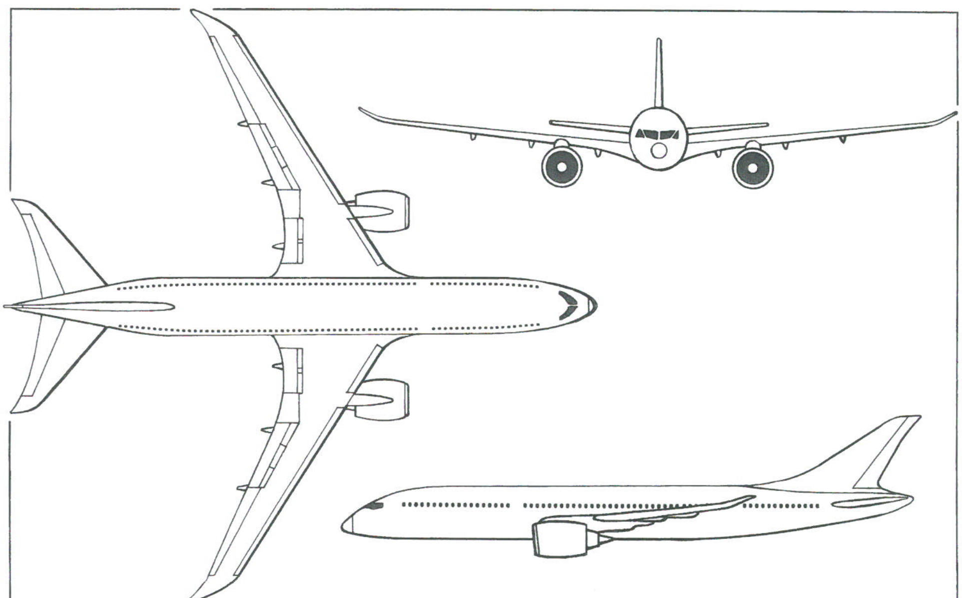
POWER PLANT: Two turbofans, each in 280 to 302 kN (63,000 to 68,000 lb st) class, with bypass ratio between 9 and 12, pressure ratio 50:1 and fan diameter up to 2.92 m (9 ft 7 in). Candidates offered by General Electric, Pratt & Whitney and Rolls-Royce, with two selected as production options. Decision postponed from late 2003 to mid-2004.

ACCOMMODATION: Eight-abreast (two-four-two) seating. Cabin max width 5.74 m (18 ft 10 in). Underfloor hold able to carry LD3 containers two abreast. Cabin equivalent altitude 1,830 m (6,000 ft) with 20 to 30 per cent humidity.

SYSTEMS: Real-time structural monitoring by continuous collection of data from embedded sensors. Variable-frequency electrical system; 350 bar (5,000 lb/sq in) hydraulic system.

NEW ENTRY

Model of Boeing 7E7 Dreamliner *(Paul Jackson)* ***NEW***/0567045



General arrangement of Boeing 7E7 Dreamliner in mid-2003 *(James Goulding)* ***NEW***/0568987

DOUGLAS PRODUCTS DIVISION (Division of Boeing Commercial Airplane Group)

The Douglas Aircraft Company became Douglas Products Division when Boeing absorbed McDonnell Douglas in August 1997. Final MD-80 series, an MD-83, was delivered on 21 December 1999; MD-90 line closed at end of 2000; last MD-11 delivered 22 February 2001. Former MD-95 now marketed as Boeing 717. Having openly questioned the future of the 717, Boeing reconfirmed its commitment to continued production on 13 December 2001, albeit with lower production rate and revised delivery dates.

VERIFIED

BOEING 717

TYPE: Twin-jet airliner.

PROGRAMME:

DEVELOPMENT MILESTONES	
Announced	Jun 91
Prototype construction started	94
Rolled out	10 Jun 98
First flight	2 Sep 98
Certification	1 Sep 99
First delivery (AirTran)	23 Sep 99
Entered service	12 Oct 99

Announced at Paris Air Show 1991 as MD-95; potential airline customers briefed and manufacturing partners announced in Berlin, November 1994; modification of former Eastern Airlines DC-9-30 into development prototype began late 1994; design acquired by Boeing in August 1997 and renamed Boeing 717 in January 1998, re-using model number originally allocated to KC-135A tanker vesion of Boeing 707. Three flight test aircraft (T1, T2 and T3); first nose section (built by MDC) delivered to Huntington Beach on 11 December 1996 for T1, which began final assembly in May 1997 and was rolled out on 10 June 1998. BR 715 engine certified 1 September 1998.

First flight of prototype (N717XA; T1) 2 September 1998; second prototype (N717XB; T2) first flew 26 October 1998; third (N717XC; T3) on 16 December 1998, at which time first two had flown 361 hours in 193 sorties. First production aircraft (N717XD; P1) rolled out 23 January 1999; JAA/FAA certification awarded 1 September 1999 at end of five aircraft, 2,000 hour, 1,900 sortie programme; first aircraft (N942AT; third production) delivered to AirTran on 23 September 1999, after demonstration flights; entered service on Atlanta-Washington, DC, route on 12 October 1999. Updated FMS certified 20 October 2000, adding GPS, fuel prediction, vertical guidance and automatic calculation of V-speeds. CIS certification awarded 20 February 2001. Delivery of 100th effected on 18 June 2002 as 37th for AirTran.

CURRENT VERSIONS: **Boeing 717-200:** Initial production version, *to which following description applies.* Available in basic (**BGW**) and high (**HGW**) gross weight versions.

Boeing 717-100: Proposed 86-seat version, formerly MD-95-20; four frames (1.9 m; 6 ft 3 in) shorter. Renamed **-100X**; wind tunnel tests began in early 2000; revised mid-2000 to eight-frame (3.86 m; 12 ft 8 in) shrink. Launch decision was deferred in December 2000 and again thereafter to an undisclosed date. Reported shelved by mid-2003.

Boeing 717-100X Lite: Proposed 75-seat version, powered by Rolls-Royce Deutschland BR 710 turbofans; later abandoned.

Boeing 717-300X: Proposed stretched version, formerly MD-95-50; studies suggest typical two-class seating for 130 passengers, with overall length increased to 42.16 m (138 ft 4 in) by addition of nine frames (five forward and four aft of wing); higher MTO and space-limited payloads weights; additional service door aft of wing; and 93.4 kN (21,000 lb st) BR 715 C1-30 engines. AirTran has expressed interest in converting some -200 options to this model. Under consideration late 2003 by Star Group (Air Canada, Austrian Airlines, Lufthausa and SAS); interest also reported from Delta, Iberia and Northwest Airlines. If launched, service entry is targeted for second half of 2006.

Boeing 717 Business Express: Corporate version of 717-200, unveiled at EBACE Convention in Geneva, Switzerland, on 7 May 2003. Configurable for 40 to 80 passengers in first and/or business class interior (typically, 60 passengers at 132 cm; 52 in seat pitch). Max range in HGW configuration, with auxiliary fuel and 60 passengers, 3,140 n miles (5,815 km; 3,613 miles). Complements BBJ family.

CUSTOMERS: Manufacturer foresees a market for over 3,000 aircraft in this class over the next 20 years. Launched 19 October 1995 with order for 50, plus 50 options, from ValuJet Airlines (later renamed AirTran), this increasing to 60 before being cut to 51 in 2002. Second

Boeing 717 of Turkmenistan Airlines *(Paul Jackson)* 0526959 customer was Bavaria International Leasing Company (five), followed by TWA (50, plus 50 options, later reduced to 30 orders). During 2001, production was set at five per month, Pembroke Capital (10, later increased to 25) and Hawaiian (13, plus seven options). Boeing delivered 12 in 1999, 32 in 2000, 49 in 2001 and 20 in 2002. By 1 January 2004, orders stood at 161, of which 125 had been delivered, including first for Midwest on 28 February 2003.

COSTS: AirTran order for 50 aircraft worth US$1 billion. January 2001 list price US$35 million per aircraft. Business Express US$27 million, basic; US$31 million in HGW configuration with five auxiliary fuel tanks (2003).

DESIGN FEATURES: All major elements of airframe based on DC-9/MD-80 series; systems and avionics are blend of low cost and advanced technology. Conventional low-wing, rear-engine, T-tail configuration.

Wing from DC-9-34, but with 1° 34′ additional incidence; sweep 24° 30′ at quarter-chord; thickness/chord ratio 11.6.

FLYING CONTROLS: Conventional and partly assisted. Elevator and ailerons are manually actuated via cables; rudder powered hydraulically with manual reversion; fly-by-wire trimming of rudder, two-section spoilers and elevator; three-section, double-slotted flaps; full-span, two-position, five-section leading-edge slats.

STRUCTURE: All-metal, two-spar wing with riveted spanwise stringers; glass fibre trailing-edges on wings, ailerons, flaps, elevators and rudder. Variations from MD-80/MD-90 include thicker skins on tail surfaces; MD-87 fuselage lengthened forward of wing by three frames 1.45 m (4 ft 9 in) and fin tip by 250 mm (10 in); wing/fuselage fillet extended forwards by three frames, using composites structure. Composites also for fuselage tailcone, fintip, elevator and aileron tabs, radome and wing trailing-edge panels; otherwise of 2024T3 aluminium alloy.

Partners are: Alenia (fuselage sections), Korean Air Lines Aerospace Division (nose structure and main passenger door/entry area), KAI (Hyundai) (wings, in conjunction with Boeing Toronto Ltd, which built initial sets of wings for flight test aircraft and early production units), BAE Systems (wing join and underwing barrel) Rolls-Royce Deutschland (power plant), Goodrich (engine nacelles), ShinMaywa Industries Ltd (horizontal tail surfaces and engine pylons), Fischer Advanced Composite Components GmbH (cabin furnishings), Andalucia Aerospacial (slats, landing gear components, aft pressure bulkhead), Israel Aircraft Industries SHL Servo Systems (landing gear), Honeywell (environmental control system, wheels and brakes, (flight guidance and avionics systems), Parker-Hannifin Corp (hydraulic and control systems), AIDC (empennage), Labinal (electric assemblies), Hamilton Sundstrand (electrical power generating system), and (in partnership with Hamilton Sundstrand) Auxiliary Power International Corporation (APU). Final assembly in Long Beach.

LANDING GEAR: Hydraulically retractable tricycle with steerable nosewheels; twin wheels on all legs. All-steel brakes; anti-skid units. Main tyres H41×15.0-19 (24 ply); nose tyres 26×6.6 (12 ply).

POWER PLANT: Two Rolls-Royce Deutschland BR 715 A1-30 turbofans, each 82.3 kN (18,500 lb st) at T-O at 30°C ambient, for 717-200 and Business Express BGW; BR 715 C1-30 of 93.4 kN (21,000 lb st) for 717-200 and Business Express HGW; optional 89.9 kN (20,000 lb st) available; switching between three thrust ratings does not involve engine hardware changes. Integrated drive generators system. Goodrich single-pivot door-type reversers for ground use only. Engine pylon based on MD-80, but thinner and without powered flap, although with extra frame for additional strength.

Standard (BGW) fuel capacity 13,904 litres (3,673 US gallons; 3,058 Imp gallons) in three tanks in wingroots and fuselage centre section. HGW has additional 1,628 litre (430 US gallon; 358 Imp gallon) tank in forward baggage hold and 1,022 litre (270 US gallon; 225 Imp gallon) tank in rear baggage hold for total volume of 16,667 litres (4,403 US gallons; 3,666 Imp gallons). Fuel recirculation system prevents wing upper surface ice accumulation and aids cooling.

ACCOMMODATION: Crew of two on advanced flight deck optimised for reduced parts count and high reliability. Cabin cross-section as for MD-80. Main passenger door, fwd, port, with optional airstair stowage below; service door opposite; aft door on centreline with rearward-facing ramp stairs; two Type III emergency exits overwing on each side. Front and rear underfloor baggage hold doors, starboard. Typical two-class seating for 106 passengers: eight first-class in four-abreast seating with 0.91 m (36 in) pitch and 98 standard class with 0.81 m (32 in) pitch in five-abreast arrangement in new modern cabin, alternatively 117 single-class in 0.79/0.81 m (31/32 in) pitch. Seating designed by Avio Interiors and complies with 16 *g* impact regulations. Cabin designed with inputs from 500 airline executives, flight attendants and passengers; interior, manufactured by Fischer Advanced Composite Components of Austria, features wider and deeper overhead baggage bins, full-grip handrail throughout length of cabin. Two vacuum-operated lavatory units at rear of cabin, plus optional further unit at front for first-class. Galley units positioned at front of cabin. Integral cabin door, with optional airstairs, behind flight deck on port side; emergency exit on opposite side, plus two above each wing. Underfloor baggage and cargo hold; latter reduced in HGW version by auxiliary fuel tanks.

SYSTEMS: Honeywell dual air cycle air conditioning and pressurisation system with digital cabin air controllers, utilising engine bleed air, maximum differential 0.54 bar (7.77 lb/sq in). Three-wheel air cycle machine and modified water separator in rear fuselage. Two separate 207 bar (3,000 lb/sq in) hydraulic systems for operation of spoilers, flaps, slats, rudder, landing gear, nosewheel steering, brakes, thrust reversers and ventral stairway. Maximum flow rate 30.3 litres (8.0 US gallons; 6.7 Imp gallons)/min. Airless bootstrap-type reservoirs, output pressure 2.07 bar (30 lb/sq in). Pneumatic system, for air conditioning/pressurisation, engine starting and ice protection, utilises engine bleed air and/or APU. Electrical system includes two 35/40 kVA integrated drive generators, plus 60 kVA APU generator. Oxygen system of diluter demand type for crew on flight deck; continuous flow chemical canister type with automatic mask presentation for passengers. Anti-icing of wing, engine inlets and tailplane by engine bleed air. Electric windscreen de-icing. Thermal anti-icing of leading-edges. APIC APS 2100 APU.

AVIONICS: Honeywell Versatile Integrated Avionics VIA 2000 computer as core avionics management system; full Cat. IIIa capability will be upgraded later to IIIb with addition of radar altimeter, ILS receiver and inertial reference unit, SFE ARINC 700 avionics.

Flight: Honeywell flight management system (FMS), inertial reference system (IRS), digital flight guidance system (DFGS), digital air data computer and windshear detection system. To be certified for Cat. IIIb automatic landings. Flight computer system upgraded and certified 20 October 2000; changes include improved GPS.

Instrumentation: Six-tube EFIS with 203 × 203 mm (8 × 8 in) LCD screens providing navigation, flight management and systems data. Flight deck features include MD-11 AFCS with glareshield-mounted controls enabling crew to fly the aircraft automatically with only push-button and thumbwheel inputs. Simplified integrated flightcrew warning and alerting panel (IFWAP) overhead control panel with four LCDs replacing 13 gauges, meters and switch panels. Central fault display system for reduced maintenance time.

DIMENSIONS, EXTERNAL:

Wing span	28.45 m (93 ft 4 in)
Wing chord: at root	5.44 m (17 ft 10 in)
at tip	1.12 m (3 ft 8 in)
Wing aspect ratio	8.7
Length: overall	37.80 m (124 ft 0 in)
fuselage	34.34 m (112 ft 8 in)
Fuselage max width	3.34 m (10 ft 11½ in)
Height overall: at OWE	9.04 m (29 ft 8 in)
at MTOW	8.76 m (28 ft 9 in)
Tailplane span	11.23 m (36 ft 10 in)
Wheel track	4.88 m (16 ft 0 in)
Wheelbase	17.60 m (57 ft 8¾ in)
Distance between engine centrelines	6.60 m (21 ft 8 in)
Passenger door (fwd, port):	
Height	1.83 m (6 ft 0 in)
Width	0.86 m (2 ft 10 in)
Height to sill: at OWE	2.46 m (8 ft 1 in)
at MTOW	2.21 m (7 ft 3 in)
Aft door (centreline):	
Height	1.83 m (6 ft 0 in)
Width	0.70 m (2 ft 3¾ in)
Height to sill: at OWE	2.01 m (6 ft 7 in)
at MTOW	1.83 m (6 ft 0 in)
Service door (fwd, stbd):	
Height	1.22 m (4 ft 0 in)
Width	0.69 m (2 ft 3 in)
Height to sill: at OWE	2.46 m (8 ft 1 in)
at MTOW	2.21 m (7 ft 3 in)
Emergency exits (above wings, two per side):	
Height	0.91 m (3 ft 0 in)
Width	0.51 m (1 ft 8 in)
Height to sill: at OWE	2.87 m (9 ft 5 in)
at MTOW	2.77 m (9 ft 1 in)
Baggage door: forward:	
Height	1.27 m (4 ft 2 in)
Width	1.34 m (4 ft 4¾ in)
Height to sill: at OWE	1.30 m (4 ft 3 in)
at MTOW	1.09 m (3 ft 7 in)
rear:	
Height	1.27 m (4 ft 2 in)
Width	0.91 m (3 ft 0 in)
Height to sill: at OWE	1.35 m (4 ft 5 in)
at MTOW	1.17 m (3 ft 10 in)

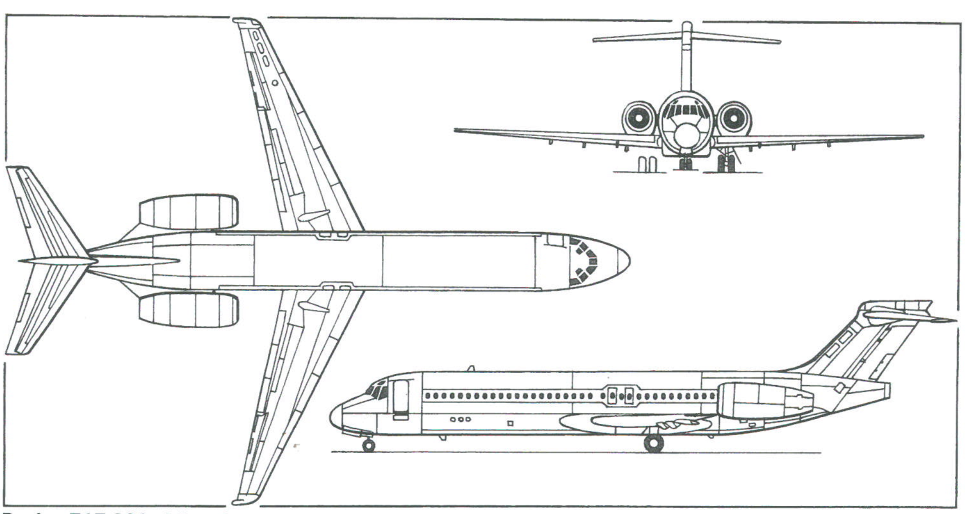
DIMENSIONS, INTERNAL (BGW: standard, HGW: with extended-range tanks):

Cabin: Length	23.44 m (76 ft (11 in)
Max width	3.33 m (10 ft 11 in)
Width at floor	3.12 m (10 ft 3 in)
Height at aisle	2.03 m (6 ft 8 in)
Underfloor baggage/freight hold:	
BGW: front:	
Length	11.04 m (36 ft 2½ in)
Height	0.99 m (3 ft 3 in)
Volume	18.3 m^3 (646 cu ft)
rear: Length	5.21 m (17 ft 1 in)
Height	0.99 m (3 ft 3 in)
Volume	8.2 m^3 (289 cu ft)
HGW:	
front: Volume	14.9 m^3 (527 cu ft)
rear: Volume	5.7 m^3 (203 cu ft)
Business Express total volume:	
BGW	34.1 m^3 (1,204 cu ft)
HGW	19.9 m^3 (703 cu ft)

BOEING 717-200 ORDERS AND DELIVERIES
(at 1 January 2004)

Customer	First Order	First Delivery	Qty
Aerolineas de Baleares	16 May 00	22 Jun 00	3
AirTran	19 Oct 95	23 Sep 99	57
Bavaria International	4 May 98	29 Dec 99	5
Hawaiian Airlines	1 Mar 00	28 Feb 01	13
Impulse Airlines	29 Dec 00	29 Dec 00	3
Midwest Airlines	15 Apr 02	28 Feb 03	25
Pembroke Capital	31 Dec 98	17 Aug 00	26
Turkmenistan Airlines	25 Jul 00	31 Jul 01	5
TWA	31 Dec 98	18 Feb 00	24
Total			**161**

Notes: Quantities are cumulative. AirTran ordered 'up to 10' more 1 July 2003



Boeing 717-200 airliner (two Rolls-Royce Deutschland BR 715 turbofans) ***(James Goulding)*** 0126948

AREAS:
Wings, gross 92.97 m² (1,000.7 sq ft)

WEIGHTS AND LOADINGS (BGW: standard, HGW: with extended-range tanks):
Operating weight empty: BGW 30,618 kg (67,500 lb)
HGW 31,071 kg (68,500 lb)
Basic operating weight, Business Express:
BGW 31,071 kg (68,500 lb)
HGW 32,146 kg (70,870 lb)
Max structural payload: BGW 12,020 kg (26,500 lb)
Business Express BGW: 11,567 kg (25,500 lb)
HGW 14,515 kg (32,000 lb)
Business Express HGW: 13,440 kg (29,630 lb)
Max fuel weight: BGW 11,162 kg (24,609 lb)
HGW 13,381 kg (29,500 lb)
Fuel for max payload:
Business Express BGW: 5,738 kg (12,650 lb)
Business Express HGW: 9,435 kg (20,800 lb)
Max T-O weight: BGW 49,895 kg (110,000 lb)
HGW 54,885 kg (121,000 lb)
Max ramp weight: BGW 50,349 kg (111,000 lb)
HGW 55,340 kg (122,000 lb)
Max landing weight: BGW 45,359 kg (100,000 lb)
HGW 49,895 kg (110,000 lb)
Max zero-fuel weight: BGW 42,638 kg (94,000 lb)
HGW 45,586 kg (100,500 lb)
Max wing loading: BGW 536.7 kg/m² (109.92 lb/sq ft)
HGW 590.4 kg/m² (120.92 lb/sq ft)
Max power loading: BGW 303 kg/kN (2.97 lb/lb st)
HGW 294 kg/kN (2.88 lb/lb st)

PERFORMANCE:
Max limiting Mach No (MMO) 0.82
Max operating speed (VMO) at FL 260
340 kt (629 km/h; 391 mph)
Normal cruising speed:
BGW, HGW 438 kt (811 km/h; 504 mph) (M0.77)
Approach speed: BGW 132 kt (244 km/h; 152 mph)
HGW 139 kt (257 km/h; 160 mph)
Initial cruise altitude, MTOW, ISA +10°C:
BGW 10,424 m (34,200 ft)
HGW 9,815 m (32,200 ft)
Max certified altitude 11,280 m (37,000 ft)
Service ceiling, OEI: BGW 5,365 m (17,600 ft)
HGW 4,360 m (14,300 ft)
T-O field length at MTOW, S/L, ISA +10°C:
BGW 1,677 m (5,500 ft)
HGW 1,753 m (5,750 ft)
Landing field length at MLW: BGW 1,418 m (4,650 ft)
HGW 1,524 m (5,000 ft)
Max range at FL342, domestic reserves, 106 passengers and baggage:
BGW 1,430 n miles (2,648 km; 1,645 miles)
HGW 2,060 n miles (3,815 km; 2,370 miles)
Range, Business Express:
30 passengers:
BGW 2,180 n miles (4,037 km; 2,508 miles)
HGW 3,330 n miles (6,167 km; 3,832 miles)
60 passengers:
BGW 2,060 n miles (3,815 km; 2,370 miles)
HGW 3,140 n miles (5,815 km; 3,613 miles)
80 passengers:
BGW 1,980 n miles (3,667 km; 2,278 miles)
HGW 2,770 n miles (5,130 km; 3,187 miles)

OPERATIONAL NOISE LEVELS (ICAO Annex 16 Ch 3)::
717/200: T-O with cutback 81.4 dB
Approach 91.4 dB
Sideline 89.2 dB
Business Express:
T-O: BGW 80.4 EPNdB
HGW 82.1 EPNdB
Approach: BGW 91.6 EPNdB
HGW 91.5 EPNdB
Sideline: BGW 91.4 EPNdB
HGW 91.6 EPNdB

UPDATED

PHANTOM WORKS

PRESIDENT: George Muellner
MANAGER, MEDIA RELATIONS: David Phillips
Tel: (+1 314) 232 13 72

Tasked with improving Boeing's competitive position through use of innovative technologies, improved processes and creation of new products, the Phantom Works was originally established by McDonnell Douglas at St Louis. Technologies and expertise have expanded in support of company-wide activities, including commercial transport aircraft; this division had workforce of 4,700 in January 2003, with personnel at every major Boeing facility.

Phantom Works activities are spread over six sites: Huntsville (operations analysis, advanced military aircraft and missiles, manufacturing technology & prototyping and advanced support concepts), Mesa (advanced rotorcraft), Philadelphia (advanced rotorcraft), Seattle (advanced commercial aircraft and information & engineering technology), Southern California (advanced tankers and transports; space and communications) and St Louis (computing technology).

In addition to the programmes described below in detail, Phantom Works is also involved with Naval Unmanned Combat Air Vehicle (UCAV-N), Solar Orbit Transfer Vehicle, X-31A Vector, X-37 Reusable Spaceplane, X-40 Space Maneuver Vehicle, X-43 Hyper-X and X-45 UCAV.

UPDATED

BOEING BLENDED WING BODY LARGE COMMERCIAL TRANSPORT

TYPE: New-concept airliner.

PROGRAMME: In 1996, shortly before absorption by Boeing, McDonnell Douglas released details of the BWB-1-1 (blended wing body) study giving the most comprehensive analysis yet of the flying wing's advantages for very large transports. At least half-a-dozen derivatives under consideration at the beginning of 2002, ranging in passenger capacity from 180 to 570. An earlier incarnation, capable of carrying 800 passengers over a 7,000 n mile (12,964 km; 8,055 mile) range, gave benefits that included a 15.2 per cent reduction in T-O weight and 12.3 per cent less empty weight; 27.5 per cent reduction in fuel burn; 27.0 per cent reduction in installed thrust; and 20.6 per cent better lift:drag. These are achieved by increasing wing area by 27.9 per cent (reducing loading by 33.6 per cent) and having a 19.2 per cent greater span. Tests of a radio-controlled 5 m (17 ft) span scale BWB-1-1 were undertaken by Stanford University, California, at El Mirage dry lake in July 1997 as part of a US$2.3 million programme to evaluate flight control laws for a flying wing. Working in tandem with Cranfield Aerospace, Boeing expects to test a 17 per cent scale low-speed vehicle in the UK and the USA. Expected to fly for the first time in early 2004, this will have a span of about 9.15 m (30 ft), three small engines and a slightly redesigned planform incorporating a cranked-arrow wing leading-edge. In addition to flight testing, it will probably also undergo wind tunnel testing at NASA Langley, Virginia, or Ames, California.

One potential application is a BWB tanker for multipoint aerial refuelling. Equipped with three 'smart' booms, two hose/drogue refuelling points and automated refuelling capabilities, BWB tanker would be able to accommodate simultaneous air-to-air refuelling of multiple conventional aircraft or UAVs. Fuel carried in wing tanks; maximum payload space would be available for up to 23 conventional pallets and 40 troops.

As a C² ISR (command, control, intelligence, surveillance, reconnaissance) platform, the BWB would provide increased loiter time, large interior space suitable for battle management control rooms, and ample exterior locations for conformal phased-array antennas for broadband communications with no increase in radar signature. These capabilities make the BWB additionally suitable as a long-range standoff weapons platform.

Several possible BWB derivatives have emerged as candidates for production, including the **BWB-250**, with accommodation for about 260 passengers, and the **BWB-450** with room for about 480 passengers. *Estimated data below refer to the 800-seat Boeing BWB-1-1 proposal powered by three 275 kN (61,900 lb st) turbofans.*

DIMENSIONS, EXTERNAL:
Wing span: excl winglets 85 m (280 ft)
incl winglets 88 m (289 ft)
Wing aspect ratio 5.1
Length overall 49 m (161 ft)
Height overall 15 m (50 ft)

AREAS:
Wings: trap 728 m² (7,840 sq ft)
gross 1,423 m² (15,325 sq ft)

WEIGHTS AND LOADINGS:
Weight empty 167,750 kg (369,800 lb)
Weight empty, equipped 186,900 kg (412,000 lb)
Max payload 104,800 kg (231,000 lb)
Max fuel weight 122,500 kg (270,000 lb)
Max T-O weight 373,300 kg (823,000 lb)
Max zero-fuel weight 291,650 kg (643,000 lb)
Fuel burn over 7,000 n miles with 800 passengers
96,820 kg (213,450 lb)
Max wing loading 513 kg/m² (105 lb/sq ft)
Max power loading 452 kg/kN (4.4 lb/lb st)

PERFORMANCE:
Normal cruising speed M0.85
Max approach speed 150 kt (278 km/h; 173 mph) EAS
Initial cruising altitude 10,665 m (35,000 ft)
T-O field length 3,353 m (11,000 ft)
Range with 800 passengers
7,000 n miles (12,964 km; 8,055 miles)

UPDATED

BOEING X-50A DRAGONFLY CANARD ROTOR/WING

TYPE: New-concept rotorcraft.

PROGRAMME: The X-50A Canard Rotor/Wing (CR/W) began as a McDonnell Douglas Helicopters project for a VTOL reconnaissance and surveillance UAV in 1992; concept based on NASA-funded studies into high-speed rotorcraft and earlier (Hughes) rotor/wing studies. Design undertaken by Phantom Works personnel at Mesa, Arizona, under a March 1998 DARPA contract calling for the manufacture and testing of two prototypes. US Marine Corps is reported to have expressed interest in a manned version armed with missiles and other weaponry for use in the escort role.

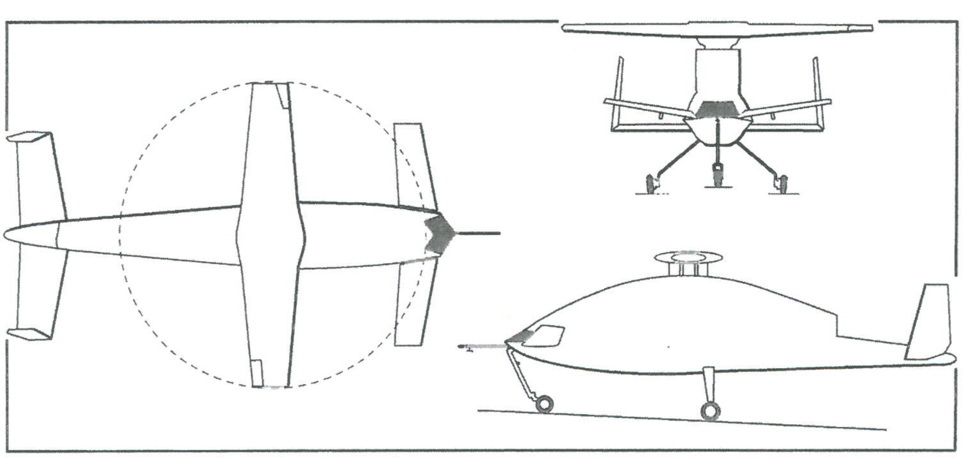
As currently envisaged, it will possess VTOL attributes of the helicopter and the ability to fly like a conventional fixed-wing aircraft, with the addition of foreplanes being a key factor in bestowing this potential. Power will be provided by a single turbofan engine. In helicopter mode, exhaust gases will pass through channels in the two-blade rotor before exiting through vents in the blade tips. In aeroplane mode, as speed increases, exhaust efflux progressively transfers from driving the rotor to a nozzle at the rear, thus providing forward thrust.

With no tail rotor, directional control in helicopter mode will rely on what Boeing calls 'reaction drive', in which exhaust gases are diverted to nozzles on both sides of the tail; for aeroplane mode, conventional control surfaces will be provided, although consideration is being given to employing reaction jets for directional control in both modes of flight.

Following vertical take-off as a helicopter, the CR/W will accelerate to about 122 kt (225 km/h; 140 mph) before making the transition to aeroplane. This will be accomplished with the assistance of flap surfaces on the foreplanes and the aft-mounted wings. These will increase the amount of lift generated by the wings and reduce rotor loadings, whereupon the rotor will be slowed to a stop before being locked in position across the fuselage to act as an extra lifting surface. The flaps will then be retracted, with the three lifting surfaces sharing the load. For landing, the process will be reversed, enabling the CR/W to operate safely from confined areas, such as a carrier deck or helicopter platform. In conventional aeroplane mode, maximum speed is predicted to exceed 375 kt (695 km/h; 432 mph).

Initial research to include studies into ways and means of using exhaust gases to perform multiple functions, with US$21 million allocated jointly by Boeing and DARPA to pay for a three-year research effort. Boeing's Mesa facility is leading the project and had responsibility for assembly; further support provided by Boeing sites in Philadelphia and St Louis.

Initial technology demonstrator to be a subscale, unmanned aerial vehicle (UAV); first X-50A prototype



General arrangement of the Boeing X-50A Dragonfly demonstrator ***(Paul Jackson)*** ***NEW***/0546966 was to have flown in 2001, but postponed; roll-out May 2002; maiden flight expected in mid-2003, following discovery of high cyclic loads during ground testing that necessitated repairs to rotor bearings as well as adoption of a modified swashplate design and use of steel instead of aluminium for greater stiffness. Total of 11 flights planned in three months, with test vehicle not to exceed 150 kt (278 km/h; 172 mph). X-50A will take-off vertically and operate as helicopter up to 60 kt (111 km/h; 69 mph), when canard and stabiliser begin to provide lift; transition to conventional wing-borne flight will occur at 130 kt (241 km/h; 150 mph). X-50A prototype is powered by a 3.11 kN (700 lb st) Williams F112 turbofan. Any subsequent production CR/W is likely to use advanced composites materials and be built in both manned and unmanned versions; Boeing studies include a 1,100 kg (2,425 lb) maritime UAV and a 10,000 to 11,000 kg (22,046 to 24,250 lb) manned aircraft that could function as an armed escort fighter in support of the MV-22B Osprey.

DIMENSIONS, EXTERNAL:

Wing span/rotor diameter	3.66 m (12 ft 0 in)
Foreplane span	2.71 m (8 ft 10¾ in)
Length overall	5.39 m (17 ft 8 in)
Height overall	1.98 m (6 ft 6 in)
Tail unit span	2.47 m (8 ft 1¼ in)

WEIGHTS AND LOADINGS:

Weight empty	574 kg (1,265 lb)
Fuel weight	66 kg (146 lb)
Max payload	91 kg (200 lb)
Max T-O weight	645 kg (1,423 lb)

PERFORMANCE (estimated):

Max level speed	150 kt (278 km/h; 172 mph)

UPDATED

BOEING ADVANCED TACTICAL TRANSPORT

TYPE: Medium transport/multirole.

PROGRAMME: Design study revealed by McDonnell Douglas (now Boeing) in September 1996 for a potential replacement for the Lockheed Martin C-130 Hercules. Original study envisaged aircraft with four 8,950 kW (12,000 shp) turboprops fixed to wing, which tilted 15° for take-off and 45° for landing; potential in-service date of 2020. Those studies provided basis for No-Tail Advanced Theater Transport (NOTAIL ATT) Tilt-wing Super Short Takeoff and Landing (SSTOL) or 'Super Frog' as project was originally known. Advanced Medium Transport (AMT) name adopted by mid-2002, although had evolved further, into Advanced Tactical Transport (ATT), by early 2003.

Concept revealed in September 1998, with 39 m (128 ft) span aircraft designed to carry up to four times the payload of the C-130J Hercules and use runways as short as 183 m (600 ft). Baseline requirement is delivery of 27,215 kg (60,000 lb) load on to 229 m (750 ft) of rough airstrip, 1,220 m (4,000 ft) AMSL in 35°C (95°F) ambient temperature. Signature of co-operative research and development agreement (CRADA) between Boeing's Phantom Works and USAF Research Laboratory at Wright-Patterson AFB, Ohio, in December 1998 paved way for development and demonstration of 'enabling technologies' that could lead to production-configured aircraft; subsequently, in late 2000, Boeing also concluded development agreement with DARPA.

Fuselage interior width is 6.4 m (21 ft) and proposed ATT will be able to accommodate various loads up to a maximum of about 36,285 kg (80,000 lb), including one AH-64 Apache or two RAH-66 Comanche helicopters; or up to 10 cargo pallets; or 40 fully equipped soldiers. Wing features four widely separated podded turboprop engines in the 8,950 kW (12,000 shp) class, each driving eight-blade propeller. Wing originally pivoted about lateral axis near rear spar, with tilt used to increase lift during take-off and landing. Directional control of tail-less design uses similar system to B-2 bomber, which has split flaps. By early 2000, however, design had progressed to forward-swept (7 to 9°) wing, pivoted at leading-edge and tilting downwards at trailing-edge, with further refinements by second quarter of 2001 adding small horizontal tail surfaces and adopting C-17-style fuselage.

Initial wind tunnel testing of subscale model completed by end of 1998, followed by further trials with a 7 per cent subscale model during 1999; latter included tethered and untethered tests which began at Gray Butte, California, on 5 June. Further wind tunnel testing of latest configuration completed in January 2001, with Boeing planning to conduct manned simulations and powered wind tunnel tests with larger models in 2001-03. In first quarter of 2003, Boeing revealed that it was considering resurrecting a McDonnell Douglas YC-15 prototype and modifying it to serve as a tilt-wing technology demonstrator. The most significant alterations would involve installation of a forward-cranked wing that could rotate the trailing-edge downwards by up to 20° and the switch from turbofan to turboprop engines. If it goes ahead, the demonstrator could be flying in early 2005, with the primary objectives of proving the viability of the tilt-wing super STOL transport aircraft concept and of validating use of cyclic controls on a fixed-wing aircraft.

If project is proceeded with, Boeing optimistic that production aircraft could be operational in 2015, with ATT a potential candidate for USAF MC-X special operations aircraft requirement.

UPDATED

SHARED SERVICES GROUP

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Shared Services Group provides information management services and computing resources to Boeing operating divisions and government customers on a worldwide basis.

VERIFIED

BOEING BUSINESS JETS

BOEING BUSINESS JETS

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PARTICIPATING COMPANIES:

Boeing Company: see this entry

General Electric Company: see *Jane's Aero Engines*

In July 1996 The Boeing Company and The General Electric Company announced formation of a joint venture, Boeing Business Jets, to develop and market corporate versions of the Next-Generation 737, deliveries of which began in 1998.

Company headquarters is at the corporate air services facility of Boeing Field's Flight Center.

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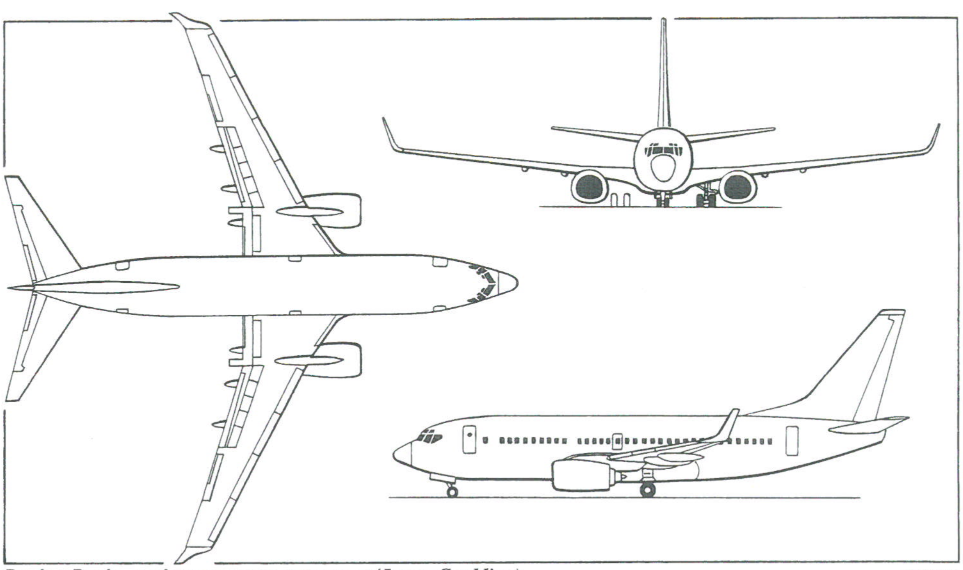


Boeing Business Jet corporate transport ***(James Goulding)*** 0100433

BOEING BUSINESS JET (BBJ)

US Air Force designations: C-40B and C-40C

TYPE: Large business jet.

PROGRAMME: Launched July 1996. Aircraft are assembled at Boeing Commercial Airplane Group's Renton facility and supplied to Boeing Business Jets, which hands them over in 'green' condition to customers and delivers them to DeCrane Aircraft at Georgetown, Delaware, for installation of long-range fuel tanks before the aircraft are delivered to the customer's chosen completion centre for interior outfitting and painting; designated completion centres are DeCrane Aircraft and Associated Air Center in Dallas, Texas; Greenpoint Technologies in Seattle, Washington; Ozark Aircraft Services in Bentonville, Arkansas; Lufthansa Technik in Hamburg, Germany; and Jet Aviation in Basle, Switzerland, but other completion centres may be used at the discretion of the customer. After completion, Boeing ferries the aircraft to the customer's base and carries out crew training.

First BBJ (101st N-G 737, N737BZ) rolled out 26 July 1998; first flight 4 September 1998; FAA and JAA certification achieved 29 October 1998; supplementary type certificate for long-range tanks awarded 20 May 1999, following demonstration non-stop flight of 6,252.5 n miles (11,580 km; 7,200.4 miles) in 13 hours 57 minutes 42 seconds.

US Air Force ordered first of up to seven C-40Bs in February 2001 to replace Air National Guard C-22s (Boeing 727s) from August 2003 onwards. Initial aircraft (01-0005) completed late 2002. C-40C designation assigned to two former Ford Air Services BBJs acquired in mid-2002 as (02-0201 and -0202) and nominally operated by BCC Equipment Leasing Corp. C-40B has typical accommodation for 11 crew and 26 passengers.

CUSTOMERS: Peak of 85 firm orders by December 2001, at which time 67 'green' airframes had been delivered and 43 completed aircraft were in customer service. By mid-2003 total of 73 BBJs and nine BBJ 2s on order including two BBJs in first half 2003. By October 2003, 83 BBJ/BBJ2s sold and same number delivered, of which 68 outfitted and in service. Launch customer General Electric ordered two in July 1996, of which first (N366G) flew 23 October 1993 and delivered 23 November 1998 for outfitting. First delivery of a completed aircraft to Dubai Air Wing Royal Flight 4 September 1999. Table of customers and deliveries accompanies this entry.

Boeing Business Jet operated by EJA ***(Paul Jackson)*** ***NEW***/0567966

BBJ/BBJ 2 CUSTOMERS

c/n	Model	Registration	Owner
28579	-75V	N367G	General Electric Company
28581	-75V	N366G	General Electric Company
28976	-75U	VP-BRM	Dobro Ltd
29024	-72T	N50TC	Tracinda Corp
29054	-73T	N500LS	Hayes Productions
29102	-73Q	N737BZ	BCC Equipment Leasing
29135	-74Q	N737CC	Wells Fargo Bank
29136	-74Q	N737GG	Wells Fargo Bank
29139	-74T	N21KR	Wells Fargo Bank
29142	-75T	N737WH	First Union Commercial Corp
29149	-7H3	TS-IOO	Government of Tunisia
29188	-7P3	HZ-TAA	HRH Talal bin AbdulAziz
29200	-73U	N742PB	Chartwell Partners
29233	-74U	N4AS	BA Leasing & Capital
29251	-7EO	A6-HRS	Dubai Air Wing
29268	-7Z5	A6-AIN	Government of Abu Dhabi
29269	-7Z5	A6-RJZ	Government of Abu Dhabi
29272	-74V	N7378P	Raytheon Company
29273	-72U	VP-BBJ	Picton II (Switzerland)
29274	-7H6	M53-01	Malaysian Air Force
29317	-79T	VP-BWR	BEL Air
29441	-79U	N1011N	Aircraft Holdings
29749	-7AH	N134AR	BB Five Inc
29791	-7BH	P4-TBN	Tango Holding
29857	-7Z5	A6-LIW	Government of Abu Dhabi
29858	-7Z5	A6-DAS	Government of Abu Dhabi
29865	-7AK	HB-IIO	Privat Air
29866	-7AK	HB-IIP	Privat Air
29971	-7DM	01-0040	US Air Force
29972	-7AN	VP-BYA	Eastern Skies
30031	-7AW	VP-CEC	BB Aviation
30070	-7AV	N889NC	Wells Fargo Bank
30076	-7BJ	VP-BBW	GAMA Aviation
30327	-7BC	N127QS	Wells Fargo Bank
30328	-7BC	N164RJ	Wells Fargo Bank
30329	-7BC	N129QS	Wells Fargo Bank
30330	-7BC	VP-BJB	Sigair
30496	-7BF	N180AD	Fun Air Corp
30547	-7BQ	HZ-DG5	Dallah al Bakara
30572	-7BC	N171QS	Wells Fargo Bank
30751	-7CG	P4-GJC	GKW Aviation
30752	-7CN	D-ABPA	Privat Air
30753	-7CP	02-0202	US Air National Guard
30754	-7CJ	N737ER	BBJ One Inc
30755	-7CP	02-0201	US Air Force National Guard
30756	-7BC	N156QS	Wells Fargo Bank
30772	-7CU	N315TS	State Street Bank & Trust
30782	-7BC	N515GM	Kevin Air
30789	-73Q	N349BA	Boeing Aircraft Holding Inc
30791	-7BC	N191QS	BNJ Sales
30790	-7DT	A36-002	Royal Australian Air Force
30829	-7DT	A36-001	Royal Australian Air Force
30884	-7BC	N184QS	Boeing
32438	-8AN	VP-BHN*	Eastern Skies
32450	-8EC	A6-MRM*	Government of Abu Dhabi
32451	-8DP	HZ-101*	Saudi Air Force
32575	-7BC	N182QS	EJA
32627	-7ED	ZS-RSA	South African Government
3228	-7BC	N7600K	SAS Institute
32774	-7EJ	XA-AEX	Omniflys
32775	-7EL	N90R	Swiftlite Aircraft Corp
32777	-8DR	G-OBBJ*	Multi Flight Ltd
32805	-7DP	HZ-102	Saudi Air Force
32806	-8AW	VP-CBB*	Bosco Aviation
32807	-7EG	HL-7770	Samsung Aerospace Industries
32915	-8DV	VP-BZL*	BZL Ltd
32916	-7DM	01-0015	US Air Force
32970	-7BC	N707BZ	Boeing
32971	-8EF	N371BC*	Boeing
33010	-7ET	N313P	Premier Executive Transport Services
33102	-7BC	N108MS	Sabra Aviation
33036	-7BC	N888YV	Aviation Air
33079	-8EV	N375BC*	Boeing
33080	-7DM	01-0005	US Air Force
33361	-8EQ	N7375P*	Wells Fargo Bank
33367	-7FB	N377JC	Boeing
33405	7FG	HZ-MF1	Saudi Ministry of Finance
33434	-7BC	N109QS	Boeing
33473	-8EX	N379BC*	Boeing
33474	-7ES	N378BC	Boeing (for Australia)
33499	-7AJ	HZ-MF2	Saudi Ministry of Finance
33500	-7FD	N357BJ	Boeing
33542	-7AJ	N358BJ	Boeing (for Australia)

Note: Some aircraft have subsequently been sold
* BBJ 2

BBJ/BBJ 2 ORDERS AND DELIVERIES

Year	BBJ orders	BBJ deliveries	BBJ 2 orders	BBJ 2 deliveries
1996	3			
1997	25		1	
1998	17	7		
1999		25		
2000	6	10	3	6
2001	14	13	4	
2002	6	4		1
Totals	**71**	**59**	**8**	**7**

The BBJ has been proposed for USAF's Commander-in-Chief (CINC) support aircraft requirement.

COSTS: US$40 million 'green', estimated US$49 million to 54 million typically equipped (2002). Direct operating cost estimated at US$1,700 per hour based on operation within the USA and utilisation of 900 hours per year.

DESIGN FEATURES: Combines fuselage of 737-700, strengthened in aft section, with centre-section, wing and landing gear of 737-800. Aviation Partners Inc winglets standard, affording 5 to 7 per cent reduction in cruise drag, resulting in four to five per cent increase in range; winglets evaluated in mid-1998 by 737-800 (N737BX), first flown on BBJ prototype (N737BZ) on 20 February 1999, received FAA approval on 6 September 2000 and fitted as standard.

POWER PLANT: Two CFM International CFM56-7 turbofans, each rated at 121.4 kN (27,300 lb st). Standard N-G 737 fuel of 26,025 litres (6,875 US gallons; 5,725 Imp gallons) contained in wing, plus between three and nine belly tanks; maximum combined capacity 40,582 litres (10,721 US gallons; 8,927 Imp gallons).

ACCOMMODATION: To customer's choice; operating weights based on allowance of 5,624 kg (12,400 lb). Typical configuration includes forward lounge and private suite with double bed; mid-section conference room; 12 first class sleeper seats at 152 cm (60 in) pitch in two rows with centre aisle, and galley, lavatory and service area at rear, with crew rest area, galley and lavatory aft of flight deck. Alternative arrangements provide for exercise room/gymnasium, office, 24 first-class sleeper seats or high-density seating for up to 63 passengers, three abreast in two rows. Maximum 149 passengers in airline configuration. Cabin equivalent altitude reduced to 1,980 m (6,500 ft) from 2004, with retrofit available.

AVIONICS: Rockwell Collins Series 90 as core system.

Comms: Triple VHF comm with 8.33 kHz channel spacing; dual HF comm; L-3 Communications 120-minute CVR and Coltech Selcal.

Flight: Dual Rockwell Collins multimode GPS/ILS/VOR/DME receivers; dual ADF; TCAS II; predictive windshear; dual Smiths Industries flight management computers; dual Honeywell ADIRU; Honeywell EGPWS; L-3 Communications FDR and CVR; Flight Dynamics HGS 4000 head-up guidance system; Teledyne airborne navigation data recorder, digital flight data acquisition unit and quick-access recorder; Teledyne Navlink, including two additional navigation computers and electronic standby artificial horizon.

Instrumentation: Honeywell flat-panel LCD displays.

Mission: Optional Teledyne Telelink. C-40B equipment includes fibre-optic communications management system; worldwide secure voice and data transmission (UHF, VHF, HF, UHF and commercial satcom, Magnastar airphones, UHF/AM, Boeing Connexion data/video Broadband, secure conferencing and Wideband data and LAN.

DIMENSIONS, EXTERNAL AND AREAS: As for 737-700 except:
Wing span, incl winglets 35.79 m (117 ft 5 in)

DIMENSIONS, INTERNAL:
Cabin: Length 24.13 m (79 ft 2 in)
Height 2.16 m (7 ft 1 in)
Width 3.53 m (11 ft 7 in)
Floor area 75.0 m² (807 sq ft)
Volume 148.7 m³ (5,250 cu ft)

WEIGHTS AND LOADINGS:
Operating weight empty, typically equipped 43,082 kg (94,980 lb)
Interior completion allowance 5,625 kg (12,400 lb)
Max fuel weight (incl supplementary tanks) 32,825 kg (72,367 lb)
Max T-O weight 77,565 kg (171,000 lb)
Max ramp weight 77,790 kg (171,500 lb)
Max landing weight 60,780 kg (134,000 lb)
Max zero-fuel weight 57,155 kg (126,000 lb)
Max wing loading 620.5 kg/m² (127.09 lb/sq ft)
Max power loading 320 kg/kN (3.14 lb/lb st)

PERFORMANCE:
Max operating Mach No. (MMO) 0.82
Cruising speed: normal M0.80
long range M0.79
Approach speed 132 kt (244 km/h; 152 mph)
Max rate of climb 980 m (3,215 ft)/min
Initial cruising altitude 11,580 m (38,000 ft)
Max certified altitude 12,500 m (41,000 ft)
Service ceiling, OEI 7,070 m (23,200 ft)
T-O field length, S/L:
fuel for range of 4,000 n miles (7,408 km; 4,603 miles) 1,369 m (4,490 ft)
fuel for range of 5,000 n miles (9,260 km; 5,754 miles) 1,515 m (4,970 ft)
fuel for range of 6,000 n miles (11,112 km; 6,905 miles) 1,765 m (5,790 ft)
Landing run at typical landing weight 706 m (2,315 ft)
Range (nine belly tanks):
with 8 passengers 6,200 n miles (11,482 km; 7,134 miles)
with 25 passengers 5,935 n miles (10,991 km; 6,829 miles)
with 50 passengers 5,365 n miles (9,936 km; 6,173 miles)

OPERATIONAL NOISE LEVELS (FAR Pt 36 Stage 3):
T-O 85.6 EPNdB
Approach 95.9 EPNdB
Sideline 95.2 EPNdB

UPDATED

BOEING BUSINESS JET 2 (BBJ 2)

TYPE: Large business jet.

PROGRAMME: Launched 11 October 1999; roll-out and first 'green' delivery 8 March 2001 to an undisclosed customer; first service entry was in early 2002; forecast production rate eight per year.

CUSTOMERS: BBJ 2 expected to account for some 25 per cent of all BBJ sales. Total of nine firm orders received by mid-2003, including one in first half of that year. Six in service and further two outfitting by October 2003. Refer to table in BBJ entry.

COSTS: US$50 million, 'green'; estimated US$61 million to US$67 million, typically equipped (2002).

DESIGN FEATURES: Based on 737-800 airframe (which see), affording 25 per cent more cabin volume and twice the cargo volume of the BBJ; Aviation Partners Inc winglets standard.

POWER PLANT: Two CFM56-7 turbofans, each 121.4 kN (27,300 lb st). Standard 737 'Next-Generation' fuel of 26,025 litres (6,875 US gallons; 5,725 Imp gallons) contained in wing, plus between three and seven belly tanks; maximum combined capacity 39,466 litres (10,426 US gallons; 8,681 Imp gallons).

ACCOMMODATION: Up to 78 passengers, with executive lounge and private suite. Maximum 189 in airliner configuration. Operating weights based on completion allowance of 7,257 kg (16,000 lb).

Interior of BBJ2 completed by Lufthansa Technik *(Gregor Schläger)* ***NEW*/0567228**

DIMENSIONS, EXTERNAL: As for BBJ, except:
  Length overall 39.47 m (129 ft 6 in)
DIMENSIONS, INTERNAL:
  Cabin: Length 29.97 m (98 ft 4 in)
  Floor area 93.27 m² (1,004 sq ft)
  Max cargo volume 34.7 m³ (1,224 cu ft)
WEIGHTS AND LOADINGS:
  Operating weight empty, typically equipped 46,226 kg (101,910 lb)
  Max fuel weight (incl supplementary tanks) 31,922 kg (70,376 lb)
  Max T-O weight 79,015 kg (174,200 lb)
  Max ramp weight 79,245 kg (174,700 lb)
  Max landing weight 66,360 kg (146,300 lb)
  Max zero-fuel weight 62,730 kg (138,300 lb)
PERFORMANCE:
  Max cruising speed M0.82
  Long-range cruising speed M0.79
  Max rate of climb at S/L 948 m (3,110 ft)/min
  Initial cruising altitude 11,505 m (37,750 ft)
  Max certified altitude 12,500 m (41,000 ft)
  Service ceiling, OEI 6,090 m (22,600 ft)
  T-O field length, S/L:
    fuel for range of 4,000 n miles (7,408 km; 4,603 miles) 1,655 m (5,430 ft)
    fuel for range of 5,000 n miles (9,260 km; 5,753 miles) 1,915 m (6,280 ft)
    fuel for range of 5,650 n miles (10,464 km; 6,502 miles) 2,118 m (6,950 ft)
  Landing run at typical landing weight 758 m (2,485 ft)
  Range (seven belly tanks):
    with 8 passengers 5,650 n miles (10,463 km; 6,501 miles)
    with 25 passengers 5,315 n miles (9,843 km; 6,116 miles)
    with 50 passengers 4,780 n miles (8,852 km; 5,500 miles)
OPERATIONAL NOISE LEVELS (FAR Pt 36 Stage 3):
  T-O 86.0 EPNdB
  Approach 96.3 EPNdB
  Sideline 94.7 EPNdB

UPDATED

BOEING SIKORSKY

BOEING COMPANY and SIKORSKY AIRCRAFT

PARTICIPATING COMPANIES:
  The Boeing Company (USA)
  Sikorsky Aircraft (USA)
Web: http://www.rah66comanche.com
VICE-PRESIDENT AND RAH-66 PROGRAMME DIRECTOR:
  Charles 'Chuck' Allen
ARMY PROGRAMME MANAGER: Colonel Michael Cantor
COMMUNICATIONS DIRECTOR: Ed Steadham

Boeing and Sikorsky began collaboration on what later became the RAH-66 in June 1985 and received a contract for the demonstration/validation programme in 1991 In early 2002, Boeing Sikorsky announced selection of Bridgeport, Connecticut, as final assembly location for the production RAH-66; also in 2002, the Joint Program Office moved from Huntsville, Alabama, to Bridgeport.

UPDATED

BOEING SIKORSKY RAH-66 COMANCHE

Programme cancelled 24 February 2004

TYPE: Attack helicopter.

PROGRAMME: Light Helicopter Experimental (LHX) design concepts requested by US Army 1981; numerous changes of programme; original plan for 5,000 to replace UH-1, AH-1, OH-58 and OH-6; reduced in 1987 to 2,096 scout/attack only, replacing 3,000 existing helicopters; further cut to 1,292 in 1990 (with another 389 possible) and then to 1,096 in 1999, although subsequently raised to 1,213 (including eight for US Army operational evaluation) by mid-2000. Under latter procurement plan, initial production examples to so-called Block I standard for armed reconnaissance; definitive Block II standard to follow with heavy attack capability; Block III to introduce added mission capabilities, including sensor fusion and AAMs. Most recent restructuring of programme has resulted in further cut in planned procurement to 650 over 12 year period, according to defence acquisition review that was completed on 7 October 2002; Army still intends to field Comanche in Blocks incorporating incremental improvements with low-rate initial production to begin in 2007. Three LRIP batches, totalling 73 aircraft, are to be built to Block I standard, followed by 108 Block II helicopters, whereupon Block III will be introduced.

LHX request for proposals issued 21 June 1988; 23 month demonstration/validation contracts to Boeing Sikorsky and Bell/McDonnell Douglas. Boeing Sikorsky selected 5 April 1991; to build four YRAH-66 demonstration/validation prototypes in 78 month programme, plus static test article (STA) and propulsion system testbed (PSTB).

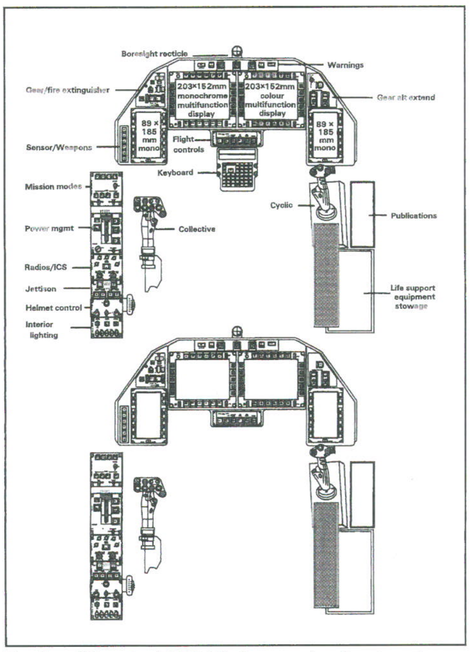
LHTEC T800 engine specified October 1988. LHX designation changed to LH early 1990, then US Army designation RAH-66 Comanche in April 1991. Several versions of programme timetable were considered prior to that currently implemented.

Prototype critical design review, completed in December 1993, authorised production of three YRAH-66 prototypes (first item for which manufactured in September 1993). At same time, however, further R&D economies under study; December 1994 decision reduced dem/val phase to two prototypes (lacking Longbow/Hellfire capability).

Prototype construction began 29 November 1993 with forward fuselage at Sikorsky, Stratford; Boeing built aft fuselage in Philadelphia. STA airframe delivered to Stratford 1994, at which time PSTB under construction there. PSTB trials commenced in 1995 at West Palm Beach, with 100 per cent torque from both engines achieved during first 10 hours of running. PSTB subsequently suffered failure of left input bevel gear, which disintegrated and punched hole in main gearbox housing during 110 per cent power test; resonance blamed for failure.

Front and rear sections of prototype joined at Stratford 25 January 1995; completed helicopter (94-0327) rolled out 25 May 1995. Following transfer to Sikorsky's Development Flight Test Center in West Palm Beach, Florida, during June 1995, first flight accomplished on 4 January 1996. Prototype retired from flight test duty on 30 January 2002, by which time it had accumulated 387.1 flight hours in 318 sorties.

Aft fuselage section of second prototype (95-0001) delivered by Boeing to Stratford in early December 1996 for mating with forward fuselage; completed helicopter exhibited at Army Aviation Association's annual meeting in April 1998 and then to West Palm Beach. Made international debut when displayed statically at Farnborough Air Show in September 1998; flew for first time on 30 March 1999. Completed initial test schedule in April 1999, recording 4.9 hours in five sorties before temporary lay-up, due to funding constraints; also used for vertical rate of climb demonstration later in year and will test integrated mission equipment package (MEP), including digital avionics, communications, navigation and target acquisition systems. By mid-December 2000, had logged almost 53 flight hours in 50 sorties; these figures had risen to 93 and 103.5 respectively in May 2001 when it was removed from flight status to be prepared for flight testing and validation of MEP. This phase of development began on 23 May 2002, when second prototype made first flight with MEP and new engines installed. Near-term objectives to be achieved by the second prototype include flight with the night vision pilotage system by October 2002, as well as completion of total weapon system critical design review in May 2003, including the Lockheed Martin Electro-Optical Sensor System (EOSS), which due for delivery in first half of 2003.



Boeing Sikorsky RAH-66 Comanche front and rear cockpit layout

Engineering and Manufacturing Development (EMD) officially began 1 June 2000, following RAH-66 meeting (on 4 April 2000) seven key Defense Acquisition Board Milestone 2 criteria, including a 107 m (350 ft)/min vertical climb rate, a specified detection range for the FLIR sensors, a radar cross-section specification, ballistic vulnerability and tolerance specifications and tower-testing of the selected FCR. Weight reduction effort under way in late 2000, to reduce from current level of about 4,310 kg (9,500 lb) to target weight of 4,218 kg (9,300 lb).

Under original plan, EMD expected to take six years and include production of five RAH-66s specifically for EMD testing, followed by further eight for initial operational test and evaluation (IOT&E) by the US Army. However, EMD contract and plan restructured in mid-2002, at which time IOC forecast to occur in September 2009. The new plan includes a start of low-rate initial production (LRIP) in 2007, with full-rate production set at 60 per year from 2011-12 onwards. First EMD RAH-66 expected to fly in March 2005. In meantime, second YRAH-66 will assume increasing burden of test duty. Production of components for the first EMD RAH-66 began at Boeing's Philadelphia factory in early 2003, with work on assembling the first empennage beginning on 21 April 2003; on completion, this shipped to Bridgeport and mated with Sikorsky-produced elements.

First -801 growth version of T800 turboshaft began bench runs in March 1994; -801 preliminary design review completed May 1993; critical design review March 1995; prototypes originally fitted with less powerful T800-LHT-800 engines, but first flight with definitive -801 engine made on 1 June 2001 by first prototype. Same engine subsequently installed on second prototype in time for resumption of flight test duty in May 2002.

CUSTOMERS: US Army, two prototypes, plus, five systems development and demonstration (SDD) helicopters and four initial operational test and evaluation (IOT&E) aircraft for test duties, operational trials and training tasks. Planned procurement of 650 production aircraft. This total to include some dedicated for use by special operations forces, which may entail addition of in-flight refuelling capability.

COSTS: US$34,000 million programme, including US$1,960 million dem/val and US$900 million FSD but reduced to US$2,240 million dem/val/FSD between 1993 and 1997 by cancellation of three of six planned prototypes; US$8.9 million flyaway unit cost (1988 values), increased to