horizontal stabilisers. Push-pull cables used on two-seat versions.

STRUCTURE: Full chromoly 4130 steel tube welded fuselage and rotor pylon; fuselage covered with Dacron fabric and polyurethane finish. Hub structure of 2024-T3 aluminium bar with bolt attachments, pivoted at rotor attachment point for ground adjustment of blade pitch.

LANDING GEAR: Non-retractable type with tailwheel. Mainwheels Hegar 6.50-6 in with 1.03 bar (15 lb/sq in) tyre pressure. Matco 3.00-2 steerable tailwheel of solid rubber. Internal expanding go-kart style brakes by Leaf. Optional shock-absorbing gear. Floats optional.

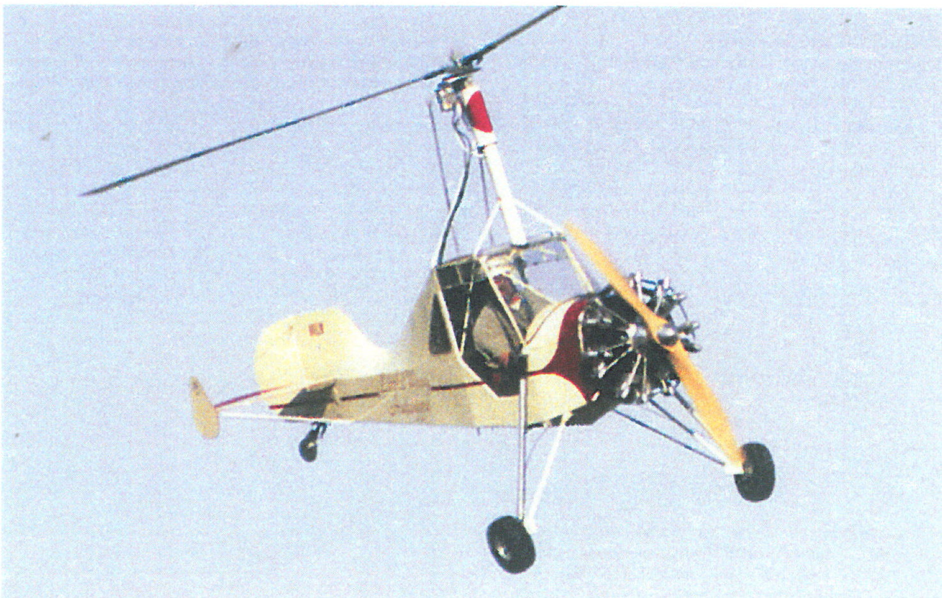
POWER PLANT: *LW-3:* One 52.2 kW (70 hp) TEC converted Volkswagen four-stroke engine with dual ignition; options include 2si 52.2 kW (70 hp) two-stroke water-cooled engine and various Rotax, Subaru and Hirth engines. Fuel capacity 38 litres (10.0 US gallons; 8.3 Imp gallons) in seat tank. Refuelling position on starboard side of cabin. Oil capacity 2.4 litres (5.0 US pints; 4.2 Imp pints).

LW-3+2: One 82.0 kW (110 hp) Hirth F30 or Rotax 912; or 84.6 kW (113.4 hp) Rotax 914 optional power plants in the range 67.1 to 112 kW (90 to 150 hp) can be fitted. Fuel capacity 49.2 litres (13.0 US gallons; 10.8 Imp gallons). In 2003, company fitted an 82 kW (110 hp) Rotec R2800 seven-cylinder radial engine driving a two-blade propeller.

ACCOMMODATION: One or two occupants, according to version, in enclosed cockpit; forward-opening door on starboard side. Baggage compartment behind single seat. Lexan polycarbonate windscreen and side windows.

SYSTEMS: 1,000 A 12 V battery for ignition back-up and rotor pre-spin. Hydraulic pre-spin optional.

AVIONICS: Micronair 760 nav/com and EIS engine electronic monitoring system are recommended.



Little Wing LW-3 fitted with Rotec R2800 radial engine ***NEW***/0553233

DIMENSIONS, EXTERNAL:

Rotor diameter: LW-2/3	7.62 m (25 ft 0 in)
LW-3+2	8.53 m (28 ft 0 in)
Rotor blade chord	0.18 m (7 in)
Fuselage length: standard	5.49 m (18 ft 0 in)
LW-5	4.88 m (16 ft 0 in)
Height to top of rotor head	2.59 m (8 ft 6 in)
Tail unit span	2.13 m (7 ft 0 in)
Wheel track	2.13 m (7 ft 0 in)
Wheelbase: standard	3.96 m (13 ft 0 in)
LW-5	3.51 m (11 ft 6 in)
Propeller diameter: VW engine	1.57 m (5 ft 2 in)
2si engine	1.73 m (5 ft 8 in)
Rotec engine	1.88 m (6 ft 2 in)

DIMENSIONS, INTERNAL:

Cabin: Length: standard	1.24 m (4 ft 1 in)
LW-5	1.90 m (6 ft 3 in)
Max width: standard	0.57 m (1 ft 10½ in)
LW-5	0.66 m (2 ft 2 in)
Max height	1.07 m (3 ft 6 in)

AREAS:

Rotor blades (each)	0.54 m² (5.83 sq ft)
Rotor disc: LW-2/3	45.62 m² (491.1 sq ft)
LW-3+2	57.21 m² (615.8 sq ft)
Dorsal fin	0.42 m² (4.52 sq ft)
Auxiliary tip plates (each)	0.15 m² (1.60 sq ft)
Rudder	0.28 m² (3.03 sq ft)
Tailplane	0.81 m² (8.80 sq ft)
Elevators (total)	0.84 m² (9.00 sq ft)

WEIGHTS AND LOADINGS:

Weight empty: LW-2	160 kg (352 lb)
LW-3+2	215 kg (475 lb)
LW-3	204 kg (450 lb)
Baggage capacity	11 kg (25 lb)
Max fuel weight	24 kg (54 lb)
Max T-O weight: LW-2	340 kg (750 lb)
LW-3+2	499 kg (1,100 lb)
Max disc loading: LW-3+2	8.72 kg/m² (1.79 lb/sq ft)

PERFORMANCE:

Never-exceed speed (VNE)	86 kt (160 km/h; 100 mph)
Max operating speed at S/L:	
LW-3	70 kt (129 km/h; 80 mph)
LW-3+2	78 kt (145 km/h; 90 mph)
Econ cruising speed at 305 m (1,000 ft):	
LW-3	52 kt (97 km/h; 60 mph)
LW-3+2	65 kt (121 km/h; 75 mph)
Touchdown speed for power-off landing	9-13 kt (16-24 km/h; 10-15 mph)
Max rate of climb at S/L: LW-3	305 m (1,000 ft)/min
LW-3+2	183 m (600 ft)/min
Service ceiling: standard	3,050 m (10,000 ft)
with Rotax 914	7,315 m (24,000 ft)
T-O run: LW-3	61 m (200 ft)
LW-3+2	92 m (300 ft)
Landing run: LW-3, LW-3+2	3-6 m (10-20 ft)
Range: LW-3	100 n miles (185 km; 115 miles)
LW-3+2	150 n miles (277 km; 172 miles)

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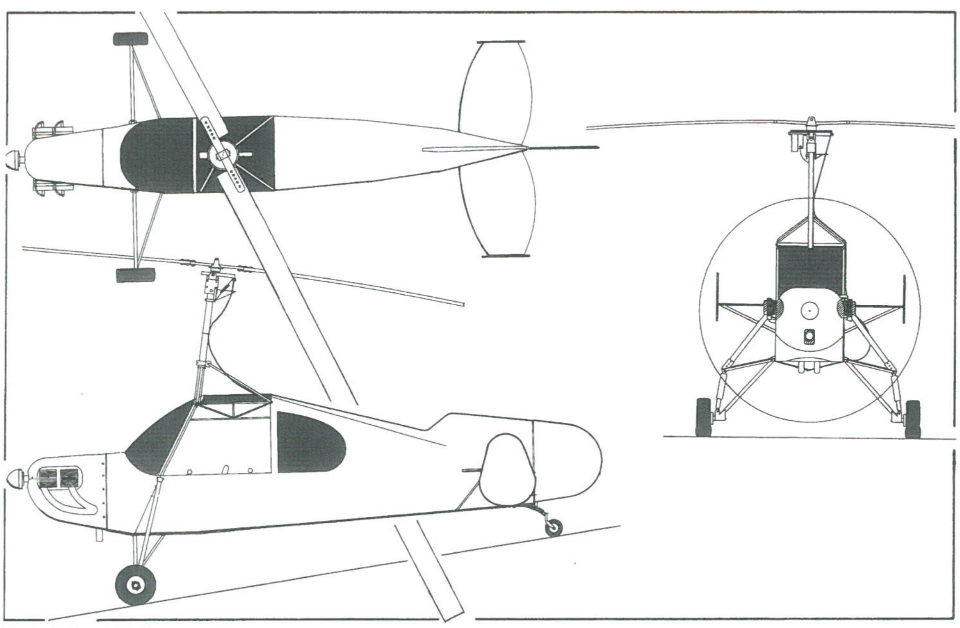

Little Wing LW-5 general arrangement 0059969

LOCKHEED MARTIN

LOCKHEED MARTIN CORPORATION

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PRESIDENT AND COO: Robert J Stevens
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Dain M Hancock
EXECUTIVE VICE-PRESIDENT, SPACE SYSTEMS:
Albert E Smith
EXECUTIVE VICE-PRESIDENT, SYSTEMS INTEGRATION:
Robert B Coutts
EXECUTIVE VICE-PRESIDENT, TECHNOLOGY SERVICES:
Michael F Camardo
SENIOR VICE-PRESIDENT, CORPORATE COMMUNICATIONS:
Dennis Boxx

Former Lockheed Aircraft Corporation renamed Lockheed Corporation in September 1977. Merger with Martin Marietta announced 30 August 1994 and completed 15 March 1995. Further expansion resulted from the acquisition of Loral Corporation's defence electronics and systems integration businesses in April 1996 for approximately US$9.1 billion and completed purchase of Comsat in August 2000 for US$2.6 billion. Workforce total of about 125,000 in mid-2002. Net sales in 2002 reported as US$26.6 billion. Activities include design and production of aircraft, electronics, satellites, space systems, missiles, ocean systems, information systems, and systems for strategic defence and for command, control, communications and intelligence.

Following major strategic and organisational review, revised corporate structure came into being in early 2000; under this, four major business groups of Lockheed Martin are:

Aeronautics Company

Space Systems, comprising:
- Lockheed Martin Space Systems – Astronautics Operations
- Lockheed Martin Space Systems – Michoud Operations
- Lockheed Martin Space Systems – Missiles & Space Operations
- Lockheed Martin Commercial Space Systems
- Lockheed Martin Management & Data Systems
- International Launch Services

Systems Integration, comprising:
- Lockheed Martin Air Traffic Management
- Lockheed Martin Systems Integration – Owego
- Lockheed Martin Canada
- Lockheed Martin Distribution Technologies
- Lockheed Martin Information Systems
- Lockheed Martin Tactical Systems
- Lockheed Martin Missiles and Fire Control
- Lockheed Martin Mission Systems
- Lockheed Martin Naval Electronics & Surveillance Systems – Akron
- Lockheed Martin Naval Electronics & Surveillance Systems – Surface Systems
- Lockheed Martin Naval Electronics & Surveillance Systems – Undersea Systems
- Lockheed Martin Naval Electronics & Surveillance Systems – Syracuse
- Lockheed Martin UK

Technology Services, comprising:
- Knolls Atomic Power Laboratory
- Lockheed Martin Aircraft & Logistics Centers
- Lockheed Martin Information Support Services
- Lockheed Martin Space Operations
- Lockheed Martin Technical Operations
- Sandia National Laboratories
- Technology Ventures

UPDATED

LOCKHEED MARTIN AERONAUTICS COMPANY (LM Aero)

1 Lockheed Boulevard, Fort Worth, Texas 76108
Tel: (+1 817) 777 20 00
Fax: (+1 817) 777 21 15
PRESIDENT AND COO: Dain M Hancock
EXECUTIVE VICE-PRESIDENT FOR CUSTOMER REQUIREMENTS: Tom Burbage
EXECUTIVE VICE-PRESIDENT FOR PROGRAMS: Robert T Elrod
EXECUTIVE VICE-PRESIDENT FOR FINANCE: John C McCarthy
EXECUTIVE VICE-PRESIDENT FOR OPERATIONS: Ralph D Heath

LM Aero includes the following operating units:
Lockheed Martin Aeronautics Company – Marietta
Lockheed Martin Aeronautics Company – Palmdale
Lockheed Martin Aeronautics Company – Fort Worth

Before merger that culminated in creation of Lockheed Martin Aeronautics Sector (subsequently renamed Lockheed Martin Aeronautical Systems Division and, since January 2000, Lockheed Martin Aeronautics Company), Lockheed aircraft manufacturing activity consolidated at Marietta, Georgia in 1991. Sales in 2001 were valued at approximately US$5.355 billion, rising in 2002 to US$6.5 billion. In June 2002, workforce numbered about 24,500.

Teaming arrangement agreed with Northrop Grumman to collaborate in development and marketing of AEW aircraft; also with KAI of South Korea to develop and co-produce the T/A-50 Golden Eagle advanced trainer/light combat aircraft, in which it has 13 per cent share of programme investment and responsibility for about 20 per cent of production work.

On 31 October 2001, Lockheed Martin and AgustaWestland announced a joint venture promoting the EHI EH101 helicopter (which see) for US military and coast guard requirements under the new designation, US101.

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LOCKHEED MARTIN AERONAUTICS – MARIETTA

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MANAGER, MEDIA RELATIONS: Sam Grizzle

In April 1991, Lockheed won competition to produce F-22 (now F/A-22) with General Dynamics (now Lockheed Martin Tactical Aircraft Systems) and (then) Boeing Military Airplanes. Lockheed Martin Aeronautics Company-Marietta also involved in studies into advanced mobility aircraft for 21st century strategic transport; was subcontractor to Boeing on NASA High-Speed Civil Transport (HSCT) programme; working with NASA on advanced subsonic technology transport programme; and engaged in other, classified projects.

Long-term activities at Marietta include production of C-130J Hercules and F/A-22 Raptor aircraft. LMAS signed joint venture agreement with Alenia of Italy in September 1996 concerning development and marketing of the C-27J tactical transport (see entry in Italian section) that incorporates systems developed for the C-130J Hercules. However, lack of sales resulted in Lockheed Martin seeking to scale down involvement in closing months of 2002, although it does intend to continue marketing C-27J as joint effort with Alenia.

Lockheed Martin Aeronautics Company-Marietta working to develop standard avionics suite for future versions (upgrades) of P-3 Orion and AEW aircraft; open architecture design for maximum flexibility and system growth; elements include AN/APS-145 radar, GPS and communications/navigation system. Also interest from several countries on possible new-build aircraft.

Aeronautical Systems Support, with headquarters in Smyrna, Georgia, is subordinate element, with responsibility for after sales support, including provision of spare parts and technical back-up for variety of aircraft types.

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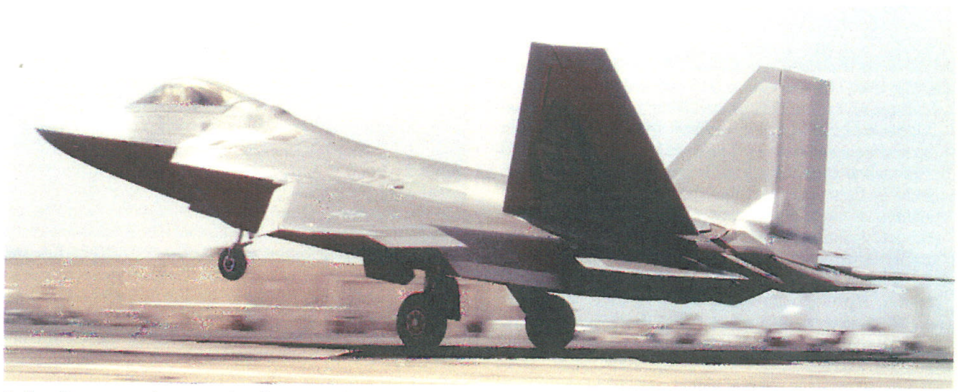


Following upgrade to production standard, Raptor 4009 was redelivered to Edwards AFB on 31 March 2003
NEW/0554442

LOCKHEED MARTIN (645) F/A-22 RAPTOR

TYPE: Multirole fighter.

PROGRAMME: US Air Force Advanced Tactical Fighter (ATF) requirement called for 750 McDonnell Douglas F-15 Eagle replacements incorporating low observables technology and supercruise (supersonic cruise without afterburning); parallel assessment of two new power plants; request for information issued 1981; concept definition studies awarded September 1983 to Boeing, General Dynamics, Grumman, McDonnell Douglas, Northrop and Rockwell; requests for proposals issued September 1985; submissions received by 28 July 1986; USAF selection announced 31 October 1986 of demonstration/validation phase contractors: Lockheed YF-22 and Northrop YF-23; each produced two prototypes and ground-based avionics testbed. Competing engine demonstration/validation programmes launched September 1983; ground testing began 1986-87; flight-capable Pratt & Whitney YF119s and General Electric YF120s ordered early 1988; all four aircraft/engine combinations flown.

Decision of 11 October 1989 extended evaluation phase by six months; draft request for engineering and manufacturing development (EMD) proposals issued April 1990; first artists' impressions released May 1990; Lockheed teamed with General Dynamics (Fort Worth) and Boeing Military Airplanes to produce two YF-22 prototypes, which first flew on 29 September and 30 October 1990.

Acquisition of former General Dynamics gave Lockheed Martin control of 67.5 per cent of programme; this involves 1,150 suppliers in more than 40 US states. Final engineering and manufacturing development (EMD) requests issued for both weapon system and engine 1 November 1990; proposals submitted 2 January 1991; F-22 and F119 power plant announced by USAF as winning combination, 23 April 1991; EMD contract given 2 August 1991 for 11 (later reduced to nine) flying prototypes, plus one static test article and one fatigue test airframe; design underwent several detail refinements through early 1990s, immediately previous layout being Configuration 644.

Combat roles reassessment of May 1993 added air-to-ground attack with precision-guided munitions (PGMs) to F-22's roles. Under US$6.5 million contract addition on 25 May 1993, main weapon bay and avionics adapted for delivery of AIM-9X missile and 454 kg (1,000 lb) GBU-32 Joint Direct Attack Munition (JDAM). Addition of ground attack capability eventually resulted in redesignation as the **F/A-22**, which was announced by USAF Chief of Staff General Jumper on 17 September 2002.

Preliminary design review, covering all aspects of the design, completed 30 April 1993; critical design review completed February 1995; preproduction verification (PPV) batch of four aircraft was scheduled to be ordered 1997 but these deleted from overall programme at start of that year; long lead items for first production batch (two aircraft), subsequently reclassified as Production

Raptor 10, the first production representative F/A-22 pictured on delivery to Lockheed Martin at Palmdale on 30 October 2002 for pre-delivery modifications *(USAF/Kevin Robertson)*
NEW/0527095

Lockheed Martin F/A-22A Raptor No. 14 departs for Edwards AFB on 22 May 2003

NEW/0554441

Representative Test Vehicles (PRTV), ordered in 1998, with full funding in FY99. Minor design changes for production aircraft announced July 1991. Suggested name of SuperStar rejected in 1991 and it remained unnamed until occasion of roll-out in April 1997 when it was announced that the name Raptor had been chosen.

Fabrication of first component for first EMD aircraft (91-4001, c/n 4001) began 8 December 1993 at Boeing's facility in Kent, Washington; assembly of forward fuselage launched at Marietta on 2 November 1995 with start of work on nose landing gear well; assembly work also begun at Fort Worth in mid-1995 with mating of three assemblies that comprise the mid-fuselage of first EMD aircraft taking place in early 1996, followed by road transfer of entire section to Marietta in September 1996 for start of final assembly. Delivery by Boeing to Lockheed Martin at Marietta of subassemblies, including wing and aft fuselage, for first EMD aircraft took place on schedule in third quarter of 1996. Pratt & Whitney also delivered first F119 flight test power plant in September. Prototype rolled out 9 April 1997; planned May 1997 first flight delayed by fuel leaks and hardware-related anomalies. First flight accomplished 7 September 1997, with aircraft airborne for 58 minutes during which initial handling evaluation undertaken before landing gear was retracted and further handling assessment performed at speeds of up to 250 kt (463 km/h; 288 mph); maiden flight also included simulated powered approach at medium altitude before landing at Marietta. Second sortie of 35 minutes took place on 14 September 1997, after which aircraft underwent minor structural modifications and was then placed in structural test fixture for load ground tests and strain gauge calibration.

Low-rate initial production (LRIP) decision originally dependent upon accumulating 183 hours of flight testing; this milestone passed on 23 November 1998 and cleared way for release of US$195.5 million in late December 1998 for advance procurement (long lead items) for six Lot 1 LRIP aircraft, which subsequently reclassified as PRTV 2 aircraft after wrangle over funding in mid-1999. Earlier, in December 1998, Lockheed Martin received contract worth US$503 million for two PRTVs and associated programme support.

Wind tunnel testing occupied 19,195 hours up to YF-22 stage and a further 16,930 hours up to mid-1995, when Configuration 645 was finalised; six major categories were investigated (aerodynamic loads and weapons bay acoustics, inlet and engine compatibility, mission/manoeuvre performance, inlet icing, stability and control flying qualities, weapons and stores separation), with last-named comprising majority of 900 hours that remained to be done in 1995-97.

Avionics trials from November 1997 in a Boeing 757 (N757A) Flying Test Bed (FTB) with AN/APG-77 radar in F-22-type nosecone; block 1 software, permitting basic radar operation including simultaneous search-and-track modes, delivered to Boeing, April 1998 and subsequently tested on 757; block 2 software delivered on 7 December 1998, with block 3S beginning flight testing on 24 April 2000; this is early version of block 3.0 software, which delivered to Seattle on 11 August 2000 in readiness for airborne trials programme that began in mid-September. Communications/navigation/identification (CNI) system and EW suite being tower-tested on full-scale model of forward fuselage at Fort Worth, Texas, during 1998-99; subsequently tested on Boeing 757 FTB, which is fitted with three common integrated processors (CIPs) for 1,400 hour software flight test programme. Further modification of Boeing 757 to mount representative wing section above forward fuselage completed in late 1998, and flight testing of conformal antennas began on 11 March 1999; by December 2000, 757 FTB had accumulated 641.9 flight test hours in 126 sorties. Radar testing also accomplished using T-39 Sabreliner as target aircraft and has involved a Lockheed T-33 for calibrated airborne trials since December 1998.

Milestones in 1999 included delivery of first AN/ALR-94 EW system on 15 February by Sanders to the Avionics Integration Laboratory in Seattle; 100th sortie in May; successful completion of design load limit testing of article 3999 on 25 September; and compliance with all five major 1999 flight test objectives (including flight at altitude of 50,000 ft; opening of side and main weapon bay doors in flight; supercruise demonstration; and flutter envelope expansion) by 24 September.

Flight test programme interrupted at least twice during 2000, with most serious occurrence arising in May after discovery of hairline cracks in canopies of first two aircraft; grounding order lifted on 5 June, when second EMD F-22 resumed testing with some restrictions while awaiting replacement unit. Major event of year was expected to be Pentagon Defense Acquisition Board review to culminate in award of contract for initial batch of LRIP aircraft; this was scheduled for 21 December, but slipped to 3 January 2001 and was further delayed by poor weather that prevented three of 11 critical test objectives being achieved; funding release dependent upon compliance with several 'exit criteria', including first flight of F-22 with block 3.0 software, first AMRAAM launch and first flights of aircraft 4004, 4005 and 4006. First AIM-120C AMRAAM launch (of 60 planned) achieved 24 October 2000; static tests completed 28 December 2000. Remaining three objectives satisfied by 6 February 2001, with first flight of aircraft 4006. However, decision to proceed with LRIP phase not taken until 15 August 2001, when initial batch of 10 aircraft approved with FY01 funds; at same time, it was revealed that LRIP will continue until FY05, with full-rate production starting in FY06 and running until at least FY13.

Objectives for 2002 comprised first flight of first Production Representative Test Vehicle, which achieved on 12 October; first supercruise launch of AIM-120, including successful interception of aerial target, which accomplished on 5 November; expansion of flight envelope to permit start of USAF pilot training in anticipation of DIOT&E; and supercruise launch of, and interception by, heat-seeking AIM-9M, which undertaken on 22 November.

In February 2003, the fifth and sixth EMD aircraft successfully demonstrated the Intraflight Datalink (IFDL) facility for the first time. Subsequently, flight operations were briefly interrupted when nose gear of one aircraft retracted as engines were being shut down; this incident occurred on 18 March 2003 and resulted in the F/A-22 being grounded until 22 March.

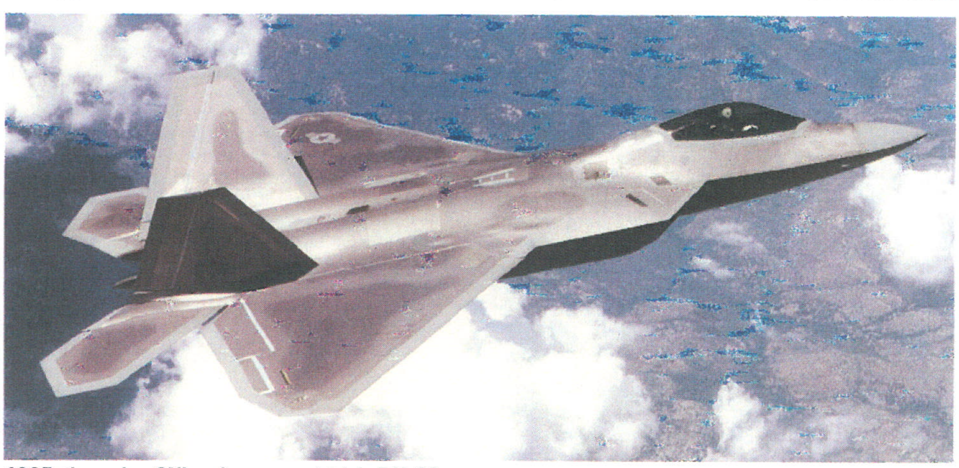
Assembly of first LRIP aircraft (4018) began at Fort Worth on 19 March 2001; first flight and delivery to Tyndall AFB, Florida, expected in 2003. Notable milestone passed on 18 April 2001, when 1,000th flight test hour recorded with 2,000th hour completed on 7 June 2002; 3,000th hour on 26 February 2003 and 3,500th on 4 June 2003. Nevertheless, delays in production and delivery of test aircraft meant programme was behind schedule, with knock-on effect on start of dedicated initial operational test and evaluation (DIOT&E); this was scheduled to begin in August 2002, but first delivery to an operational unit was not effected until 26 September 2003, when Raptor 01-4018 was flown from Marietta production plant to Tyndall AFB, Florida, for 43rd FS of 325th FW. Similarly, overall development programme was expected to be completed in March 2004, but will now continue until at least November 2005; this delay largely attributed to problems experienced with avionics software, such as tendency for elements of the avionics suite to shut down every 3 to 4 hours.

Block 3.1 software package delivered 5 February 2002 and flown for first time (on 91-4006) on 25 April at Edwards AFB.

CURRENT VERSIONS (specific): Test programme involves total of nine EMD aircraft, plus two non-flying test articles. Airframe 3999 for static loads testing built between second and third flying F-22s, and airframe 4000 for fatigue testing built between third and fourth flying F-22s. Final assembly of 3999 began in July 1998; following completion in January 1999, it was transferred to the structural test facility at Marietta and began load testing in March 1999. All planned static testing completed by mid-May 2002, with 'first service-life' fatigue testing satisfactorily concluded on 17 May 2002, at which time second cycle of full lifetime testing began.

Clear division of test assignments resulted in three aircraft (4001-03) being allocated to airframe structure evaluations, with remaining six concentrating on avionics test taskings. Use of separate instrumentation configurations for airframe and avionics-dedicated test articles provides back-up for almost every aircraft and offers potential to switch missions between test fleet if necessary. Tasks allocated to EMD aircraft are:

4001/91-4001: 'Spirit of America'. Rolled out on 9 April 1997 at Lockheed Martin's Marietta, Georgia, facility and made first flight on 7 September 1997. Following completion of structural ground tests, disassembled and airlifted to Edwards AFB on 5 February 1998; used for evaluation of flying qualities, flutter and loads characteristics. Flown to Wright-Patterson AFB, Ohio, on 2 November 2000 and formally retired from flight



4005, the radar, CNI and armament trials F/A-22

0554447

test duty; 175 flights and 372.7 hours; stripped of useful components and used for live-fire testing, involving exploding shells and missile fragments, during 2001.

4002/91-4002: 'Old Reliable'. Rolled out 10 February 1998; maiden flight on 29 June 1998 at Marietta; flew to Edwards AFB on 26 August and by end October 1998 had made 27 flights (66.1 hours), expanding flutter and handling qualities envelope, including 26° AoA. Used to launch first AIM-9M Sidewinder on 25 July 2000, followed by first AIM-120C AMRAAM on 24 October and had previously been employed for fit checks and captive-carry trials with AGM-88 HARM in April 1999. Tasks include performance assessment (propulsion; high AoA) plus stores separation and jettison as well as some electronic warfare and IR signature evaluations.

4003/91-4003: First Block 2 aircraft, with internal structure fully representative of production version; rolled out at Marietta on 25 May 1999; first engine runs in October 1999; taxi trials completed at beginning of March 2000, with first flight following on 6 March and delivery to Edwards AFB (fourth flight) on 15 March; regained flight status on 19 September 2000, being previously engaged on planned ground testing and upgrade programme. Assigned to envelope expansion, replacing 4001, including loads testing, crosswind landings, validation of arrester hook and weapons bay environment work. Mid-fuselage section used for fit checks of Sidewinder and AMRAAM weapons at Fort Worth in July 1998 shortly before delivery to Marietta for final assembly. Accomplished first AIM-120 AMRAAM launch at supersonic speed on 21 August 2002, when single missile fired while flying at M1.2 at 3,650 m (12,000 ft). Will also test M61A2 cannon and JDAM integration.

4004/91-4004: First EMD aircraft with Hughes CIP software, including AN/APG-77 radar and ILS. Allocated to avionics development, but also to be used for low observables evaluation including radar cross-section and IR signature assessments; and comms/nav/ident (CNI) testing. Mid-fuselage section delivered from Fort Worth to Marietta on 28 December 1998. Block 1.1 avionics installed at Marietta, with electrical power applied for first time on 31 August 1999; Block 1.2 avionics then incorporated to support taxi trials and initial flight testing at Dobbins Air Reserve Base, from where first flight took place on 15 November 2000. Aircraft ferried to Edwards AFB at end January 2001.

4005/91-4005: Radar, CNI and armament development tasks. Assigned to initial testing of Block 3.0 software. Primary fire-control evaluation aircraft, with first flight made on 5 January 2001; made first guided launch of AIM-120C against target drone over Point Mugu test range on 21 September 2001.

4006/91-4006: Avionics development tasks. Primarily for integrated avionics testing, RCS testing and, eventually, for systems effectiveness/military utility evaluation. Expected to fly for first time in December 2000, but did not do so until 5 February 2001.

4007/91-4007: Was to have been initial two-seat F-22B but completed as single-seat F-22A and assigned to integrated avionics testing. First flight made 15 October 2001, thereafter joining test fleet at Edwards AFB on 5 January 2002. Assigned to DIOT&E programme as back-up aircraft.

4008/91-4008: Allocated to avionics development tasks and also destined to validate observability specification data. Subsequently to be used for DIOT&E programme, beginning in August 2003. Flown for first time on 8 February 2002 and ferried to Edwards AFB on 31 May 2002. On 2 July 2002, aircraft flown to Palmdale for modifications and upgrades necessary to prepare it for DIOT&E; this was completed at start of October 2002, when aircraft resumed developmental flight test duty at Edwards.

4009/91-4009: Was to have been the second F-22B but completed as F-22A. Avionics development and observability trials. First flight originally planned for 1 June 2001, but retained for ground testing at Marietta, where formally delivered for maintenance trials 15 April 2002; flown to Edwards to join test fleet on 31 March 2003 (last of four – 4008 to 4011 – modified at Palmdale to production standard) and will participate in DIOT&E programme from August 2003.

4010/99-4010 and **4011/99-4011:** First PRTV aircraft; both to participate in DIOT&E and will also be used for additional service testing at Nellis AFB, Nevada from the third quarter of 2003. First flight of a PRTV aircraft (99-4011, the second example) took place at Marietta on 16 September 2002; was formally accepted by USAF on 26 November 2002, completing DIOT&E fleet. First PRTV aircraft (99-4010) made maiden flight on 12 October 2002; was officially delivered to the USAF at Marietta on 23 October; and transferred to Palmdale on 30 October 2002 for modifications before joining Air Force Operational Test and Evaluation Center (AFOTEC) Detachment 6 at Edwards AFB.

4012/00-4012: Initial delivery to Nellis AFB, Nevada, for assignment to 422nd Test and Evaluation Squadron, from 14 January 2003. This aircraft to be joined by seven more in developing F/A-22 tactics, techniques and operating procedures at the USAF Air Warfare Center; **4013/00-4013** and **4014/00-4014** both delivered to Nellis by 22 May 2003, with three more to follow later in year.

Trials by 4001 to 4009 were originally to occupy 4,337 hours in 2,409 sorties. Of these totals, 2,110 hours and 1,200 sorties dedicated to airframe and systems testing, with balance allocated to mission avionics testing; however, as part of an effort to make up for delays in test programme, amount of time allocated to avionics flight testing was cut to 1,530 hours in third quarter of 2001.

CURRENT VERSIONS (general): **F/A-22A:** Originally designated F-22A. Single-seat production version for USAF. Planned in-service date is December 2005.

F-22B: Projected two-seat version for USAF; development terminated 10 July 1996 to reduce costs.

FB-22: Proposed single- or two-seat long-range strike-dedicated derivative under study by Lockheed Martin at USAF request in 2002; larger than F/A-22, with combat radius of up to 1,565 n miles (2,897 km; 1,800 miles) and significantly bigger payload of 30 small diameter bombs rather than eight as on F/A-22. If goes ahead, likely to have 90 per cent avionics and 30 per cent structural commonality with F/A-22, but may feature different power plant, with General Electric F110 and Pratt & Whitney F135 also under consideration. Other changes include modified delta wing planform, insertion of fuselage plug to increase weapons bay size and carriage characteristics and compromised air-to-air combat capability, with lower *g* limit of 5 rather than 9 on F/A-22. Secretary of the Air Force James Roche informed US Congress in late February 2003 that his optimum bomber force would include at least 150 FB-22s; however, USAF unlikely to require new aircraft for many years. In meantime, it was scheduled to complete future long-range strike option study in September 2003 that should provide some indication of requirements.

NATF: Projected US Navy variant to replace Grumman F-14 Tomcat; development abandoned.

CUSTOMERS: US Air Force: two YF-22 demonstrators; nine EMD aircraft plus one static and one fatigue test airframes; original 648 production aircraft programme of 1991 reduced to 442 in January 1994; latter originally to be funded from 1997 (long lead), beginning with four preproduction verification (PPV) aircraft in FY98, followed by series production of 438 (but PPV aircraft cancelled in early 1997). Quadrennial Defense Review (QDR) report in May 1997 resulted in planned procurement falling to 339 (including eight PRTV aircraft); further cuts followed, first to 333 in 1999 and then to 295 in 2001, although in early 2003, it appeared that as few as 276 could be acquired, with peak production rate of 32 per year during FY07 to FY10. Contracts for two PRTV 1 aircraft and long lead items for batch of six PRTV 2 aircraft signed December 1998. Decision to authorise LRIP expected in December 2000 but delayed until 15 August 2001. Pilot training to be accomplished at Tyndall AFB, Florida, by 43rd Fighter Squadron, 325th Fighter Wing from 2003, with IOC of first squadron following in December 2005, this being element of 1st Fighter Wing at Langley AFB, Virginia.

F/A-22 PROCUREMENT
(at June 2003)

FY	Lot	Quantity
99	PRTV 1	2
00	PRTV 2	6
01	LRIP 1	10
02	LRIP 2	13
03	LRIP 3	21
04	LRIP 4	22
05	LRIP 5	24
Total		**98**

Note: Excludes two prototypes and nine EMD aircraft. FY04 and FY05 totals subject to approval and could change.

COSTS: US$818 million contracts to both ATF teams, October 1986, for 54-month studies; each airframe team investing own funds (Lockheed/Boeing/GD team investment totalled US$675 million in addition to DoD funding); each engine contractor, about US$50 million; total US$3,800 million spent by USAF on both ATFs up to April 1991; programme cost for 648 aircraft was US$13 billion for development (1991 base year) and US$52.5 billion for production (1994 then-year); flyaway cost US$61.2 million at 1991 prices.

EMD contract, 2 August 1991, comprised US$9,550 million for 11 (subsequently nine) airframes, plus US$1,375 million to P&W for 33 (later amended to 27) engines. FY94 US Congressional appropriation of US$2,100 million was US$163 million below expectations, resulting in slippage of critical design review and first flight. Similarly, FY95 appropriation of US$2,300 million was US$110 million below expected figure, leading to further delay in maiden flight; and on 9 December 1994, Defense Secretary William Perry announced 10 per cent cut (approximately US$210 million) in FY96 budget, necessitating a third restructuring of the programme.

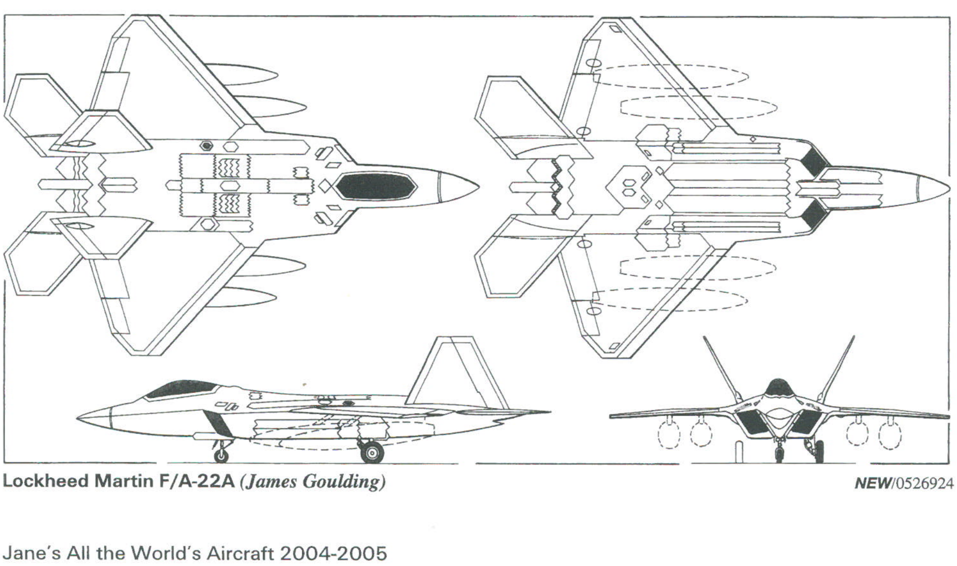
On 30 December 1999, Lockheed Martin awarded contract for approximately US$1.3 billion, covering procurement of six PRTV 2 aircraft, augmenting earlier US$195.5 million contract for long-lead items; at same time, Pratt & Whitney received separate US$180 million award for 12 F119 engines. Additional appropriation of US$277.1 million allocated to Lockheed Martin for long-lead items for 10 Lot 1 LRIP aircraft; further US$862 million contract awarded 19 September 2001 towards remaining cost of producing these 10 aircraft. Total cost of LRIP 2 batch of 13 aircraft quoted as US$3.03 billion, with US$4.47 billion requested for 20 LRIP 3 aircraft in FY03; additional US$117.6 million appropriated in March 2003 to add single aircraft to LRIP 3 batch, increasing FY03 purchase to total of 21. Congressional cap on production budget currently US$37.6 billion although, in third quarter of 2001, US DoD was considering asking Congress to increase this to US$45 billion; most recent (March 2003) production cost estimate is US$42.2 billion. At same time, total development cost estimated to be US$21.9 billion.

DESIGN FEATURES: Low-observables configuration and construction; stealth/agility trade-off decided by design team. Antennas located in leading- or trailing-edges of wings and fins, or flush with surfaces, to minimise radar signature. Target thrust/weight ratio 1.4 (achieved ratio 1.2 at T-O weight); greatly improved reliability and maintainability for high sortie-generation rates, including under 20 minutes combat turnround time; enhanced survivability through 'first-look, first-shot, first-kill' capability; short T-O and landing distances; supersonic cruise and manoeuvring (supercruise) in region of M1.5 without afterburning; internal weapons storage and generous internal fuel; conformal sensors.

Highly integrated avionics for single-pilot operation and rapid reaction. Radar, RWR and comms/ident managed by single system presenting relevant data only, and with emissions controlled (passive to fully active) in stages, according to tactical situation. CIP handles all avionics functions, including self-protection and radio, and automatically reconfigures to compensate for faults and failures. Two CIPs, with space for third, linked by 400 Mbits/s fibre optic network (see Avionics).

Wing and horizontal tail leading-edge sweep 42°; trailing-edge 17° forward, increased to 42° outboard of ailerons; all-moving five-edged horizontal tail. Vertical tail surfaces canted outwards at 28°; leading- and trailing-edge sweep 22.9°; biconvex aerofoil. Wing taper ratio 0.169; leading-edge anhedral 3.25°; root twist 0.5°; tip twist –3.1°; thickness/chord ratio 5.92 per cent at root, 4.29 per cent at tip; custom-designed aerofoil. Horizontal tails have no dihedral or twist.

Diamond-shaped cheek air intakes with highly contoured air ducts; single-axis thrust vectoring included



Lockheed Martin F/A-22A ***(James Goulding)*** ***NEW***/0526924 on F119, but most specified performance achievable without.

Production aircraft to be coated with new, Boeing-developed, stealthy paint intended to enhance low-visibility attributes; this first applied to second EMD aircraft in March 2000.

FLYING CONTROLS: Triplex, digital, fly-by-wire system with GEC sidestick control, using line-replaceable electronic modules to enhance maintainability; thrust vectoring utilised to augment aerodynamic pitch control power and provide firm control even at low speeds and high angles of attack. Technology and control concepts demonstrated throughout the flight envelope during prototype air vehicle test programme, including flight at AoA greater than 60°; wind tunnel testing with models of production aircraft successfully attained AoAs greater than 85°.

Ailerons and flaperons occupy almost entire wing trailing-edge; full-span leading-edge flaps; conventional rudders in vertical tail surfaces; slab taileron surfaces; airbrake not included (differential rudder and wing trailing-edge surfaces for speed control). Control surface authorities: leading-edge flaps 0° up/35° down (2°/37° overtravel); trailing-edge flaperons 20° up/35° down; ailerons ±25°; horizontal tail leading-edges 30° up/25° down; rudders ±30°; speedbrake (rudder) 30° out.

STRUCTURE: Lockheed Martin at Marietta constructs forward fuselage, including cockpit (with avionics architecture, displays, controls, air data system), apertures, edges, tail assembly, landing gear and environmental control system and undertakes final assembly. Lockheed Martin's Fort Worth plant builds the centre-fuselage; Palmdale, the radome. Boeing responsible for wings, fuselage aft sections, power plant installation, auxiliary power generation system, radar, arresting gear system and avionics integration laboratory.

Total airframe weight comprises approximately 36 per cent titanium 64, three per cent titanium 62222, 24 per cent thermoset composites (both epoxy resin and bismaleimide), one per cent thermoplastic composites, 16 per cent aluminium, 6 per cent steel and 14 per cent other materials. Forward fuselage substructure is aluminium and composites; centre-fuselage includes titanium, aluminium and composites; both forward and centre-fuselage skins primarily graphite bismaleimide. Four main mid-fuselage section bulkheads are single-piece, closed-die, titanium forgings. Rear fuselage approximately 67 per cent titanium, 22 per cent aluminium and 11 per cent composites. Engine bay doors titanium honeycomb, produced by liquid-interface diffusion bonding. Tailbooms assembled by electron beam welding. Titanium vent screens (to reduce radar reflectivity) contain thousands of precisely shaped holes in special alignment, each cut by abrasive water-jet. Thermoplastics used in areas requiring high tolerance to damage, examples including doors for landing gear and weapon bay.

Wing skins are monolithic graphite bismaleimide. Main (front) wing spars are machined titanium forgings; intermediate spars are mix of resin transfer moulded (RTM) sine-wave composites and titanium for strength to meet vulnerability requirements in wing fuel tank; rear spars composites and titanium. Wingroot and control surface actuator attachment fittings are titanium HIP castings. Horizontal stabiliser incorporates 'tow placed' composites pivot shaft in addition to aluminium honeycomb core and graphite bismaleimide skins; vertical stabilisers use solid graphite bismaleimide skins over graphite epoxy RTM spars. Wing control surfaces are combination of co-cured composites skins/substructure and non-metallic honeycomb core construction.

LANDING GEAR: Menasco retractable tricycle type, stressed for no-flare landings of up to 3.05 m (10 ft)/s. Honeywell wheels, brakes and anti-skid system. Nosewheel tyre Goodyear or Michelin 23.5×7.5-10 (22 ply) tubeless; mainwheel tyres Goodyear or Michelin 37×11.50-18 (30 ply) tubeless. Kaiser airfield arrester hook in enclosed fairing between engines.

POWER PLANT: Two 156 kN (35,000 lb st) class Pratt & Whitney F119-PW-100 advanced technology reheated turbofans, each fitted with a two-dimensional, convergent/divergent thrust vectoring (±20° in vertical plane) exhaust nozzle for enhanced performance and manoeuvrability.

Fuel in eight tanks located in forward fuselage, mid-fuselage, wings and tailbooms; provision for later addition of fuel in saddle and fin tanks. Additionally, up to four external fuel tanks, each 2,271 litres (600 US gallons; 500 Imp gallons), on underwing hardpoints. Dorsal Xar Industries aerial refuelling receptacle covered by doors, except when required. Fuel grade JP-8.

ACCOMMODATION: Pilot only, on zero/zero modified Boeing ACES II ejection seat and wearing tactical life support system with improved *g*-suits, pressure breathing and arm restraint. Pilot's view over nose is −15°. Canopy manufactured by Sierracin Sylmar Corp as single-piece unit, hinged at rear.

SYSTEMS: Twin 276 bar (4,000 lb/sq in) hydraulic systems with four pumps (each 273 litres; 72.0 US gallons; 60.0 Imp gallons per minute), but single Parker Bertea actuator on each control surface to save weight and cost. Curtiss Wright actuators on leading-edge flaps. Two 65 kW engine-driven generators. Honeywell G250 335 kW (450 hp) APU driving a Hamilton Sundstrand 27 kW generator and 100 litre (26.5 US gallon; 22.0 Imp gallon)/min pump. Smiths 270 V DC electrical distribution system. Honeywell environmental control system for life support system and flight avionics (open loop air cycle), mission avionics (closed loop vapour cycle) and fuel cooling (thermal management). OBIGGS and Normalair-Garrett OBOGS.

First operational F/A-22A Raptor arrives at 43rd FS/325th FW, Tyndall AFB, Florida, on 26 September 2003 *(Edwards AFB)* **NEW**/0567764

AVIONICS: Final integration, as well as integration of entire suite with non-avionics systems, undertaken at Avionics Integration Laboratory, Seattle, Washington; airborne integration supported by Boeing 757 flying testbed and the Air Vehicle Integration Facility (including coherent RF stimulation) at Marietta.

Comms: TRW AN/ASQ-220 communication/navigation/identification (CNI) system includes Mk 12 IFF and UHF/VHF. CNI system uses modules contained in two integrated CNI racks, CIP assets and integrated display/control panels. Intra-Flight Data Link (IFDL) encrypted radio and wireless communications modem allows all Raptors in a flight to share target and system data without fear of being overheard. Supplier team, responsible for electronics and software, also includes Rockwell Collins, ITT and GEC.

Radar: Northrop Grumman/Raytheon AN/APG-77 multimode radar incorporates active electronically scanned array (AESA), capable of interleaving air-to-air search and multitarget track functions. Also has weather mapping mode and provisions for air-to-ground modes and side arrays. Radar reported to be capable of detecting 1 m² (10.76 sq ft) target at range of approximately 109 n miles (201 km; 125 miles). AN/APG-77 to be replaced starting with Lot 5 production by new AESA radar that will eventually incorporate advanced air-to-ground computer software.

Flight: Vehicle management system (VMS) combines flight and propulsion controls; integrated vehicle subsystem control (IVSC) operates utilities via digital databus. Total of 18 Raytheon 1750A common processor modules used for VMS, IVSC and stores management system. F/A-22 is first fighter with triplex digital flight control computers and no electrical or mechanical back-up; control reconfiguration modes provide safe flying after actuator or hydraulic failures. VMS controls 14 surfaces (horizontal tail, ailerons, flaperons, rudders, leading-edge flaps and inlet bleed and bypass doors). No AoA limitation, but overstressing made impossible by restrictions to roll rate and load factor, according to fuel state, stores carriage and flight condition. Lear Astronics VMS integrated with Rosemount low-observable air data system, including two AoA probes and four sideslip plates on nose. CNI system includes GPS, Tacan and ILS. Twin Litton LN-100F INS. Throttle and stick contain 20 controls with 63 functions.

Software Block 0 for initial flight tests. Block 1.1 installed on aircraft 4004 in 1999, was primarily for radar, but included more than half of the avionics suite's source lines of code. Block 2, installed in the 757 FTB in October 1999, began sensor fusion, including radio frequency co-ordination and some electronic warfare functions. Block 3S added CNI and ECCM; Block 3.0, tested in the 757 FTB in fourth quarter of 2000 and flown for first time in F/A-22 on 5 January 2001, provided full sensor fusion and weapon delivery function; Block 3.1.3 adds GBU-32 JDAM, JTIDS receive and GPS and will be available to IOC aircraft. Block 4 will incorporate helmet cueing and AIM-9X. Work is under way on a Block 5 upgrade that should provide JTIDS transmit as well as enhanced air-ground capability from around 2006, including compatibility with forthcoming Small Diameter Bomb (SDB).

Instrumentation: Fused situational awareness information is displayed to pilot via four Lockheed Martin colour liquid crystal multifunction displays (MFD); MFD bezel buttons provide pilot format control. Centre screen measures 203 × 203 mm (8 × 8 in) and typically will function as situation display; right and left screens measure 152 × 152 mm (6 × 6 in) and function as attack and defensive displays respectively; fourth screen (directly below situation display) can be used to provide global side-view depiction of tactical situation and may also present other data such as fuel status, engine parameters, stores data, BIT reports and electronic checklists. Additionally, 76 × 102 mm (3 × 4 in) upfront display screens are each side of the integrated control panel, immediately below the BAE Systems HUD. Illumination is fully NVG-compatible.

Mission: Two Hughes common integrated processors (CIP); CIP also contains mission software that uses tailorable mission planning data for sensor emitter management and multisensor fusion; mission-specific information delivered to system through Fairchild data transfer equipment/mass memory (DTE/MM) system that contains mass storage for default data and air vehicle operational flight programme; stores management system. General purpose processing capacity of CIP is rated at more than 700 million instructions per second (Mips) with growth to 2,000 Mips; signal processing capacity greater than 20 billion operations per second (Bops) with expansion capability to 50 Bops; CIP contains more than 300 Mbytes of memory with growth potential to 650 Mbytes. Of 132 slots available in CIPs 1 and 2, 41 are initially vacant and thus available for growth. Intra-flight datalink automatically shares tactical information between two or more F/A-22s. CNI system includes JTIDS (receive-only terminal). Lockheed Martin airborne video recorder. Lockheed Martin stores management system. Airframe contains provisions for IRST and side-mounted phased-array radar.

Self-defence: BAE Systems AN/ALR-94 electronic warfare (RF warning and countermeasures and missile launch detection functions) subsystem. AN/ALE-52 flare dispenser.

ARMAMENT: Internal long-barrel General Dynamics M61A2 20 mm cannon with hinged muzzle cover and 480-round magazine capacity (production aircraft). Three internal bays for AIM-9M Sidewinder or next-generation AIM-9X (one in each side bay on Hughes LAU-141/A trapeze-type launcher) and six AIM-120C AMRAAM AAMs and/or 460 kg (1,015 lb) GBU-32 JDAM PGMs on Edo LAU-142/A hydraulic ejection launchers in main weapons bay. Four underwing stores stations at 317 mm (125 in) and 442 mm (174 in) from centreline of fuselage capable of carrying 2,268 kg (5,000 lb) each.

Typical weapon loads include six AIM-120s and two AIM-9s carried internally for air combat; two JDAMs, two AIM-120s and two AIM-9s carried internally for air-to-ground attack; and six AIM-120s and two AIM-9s internally, plus two external fuel tanks and further four AAMs (AIM-120 or AIM-9) underwing for long-range air combat.

Other weaponry envisaged for use by the F/A-22 includes the BLU-109 Penetrator, the wind-corrected munitions dispenser (WCMD), AGM-88 HARM, GBU-22 Paveway 3 guidance unit (with 500 lb bomb), new Small Diameter Bomb (SDB) and the low-cost autonomous attack system (LOCAAS) submunitions dispenser package.

DIMENSIONS, EXTERNAL:

Wing span	13.56 m (44 ft 6 in)
Wing chord: at root (theoretical)	9.85 m (32 ft 3½ in)
at tip (reference)	1.66 m (5 ft 5½ in)
at tip (actual)	1.14 m (3 ft 9 in)

Wing aspect ratio	2.4
Length overall	18.92 m (62 ft 1 in)
Height overall	5.08 m (16 ft 8 in)
Tail span: horizontal surfaces	8.84 m (29 ft 0 in)
vertical surfaces	5.97 m (19 ft 7 in)
Wheelbase	6.04 m (19 ft 9¾ in)
Weapon bay ground clearance	0.94 m (3 ft 1 in)
AREAS:	
Wings, gross	78.0 m² (840.0 sq ft)
Leading-edge flaps (total)	4.76 m² (51.20 sq ft)
Flaperons (total)	5.10 m² (55.00 sq ft)
Ailerons (total)	1.98 m² (21.40 sq ft)
Vertical tails (total)	16.54 m² (178.00 sq ft)
Rudders/speedbrakes (total)	5.09 m² (54.80 sq ft)
Stabilators (total)	12.63 m² (136.00 sq ft)
WEIGHTS AND LOADINGS (estimated):	
Weight empty (target)	14,365 kg (31,670 lb)
Max T-O weight	almost 27,216 kg (60,000 lb)
Max wing loading	348.7 kg/m² (71.43 lb/sq ft)
Max power loading	87 kg/kN (0.86 lb/lb st)
PERFORMANCE (YF-22, demonstrated):	
Max level speed: supercruise	M1.58
with afterburning	M1.7 at 9,150 m (30,000 ft)
Ceiling	15,240 m (50,000 ft)
g limit	+7.9
PERFORMANCE (F/A-22A, design target, estimated):	
Max level speed at S/L	800 kt (1,482 km/h; 921 mph)
g limit	+9

UPDATED

Royal Air Force Lockheed Martin C-130J Hercules C. Mk 5 ***(Paul Jackson)*** ***NEW***/0552708

LOCKHEED MARTIN 382U/V HERCULES

US Air Force designations: C-, CC-, EC-, WC-130J
US Coast Guard designation: HC-130J
US Marine Corps designation: KC-130J
RAF designations: Hercules C. Mk 4 (C-130J-30); Hercules C. Mk 5 (C-130J)

TYPE: Medium transport/multirole.

PROGRAMME: US Air Force specification issued 1951, leading to first-generation Hercules (Allison T56 turboprops); first production contract for C-130A to Lockheed September 1952; first flight 23 August 1954; two YC-130 prototypes, 231 C-130As, 230 C-130Bs, 491 C-130Es, 1,089 C-130Hs and 113 L-100s manufactured before introduction of C-130J and commercial L-100J equivalent. Official total of 2,156 (including prototypes) delivered by January 1998, when final C-130H handed over.

Privately funded development and flight test programme for next-generation version began in 1991 as Hercules II, but now known as C-130J Hercules, or L-100J in equivalent civilian form.

Initial British delivery accomplished on 24 August 1998; aircraft involved was ZH865, which arrived at Boscombe Down on 26 August for start of clearance trials by UK Defence Evaluation Research Agency (DERA). First aircraft ferried to RAF transport force at Lyneham was ZH878 on 21 November 1999. Final RAF aircraft flown from Marietta to Cambridge in late May 2000; final delivery to RAF on 21 June 2001.

First 'operational' mission accomplished by Lockheed Martin test crew in late November 1998, when C-130J completed three sorties from Marietta and airlifted 37,650 kg (83,000 lb) of hurricane relief supplies to Tegucigalpa, Honduras. Subsequently, 1999 witnessed start of deliveries to US Air Force Reserve Command and Air National Guard, as well as to operating units in Australia and the UK. Entire fleet had accumulated 30,000 flight hours by February 2002; by 24 July 2002, this had risen to 50,000 hours. Roll-out of the 100th C-130J – an aircraft for delivery to the US Coast Guard – took place on 17 February 2003.

Block 5.3 software configuration available from third quarter 2001 is standard equipment for latest deliveries and was retrofitted to existing aircraft by end of 2002; Block 5.3 offers ability to fly integrated precision radar approaches, gives enhanced navigation capabilities and permits fully automatic formation flying using co-ordinated aircraft positioning system (CAPS). Next version will be Block 5.4, which will be introduced in about FY05-06; new features include an AN/APX-119 IFF transponder and 8.33 kHz VHF radios. A Block 6.0 configuration is expected to follow and will be a phased upgrade programme allied to implementation of the civil global air traffic management system.

CURRENT VERSIONS: **C-130J:** Baseline version. Dimensionally similar to preceding C-130H, but incorporating new equipment and features as subsequently described. Subject of initial order for two from USAF in FY94, with subsequent contract for two in FY96; these initially earmarked for trials and eventually to Air Force Reserve Command (AFRC), while further eight funded in FY97 and FY98 assigned to Air National Guard's 135th Airlift Squadron at Warfield ANGB, Martin State Airport, Baltimore, Maryland, which fully equipped by mid-July 2000. Initial aircraft delivered to AFRC 403rd Wing at Keesler AFB, Mississippi, on 31 March 1999 for training.

Description applies mainly to baseline C-130J except where indicated.

C-130J-30: Stretched version of current production C-130; fuselage lengthened by 4.57 m (15 ft 0 in), offering increases in capability of between 31 and 50 per cent, dependent upon mission and configuration (see accompanying diagram). Orders received from Australia, Denmark, Italy, UK and USA.

CC-130J: Designation allocated to C-130J-30 aircraft in USAF service. First three funded in FY99, with two more in FY00 and five in FY02. Initial deliveries to ANG units in Rhode Island and California; FY02 aircraft to be assigned to 146th AW (two aircraft), 143rd AW (one), 403rd Wing (one) and a new USAF C-130J training unit that will be established at Little Rock AFB, Arkansas (one); all five to be delivered in 2004. In March 2003, USAF concluded contract for multiyear procurement of 40 CC-130Js, at rate of eight per year from FY04 up to and including FY08.

EC-130J: 'Commando Solo' psychological warfare version; first two funded in FY98 budget, with first (99-1933) handed over on 17 October 1999; after flight testing, it moved to Palmdale, California, in July 2000 for fitting out before being delivered to the 193rd Special Operations Squadron, Air National Guard, at Harrisburg IAP, Pennsylvania. IOC was expected by the end of 2003, but is likely to slip into 2004 because of problems encountered in integrating a new switchable 60/90 kVA generator with the broadcast system; this has caused delay in delivery of fully equipped aircraft to the 193rd SOS. Additional procurement comprises third example in FY99 budget, fourth in FY00 and fifth in FY01.

HC-130J: Replacement for earlier US Coast Guard HC-130s; funding for initial six contained in FY01 budget. First example handed over shortly before end of 2002.

KC-130J: Tanker/transport version for US Marine Corps, which has requirement for 79 to replace KC-130F, KC-130R and KC-130T variants. Fitted with two Flight Refuelling Mk32B-901E hose-and-drogue wing-mounted refuelling pods; three aircraft funded in FY97 budget, two in FY98, two in FY99, one in FY00, three in FY01 and two in FY02. Further 20 aircraft for USMC covered by multiyear procurement contract concluded in March 2003; this comprises initial batch of four in FY03, with additional aircraft at rate of four per year during FY05 to FY08. First contract for five USMC conversions (to be accomplished by end of 2000) announced 21 July 1998. Final assembly of first KC-130J (165735) began 22 March 1999, with first flight on 9 June 2000; total of three aircraft assigned to test programme at Patuxent River in latter half of 2000; first drogue engagement accomplished by Navy F/A-18 Hornet on 30 August 2000; initial trials revealed that aft fairing of pod was unsatisfactory, with cracks appearing in hose/drogue coupling; redesign of fairing in 2000-01 cleared way for further testing in second quarter of 2001, which confirmed much improved performance in areas of flying quality and durability. On completion of trials, all three test aircraft assigned to USMC tanker/transport squadron VMGR-252 at MCAS Cherry Point, North Carolina, which took delivery at beginning of September 2001; total of seven handed over by end 2001. Pod refuelling rate (each) 1,136 litres (300 US gallons; 250 Imp gallons) per minute; total offload capability is 32,005 litres (8,455 US gallons; 7,040 Imp gallons) using only wing and external tanks. Provisions for installation of refuelling probe incorporated in basic aircraft. Additional fuel in underwing and cargo hold tanks; see Power Plant.

MC-X Combat Talon 3: Potential new variant for USAF Special Operations Command, which has requirement for up to 54 aircraft, with procurement likely to begin in 2006. This will almost certainly be based on the C-130J. The same organisation is also contemplating acquisition of a new **AC-X** gunship that could utilise the C-130J airframe.

WC-130J: Weather reconnaissance version to be equipped with aerial reconnaissance weather officer console, dropsonde system operator console and dropsonde launch tube; initial batch of four included in FY96 budget, with three more in FY97, two in FY98 and one in FY99; for 53rd WRS, Air Force Reserve Command at Keesler AFB, Mississippi. US$46.9 million contract for modification of first six, with option for further four, signed 18 September 1998; deliveries began on 30 September 1999; formal acceptance 12 October 1999.

CUSTOMERS: See tables. Total of 178 ordered by March 2003. First customer was RAF, which ordered 25 in December 1994; of these, 15 are stretched C-130J-30, designated C. Mk 4, with final 10 as standard C-130Js, designated Hercules C. Mk 5. Delivery of first example to the trials unit at Boscombe Down was due in November 1996, but was delayed until 26 August 1998. First service recipient was J Conversion Flight of No. 57 (Reserve) Squadron, followed by No. 24 and then No. 30 Squadrons at RAF Lyneham. Deliveries to Lyneham began on 21 November 1999, when C. Mk 4 ZH878 arrived for duty as temporary ground procedures trainer; two days later, on 23 November, C. Mk 4 ZH875 was formally handed over in official ceremony at Lyneham. Completion of deliveries occurred on 21 June 2001; operational service with RAF began 14 November 2000, when No.24 Squadron flew scheduled mission to Puerto Rico. No.30 Squadron attained operational status in June 2002. In mid-2002, it appeared likely that some RAF C. Mk 5 aircraft would be fitted with in-flight refuelling systems identical to those of the USMC KC-130J.

Second order covered two C-130Js for evaluation by the USAF and was finalised on 13 October 1995, one week before the first was rolled out at Marietta. Further two funded in FY96, four in FY97 and four in FY98 for Air Force Reserve Command and Air National Guard units; first ANG squadron was 135th AS at Martin State Airport, Baltimore. Further orders began FY99 with contract for three CC-130J aircraft, with FY01 procurement including two more CC-130Js for USAF and initial batch of six C-130Js for long-range SAR duties with US Coast Guard;

Lockheed Martin CC-130J of Rhode Island Air National Guard 0127027

Flight deck of the C-130J, showing HUDs and EFIS 0075954

US C-130J PROCUREMENT
(To March 2003)

FY	C-130J	CC-130J	EC-130J	HC-130J	KC-130J	WC-130J	Total
94	2						2
96	2					4	6
97	4				3	3	10
98	4		2		2	2	10
99		3	1		2	1	7
00			1		1		2
01		2	1	6	3		12
02		5			2		7
03-08		40			20		60
Total	**12**	**50**	**5**	**6**	**33**	**10**	**116**

Note: FY03-08 procurement covered by multiyear contract, with initial tranche of four KC-130Js funded in FY03. USAF plans to acquire eight CC-130Js per year during FY04 to FY08, with USMC obtaining four KC-130Js per year during FY05 to FY08. Additional aircraft are likely to be purchased for Air National Guard and and Air Force Reserve Command

five more CC-130Js in FY02 budget. First CC-130J rolled out 25 January 2001; following testing, this delivered to 143rd AW, Rhode Island ANG, on 2 December 2001. Two more CC-130Js to 143rd AW by end 2001, with next two for 146th AW, California ANG, which received its first example on 2 June 2002.

Second order received in 1995 was from Australia, for 12 C-130J-30s to replace C-130Es of No. 37 Squadron at Richmond, at total cost of US$660 million. Order placed on 21 December 1995 and included options for an additional 24 aircraft, plus eight options for New Zealand, which was guaranteed pricing based on Australia's larger order; options have not been converted to firm orders and appear unlikely to be. First Australian C-130J (A97-440/N130JQ, c/n 5440) flew on 15 February 1997; delivery began 7 September 1999, when A97-464 arrived at Richmond; last of initial batch handed over on 1 June 2000, with operational status achieved in December 2001.

Third overseas customer was Italy, which initially ordered 18 C-130Js, subsequently adding two more in January 2000 and another two in March 2000; last four were stretched C-130J-30 version. At same time as placing final order, Italy revised overall procurement plan and will now receive 12 C-130Js and 10 C-130J-30s. First aircraft rolled out at Marietta on 11 July 2000. Italian military certification also awarded in July 2000, with first C-130J delivery (actually second aircraft, MM 62176, c/n 5497) to 2° Gruppo, 46° Aerobrigata at Pisa departing USA on 16 August; formal acceptance 21 September 2000. All will be tanker-capable and configured to receive fuel, although only six likely to be operated as such at any one time. Two of the original aircraft are to be adapted as sigint platforms by 2006, with antennae fitted to removable panels; reconfiguration from basic transport role to specialised sigint mission would require maximum of 24 hours; equipment is to include 12 workstations, a communications suite and secure datalinks. C-130J-30 version assigned to 50° Gruppo, 46° Aerobrigata, from third quarter of 2002. Newest export customer is Denmark, which ordered three C-130J-30s, with option on fourth, in December 2000.

Other potential customers reported to be in discussion with Lockheed Martin include Bahrain, Canada, Egypt, Israel, Kuwait and Portugal. Norway has expressed interest in obtaining six as replacements for its current fleet of six C-130Hs, while Saudi Arabia reported to have requirement for up to 24 aircraft.

MILITARY/GOVERNMENT C-130J SALES
(To March 2003, excluding USA)

Country	J	J-30	Total
Australia		12	12
Denmark		3	3
Italy	12	10	22
UK	10	15	25
Total	**22**	**40**	**62**

Note: Options not included

COSTS: US$55 million programme unit cost (Australia) (1995). Italian order of November 1997 valued at US$1.2 billion. Baseline price of C-130J-30 quoted as US$67 million in early 2002. Multiyear procurement of 40 CC-130Js for USAF and 20 KC-130Js for US Marine Corps valued at US$4.05 billion (unit price US$67.5 million). FY03 contract for one CC-130J for Air Force Reserve Command worth US$70.5 million.

DESIGN FEATURES: Archetypal tactical transport: upswept rear fuselage for ramp access; high wing for propeller ground clearance despite low floor height; latter provided by pannier-mounted landing gear, which obviates long mainwheel legs stowed in wings. Can deliver loads and parachutists over open ramp and parachutists through side doors; cargo hold pressurised.

Significant changes introduced with C-130J, which optimised for economical operation, justifying customers' substitution for earlier C-130s on 30 year lifetime savings alone. Entirely revised flight deck reduces LRUs by half and wire assemblies by 53 per cent, with wire terminations cut by 81 per cent; has four MFDs, plus HUD for both pilots; lighting compatible with NVGs. Most systems have digital interfaces with the main mission computer to include unmodified mechanical systems like the hydraulics, which are largely unaltered from those of C-130H; provision for integrated self-defence suite (RWR, MAW, chaff/flare dispensers and IR jammers). Propulsion system provides 29 per cent more take-off thrust and is 15 per cent more efficient; fuel efficiencies obviate requirement for external tanks on most types of mission; propeller has 50 per cent fewer parts and weighs 15 per cent less. Manpower requirements of typical 16-aircraft squadron cut by 38 per cent compared with earlier versions of C-130, as result of reduced flight crew and 50 per cent better maintainability. Comprehensive computerised maintenance system employs a hand-held data module as interface between aircraft's BITE and operating base's central technical records.

Wing section NACA 64A318 at root and NACA 64A412 at tip; dihedral 2° 30′; incidence 3° at root, 0° at tip.

FLYING CONTROLS: All flying controls integrated with digital autopilot/flight director and comprise control surfaces boosted by dual hydraulic units; trim tabs on ailerons, both elevators and rudder; elevator tabs have AC main supply and DC standby; Lockheed-Fowler composites trailing-edge flaps.

STRUCTURE: All-metal two-spar wing with integrally stiffened taper-machined skin panels up to 14.63 m (48 ft 0 in) long. Incorporates carbon fibre composites materials for flaps and 32 graphite-epoxy trailing-edge panels.

LANDING GEAR: Hydraulically retractable tricycle type. Each main unit has two wheels in tandem, retracting into fairing built on to fuselage side. Nose unit has twin wheels and is steerable ±60°. Mainwheels 20.00-20 (26 ply) tubeless; nose 12.50-16 (12 ply) tubed or tubeless. Oleo shock-absorbers. Minimum ground turning radius: C-130J, 11.28 m (37 ft) about nosewheel and 25.91 m (85 ft) about wingtip; C-130J-30/CC-130J 14.33 m (47 ft) about nosewheel and 27.43 m (90 ft) about wingtip.

POWER PLANT: Four Rolls-Royce AE 2100D3 turboprops, flat rated to 3,424 kW (4,591 shp) (manufacturer's rating 3,458 kW; 4,637 shp at ISA + 25°C), fitted with Dowty Aerospace R391 six-blade composites propellers and Lucas Aerospace FADEC. Automatic thrust control system (ATCs) and autofeather systems, plus engine monitoring system (EMS) which is incorporated into aircraft's integrated diagnostic system (IDS).

Total internal fuel capacity of 25,552 litres (6,750 US gallons; 5,621 Imp gallons) without foam and 24,363 litres (6,436 US gallons; 5,359 Imp gallons) with foam. Provisions only for two optional underwing pylon tanks, each with capacity of 5,220 litres (1,379 US gallons; 1,148 Imp gallons) without foam and 4,883 litres (1,290 US gallons; 1,074 Imp gallons) with foam. Total fuel capacity 35,992 litres (9,508 US gallons; 7,917 Imp gallons) without foam and 34,129 litres (9,016 US gallons; 7,507 Imp gallons) with foam. Tanker versions can carry cargo hold tank with additional 13,578 litres (3,587 US gallons; 2,987 Imp gallons). Single pressure refuelling point and overwing gravity fuelling. In-flight refuelling probe fitted as standard on port side of RAF aircraft; optional for all others, with Italian aircraft currently unique in being configured as receiver/tankers.

ACCOMMODATION: Crew of two on flight deck, comprising pilot and co-pilot, with provisions for optional third workstation. Ergonomic problems suffered by short pilots necessitated a number of alterations to cockpit, including redesign of seat and seat track, HUD and main control yoke, with throttle quadrant also modified. Two crew bunks, with lower incorporating three additional seats and harnesses for relief crew/flight deck passengers. Galley. Separate loadmaster's station in cargo hold, including folding desk, is standard equipment on RAF aircraft; optional for all others. Flight deck and main cabin pressurised and air conditioned.

Standard complements for C-130J are as follows: 92 troops, 64 paratroopers, 74 litter patients plus two attendants, 54 passengers on palletised airline seating. Corresponding data for C-130J-30/CC-130J are 128 troops, 92 paratroopers, 97 litter patients plus four attendants and 79 passengers on palletised airline seating. Airdrop loads comparable to C-130H/H-30 and include light armoured vehicles. Light and medium towed artillery pieces, wheeled and tracked vehicles and 463L palletised loads (five in C-130J and seven in C-130J-30/CC-130J, plus one on ramp in each model) are transportable. Hydraulically operated (with dual actuators) main loading door and ramp at rear of hold; can be opened in flight at up to 250 kt (463 km/h; 288 mph). Crew door on port forward fuselage side. Paratroop door on each side aft of landing gear fairing. Two emergency exit doors standard. Optional cargo handling system ordered by the USAF includes flush-mounted winch; in-ramp towplate for airdrop operations; low-profile rails and electric locks; flip-over rollers with covers; container delivery system centre vertical restraint rails. Capable of automatic preprogrammed cargo drops.

SYSTEMS: Lucas generator. Environmental control system in starboard undercarriage fairing is similar to that of the C-130H, incorporating dual air cycle machines, but with

Lockheed Martin C-130J-30 in Royal Australian Air Force service *(Paul Jackson)* ***NEW***/0552872

30 per cent greater cooling capacity and a digital electronic control system. Honeywell GTCP85-185L(A) auxiliary power unit in port undercarriage fairing furnishes ground electrical power and bleed air for environmental control system. MIL-STD-1553B digital databus architecture. Integrated diagnostic system (IDS) incorporating fault detection/isolation subsystem with BIT (built-in test) facility. Goodrich pneumatic fin anti-icing system.

AVIONICS: *Comms:* Honeywell com/nav/ident management system, with Intel 80960 processor. AN/ARC-222 VHF, HF/UHF radio, intercom and IFF, with provisions for satcom system. All communication radios have secure features. AN/APX-119 IFF to be included on Block 5.4 and subsequent aircraft.

Radar: Northrop Grumman AN/APN-241 low-power colour radar incorporates Doppler beam-sharpening ground mapping mode, air-to-air skin paint mode and protective windshear mode as well as conventional colour weather radar.

Flight: HG-9550 radar altimeter, AN/ARN-153(V) Tacan, digital autopilot/flight director (DA/FD), dual Honeywell laser INS with embedded GPS receivers, Doppler velocity sensor, VOR, ILS, marker beacon receiver, UHF/VHF DF, ADF, E-TCAS, ground collision avoidance system (GCAS), global digital map display units and provision for microwave landing system.

Instrumentation: 'Dark cockpit' concept. Flight Dynamics HUD as certified primary flight instrument at pilot and co-pilot positions, four 152 × 203 mm (6 × 8 in) Avionics Display Corporation active matrix liquid-crystal display (AMLCD) colour multipurpose display systems (CMDSs) which are NVG-compatible for flight instrumentation, navigation and engine information and five Avionics Display Corporation 58 × 76 mm (2.3 × 3 in) monochrome AMLCDs for digital selector panels.

Mission: Sierra Technologies AN/APN-243(V) station-keeping equipment. Provision for secure voice communication system.

Self-defence: Provisions for Lockheed Martin AN/AAR-47 missile warning system, Sanders AN/ALQ-157 IR countermeasures system, BAE Systems AN/ALE-47 chaff/flare dispensing systems and AN/ALR-56M radar warning receiver or AN/ALR-69 enhanced radar warning system. RAF aircraft originally ordered with US-supplied systems, but RWR and countermeasures dispensing systems now subject to bidding from UK defence sector, with formal contest beginning early 1998. Northrop Grumman Large Aircraft Infra-Red Countermeasures (LAIRCM) system to be installed on Air Mobility Command CC-130J, following successful conclusion of EMD testing in 2002-04.

EQUIPMENT: USMC KC-130Js and Italian C-130Js have Flight Refuelling Mk 32B-901E hose pods underwing. Latest CC-130Js for Air National Guard's 146th AW are equipped with Airborne Fire Fighting System (AFFS), which allows them to drop up to 15,142 litres (4,000 US gallons; 3,331 Imp gallons) of fire retardant in a single pass. Italian C-130J configured to operate with Special Avionics Mission Strap-on-Now (SAMSON) C-130 Open Skies System (COPS) in support of international arms control verification efforts.

DIMENSIONS, EXTERNAL:

Wing span	40.41 m (132 ft 7 in)
Wing aspect ratio	10.1
Length overall: C-130J	29.79 m (97 ft 9 in)
C-130J-30/CC-130J	34.37 m (112 ft 9 in)
Height overall: C-130J	11.84 m (38 ft 10 in)
C-130J-30/CC-130J	11.81 m (38 ft 9 in)
Tailplane span	16.05 m (52 ft 8 in)
Wheel track	4.34 m (14 ft 3 in)
Propeller diameter	4.11 m (13 ft 6 in)
Main cargo door (rear of cabin):	
Height	2.77 m (9 ft 1 in)
Width	3.12 m (10 ft 3 in)
Height to sill	1.03 m (3 ft 5 in)
Paratroop doors (each): Height	1.83 m (6 ft 0 in)
Width	0.91 m (3 ft 0 in)
Height to sill	1.03 m (3 ft 5 in)
Emergency exits (each): Height	1.22 m (4 ft 0 in)
Width	0.71 m (2 ft 4 in)

DIMENSIONS, INTERNAL:

Cabin, excl flight deck:	
Length excl ramp: C-130J	12.19 m (40 ft 0 in)
C-130J-30/CC-130J	16.76 m (55 ft 0 in)
Length incl ramp: C-130J	15.32 m (50 ft 3 in)
C-130J-30/CC-130J	19.89 m (65 ft 3 in)
Max width	3.12 m (10 ft 3 in)
Max height	2.74 m (9 ft 0 in)
Total usable volume: C-130J	128.9 m³ (4,551 cu ft)
C-130J-30/CC-130J	170.5 m³ (6,022 cu ft)

AREAS:

Wings, gross	162.12 m² (1,745.0 sq ft)
Ailerons (total)	10.22 m² (110.00 sq ft)
Trailing-edge flaps (total)	31.77 m² (342.00 sq ft)
Fin	20.90 m² (225.00 sq ft)
Rudder, incl tab	6.97 m² (75.00 sq ft)
Tailplane	35.40 m² (381.00 sq ft)
Elevators, incl tabs	14.40 m² (155.00 sq ft)

WEIGHTS AND LOADINGS (internal fuel only, except where specified):

Operating weight empty:	
C-130J	34,274 kg (75,562 lb)
C-130J-30/CC-130J	35,966 kg (79,291 lb)
Max fuel weight: internal	20,819 kg (45,900 lb)
external (optional)	8,506 kg (18,754 lb)
Max payload, 2.5 *g*: C-130J	18,955 kg (41,790 lb)
C-130J-30/CC-130J	17,264 kg (38,061 lb)
Max normal T-O weight	70,305 kg (155,000 lb)
Max overload T-O weight:	
C-130J, C. Mk 4	79,380 kg (175,000 lb)
Max normal landing weight	58,965 kg (130,000 lb)
Max overload landing weight	70,305 kg (155,000 lb)
Max zero-fuel weight, 2.5 *g*	53,230 kg (117,350 lb)
Max wing loading (normal)	433.7 kg/m² (88.83 lb/sq ft)
Max power loading (normal)	5.14 kg/kW (8.44 lb/shp)

PERFORMANCE (C-130J except where indicated):

Never-exceed speed (V_{NE}) at 3,050 m (10,000 ft)	
C. Mk 4	378 kt (700 km/h; 435 mph)
Max cruising speed:	
C-130J	348 kt (645 km/h; 400 mph)
C. Mk 4 at 7,620 m (25,000 ft)	356 kt (659 km/h; 410 mph)
Econ cruising speed	339 kt (628 km/h; 390 mph)
Stalling speed	100 kt (185 km/h; 115 mph)
Max rate of climb at S/L	640 m (2,100 ft)/min
Time to 6,100 m (20,000 ft)	14 min
Cruising altitude	8,535 m (28,000 ft)
Service ceiling at 66,680 kg (147,000 lb) AUW	9,315 m (30,560 ft)
Service ceiling, OEI, at 66,680 kg (147,000 lb) AUW	6,955 m (22,820 ft)
T-O run	930 m (3,050 ft)
T-O to 15 m (50 ft)	1,433 m (4,700 ft)
T-O run using max effort procedures	549 m (1,800 ft)
Landing from 15 m (50 ft) at 58,967 kg (130,000 lb) AUW	777 m (2,550 ft)
Landing run at 58,967 kg (130,000 lb) AUW	427 m (1,400 ft)
Runway LCN: asphalt	37
concrete	42
Range with 18,144 kg (40,000 lb) payload and Mil-C-5011A reserves	2,835 n miles (5,250 km; 3,262 miles)

UPDATED

LOCKHEED MARTIN ADVANCED MOBILITY AIRCRAFT (AMA)

TYPE: Medium transport/multirole.

PROGRAMME: Studies under way since early 1995; initially known as 'World Airlifter' and New Strategic Aircraft (NSA). Lockheed Martin's primary objective was to develop a replacement for Boeing KC-135 Stratotanker in-flight refuelling aircraft, Lockheed C-141 StarLifter strategic transport and tanker/transport types such as the Lockheed L-1011 TriStar and McDonnell Douglas KC-10 Extender, although it is also intended to offer commercial freighter versions as well as special mission aircraft configured for AEW and battlefield surveillance tasks.

Lockheed Martin is proposing to develop the AMA as a private venture and is seeking two or three risk-sharing international partners to form a consortium; past discussions took place with several potential partners, including Aerospatiale Matra, DaimlerChrysler Aerospace and BAE Systems.

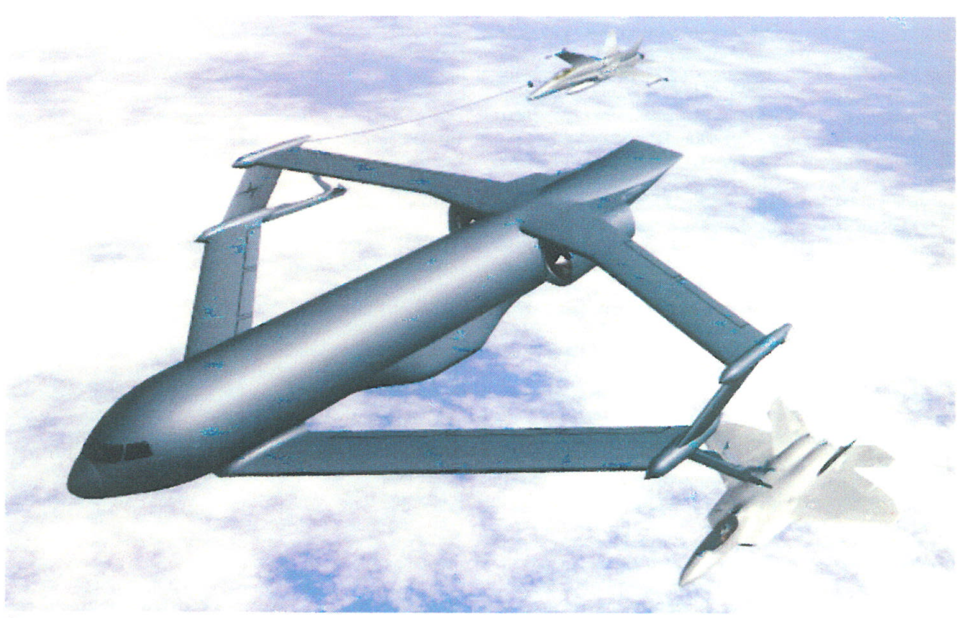
Recent studies envisage a twin-engined design with high bypass turbofans in the 267 to 311 kN (60,000 to 70,000 lb st) class, an M0.85 cruise speed, with 30 per cent greater fuel offload than the KC-135R/T Stratotanker. In the cargo role, AMA will carry a payload of 45,360 to 54,430 kg (100,000 to 120,000 lb) over 4,000 n miles (7,408 km; 4,603 miles).

Over 40 advanced aircraft designs examined, leading to further study of four basic concepts, all of which feature modular design using common basic structure and systems to reduce initial manufacturing costs and facilitate airframe upgrades during service life. Modular systems and avionics bus architecture will easily accommodate mission-orientated equipment for specific roles. Configurations studied include a conventional high-wing aircraft; a blended wing/body aircraft; a box-wing aircraft with two refuelling booms and two hose-and-drogue assemblies; and a global transport with an unrefuelled range of 12,000 n miles (22,220 km; 13,810 miles).

Design effort directed to the box-wing aircraft concept during 1997-2000, by virtue of aerodynamic and structural efficiency, combined with greatly reduced aircraft size. As recently envisaged, it will have two flight deck crew, plus advanced refuelling and loadmaster workstations; incorporate roll-on/roll-off cargo handling capability and be compatible with 20 and 40 ft ISO containers; and embody fly-by-light/power-by-wire flight control systems. Testing of a radio-controlled scale model began on 7 March 1997, this exhibiting excellent flight characteristics and meeting, or surpassing, test objectives during a total of 18 sorties.

Current planning expects AMA development effort to reach a peak during 2004-13, with resultant production aircraft ready for delivery from 2013; however, USAF purchase seems less likely in view of decision to acquire Boeing KC-767 tanker on lease. No recent news received.

UPDATED



Computer-generated image of Lockheed Martin box-wing tanker/transport design 0121681

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Palmdale performs upgrades and modifications to Lockheed U-2, F-117 and C-130. Is also headquarters for Advanced Development Programs (ADP) initiatives across the Lockheed Martin Aeronautics Company, this facility also being known as the legendary Skunk Works. Responsibilities include derivatives or upgrades of current aircraft systems, new development systems, critical technology development and integration, and operational effectiveness and system analysis. Palmdale performs rapid prototyping – examples including the X-35 Joint Strike Fighter concept demonstrators. Next-generation platforms such as Unmanned Air Vehicle concepts are undergoing research and test at Palmdale.

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General Dynamics' Fort Worth Division sold to Lockheed; became Lockheed Fort Worth Company on 1 March 1993; renamed Lockheed Martin Tactical Aircraft Systems following merger between Lockheed and Martin Marietta in 1995. Adopted current title in January 2000 with consolidation of all Lockheed Martin aeronautical operations into single company with headquarters in Fort Worth, Texas.

Activities include production, development and support of F-16 Fighting Falcon; one-third share of F/A-22 Raptor development and initial production; and leadership of F-35 Joint Strike Fighter development team (with Northrop Grumman and BAE Systems). Is principal subcontractor to Mitsubishi for production of F-2 in Japan and to KAI for development of T-50 in South Korea.

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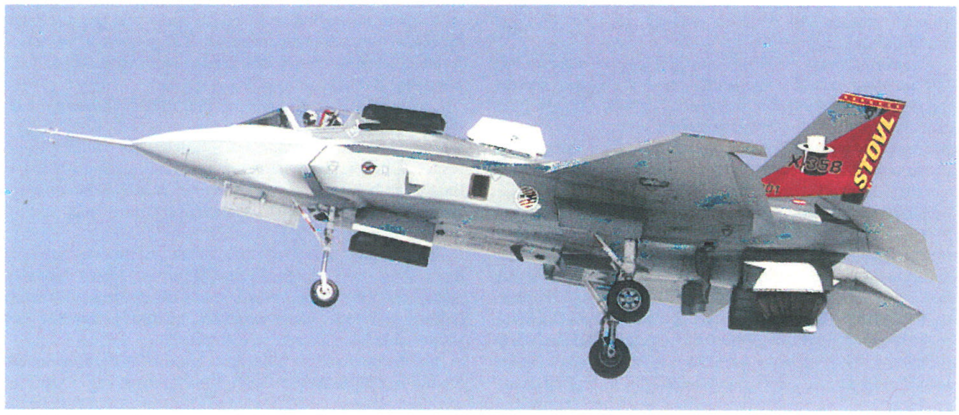


X-35B in transition mode with fan doors open and landing gear deployed 0527090

LOCKHEED MARTIN F-35 JOINT STRIKE FIGHTER

TYPE: Multirole fighter.
PROGRAMME:

DEVELOPMENT MILESTONES

Requirement issued	Nov 94
Request for proposals	Dec 95
Programme launched	16 Nov 96
First prototype material cut	Sep 97
First flight	24 Oct 00
Production go-ahead	26 Oct 01

Origins of Joint Strike Fighter (JSF) programme vested in separate USAF/USN Joint Advanced Strike Technology (JAST) and Defense Advanced Research Project Agency (DARPA) Common Affordable Lightweight Fighter (CALF) projects of early 1990s.

Projects merged in November 1994, as JAST, after Congressional directive in mid-1994; programme renamed JSF in latter half of 1995. Previously, formal request for proposals (RFP) for preliminary research contracts released on 2 September 1994, stipulating industry response by 4 November and issue of contract awards by 16 December.

Some elements of US industry joined forces to win JAST/JSF work, with international collaboration in evidence. McDonnell Douglas led one team after signing October 1994 Memorandum of Understanding (MoU) with Northrop Grumman and British Aerospace; each company submitted individual bids, but all three would participate in event of securing contract. Boeing allied with Dassault of France on aspects of subsystem design effort.

Subsequent research contracts worth US$99.8 million were distributed between four companies: Boeing (US$27.6 million), Lockheed Martin (US$19.9 million), McDonnell Douglas (US$28.2 million) and Northrop Grumman (US$24.1 million). Further US$28 million allocated for associated avionics, propulsion systems, structures and materials, and modelling and simulation.

Merger of JAST and CALF resulted in expanded flight test programme, involving two finalists; each to build two demonstrators, one with ASTOVL capability and the other to use conventional take-off and landing (CTOL).

Draft RFP issued December 1995, with USA and UK signing MoU on 20 December 1995, which committed UK to participate in four year weapons system concept demonstration (WSCD) phase. MoU also stipulated that UK must contribute some 10 per cent (approximately US$200 million) of demonstration phase costs as full collaborative partner.

Formal release of the final RFP for JSF was expected on 7 March 1996, but was delayed to June 1996, with contract award date in November 1996.

All WSCD contenders chose Pratt & Whitney's F119 (later redesignated F135) engine for their proposals, although a General Electric/Allison/Rolls-Royce team secured a US$7 million contract in March 1996 to examine alternative power plants. These were based on the General Electric F110 and YF120 engines, with the latter being chosen in May 1996 following Congressional directive aimed at fostering competition and also overcoming possible impact of developmental or operational problems with the F119. Further US$96 million multiyear contract awarded in February 1997 to cover technology maturation and core engine development of alternate F136 engine over four-year period. Original intent was to begin full-scale EMD of F136 in about 2004, but US$511 million cut in funding during FY04 to FY09 expected to result in two-year delay, with production engine not now likely to be available until 2013, at earliest.

On 16 November 1996, US Secretary of Defense, William J Perry announced that Boeing and Lockheed Martin had been chosen to participate in WSCD. Simultaneously, Boeing was awarded a US$661.8 million contract for the X-32, while Lockheed Martin received US$718.8 million for the X-35; in addition, Pratt & Whitney secured a contract worth US$804 million for the associated Engine Ground and Flight Demonstration Program. Subsequently, Northrop Grumman and British Aerospace joined Lockheed Martin team.

Australia, Canada, France, Germany, Greece, Israel, Singapore, Spain and Sweden were all briefed on JSF programme. For System Development and Demonstration (SDD) phase, four partnership options available. Most costly is Level 1, with responsibility for 10 per cent of cost; UK is only partner at this level. Italy and the Netherlands are Level 2 partners, each contributing about 5 per cent of cost. Level 3 involves payment of 1 to 2 per cent, with Denmark and Norway having teamed up to share burden, while Australia, Canada and Turkey meet the cost alone. Finally, Security Co-operation Participant Level involves smaller contribution of US$75 million; Israel and Singapore were first two subscribers, signing letters of intent in February 2003. Greece, Poland and South Korea are potential future additions and Taiwan may also acquire STOVL version in due course.

Lockheed Martin development included production of 91 per cent scale powered model of JAST demonstrator for wind-tunnel tests. Model JAST, with F100 engine, began trials at Pratt & Whitney's West Palm Beach, Florida, facility in February 1995; subsequently to outdoor hover test rig at NASA Ames and then installed in 24 × 36 m wind tunnel at Mountain View, California, for series of powered hover and transition tests which ran from December 1995 to 5 March 1996; total of 196 hours accumulated, representative of approximately 2,400 take-offs and landings with the vertical lift system. Midway through outdoor hover tests, design was reconfigured to eliminate canards.

Lockheed Martin design, development, construction and flight testing of full-scale demonstrator aircraft, required one initially to be flown as CTOL version (X-35A) to demonstrate land-based USAF model, before being reconfigured to serve as STOVL version (X-35B) for US Marine Corps, Royal Air Force and Royal Navy; other aircraft representative of carrier-capable US Navy model (X-35C). Although Fort Worth is team leader, both X-35 aircraft built at Palmdale, California, using rapid prototyping techniques.

Design of X-35 frozen as **Configuration 220** 13 June 1997 after Initial Design Review, at which time 11,000 hours of model testing accumulated. Development team joined by Northrop Grumman on 8 May 1997 and BAe (now BAE Systems) on 18 June 1997.

Release of engineering drawings in early September 1997 heralded start of parts production at Palmdale for demonstrator aircraft; by end of 1997, Lockheed Martin had completed about 70 per cent of required tooling and had conducted second interim programme review. X-35 final design review completed in September 1998 and coincided with roll-out of full-scale mockup at Fort Worth. Assembly of first aircraft began in April 1998, with main wing carry-through bulkhead installed in early August 1998, by which time manufacturing of large composites skins for upper and lower wing surfaces also complete; aircraft moved from assembly testing to factory floor on 18 September 1999, in readiness for installation of flight control surfaces and landing gear as well as systems checks.

Flight control system software tested on NF-16D VISTA in 1998 as part of integrated subsystem technology demonstration. Further trials using AFTI/F-16 in 1999-2000 involved all-electric flight control system and modular electric power system planned for JSF. JSF avionics also tested on Northrop Grumman's BAe One-Eleven Co-operative Avionics Test Bed (CATB), which was fitted with sensors, processors and software in 1999; trials begun of Northrop Grumman radar and distributed infra-red sensor system, Kaiser helmet-mounted display and Lockheed Martin core processor in first quarter 2000.

More than 100 hours of flight time accumulated by early September 2000 using CATB, when avionics development and integration process completed; successful demonstrations included automatic target cueing (ATC), whereby sensors acquire targets rapidly and automatically; electro-optical targeting system (EOTS); electronic warfare suite and electronically scanned radar. Subsequent testing included co-operative engagement between CATB and Northrop Grumman E-8C Joint STARS, demonstrating all-weather precision targeting and combat identification techniques for fixed and moving targets.

Lockheed Martin X-35C US Navy version 0528624

Design of JSF continued to be refined after selection of Configuration 230-1. By 1998, third version of **Configuration 230 (230-3)** had reduced area of USAF/USMC JSF wings by seven per cent, but increased USN variant's wing area by 11 per cent. Further redesign occurred in 1999, culminating in September with Configuration 230-5, which has enlarged wing to satisfy sustained turn performance requirement and strengthened to meet 9 *g* stress requirement for the CTOL variant; further main change involved redesign of lift-fan nozzle from D-shape extendible box to venetian blind-type box, offering dual benefits of simpler design and reduced weight for the STOVL configuration.

Redesign process continued into 2000, with Configuration 230-5 adding further refinements aimed at reducing weight and increasing payload bringback capability; resultant structural modification entailed weight reduction in several areas such as weapon bay and landing gear door assemblies. Configuration 230-5 finally submitted as Preferred Weapons System Concept design in mid-2000.

Significant programme events in latter part of 1998 and 1999 included first test run of basic Pratt & Whitney JSF119 engine (designated FX661) at West Palm Beach, Florida, facility on 11 June 1998; over 330 hours of developmental testing performed by end August 1999, validating complete X-35 flight envelope. Final altitude flight qualification testing undertaken with another engine (designated FX663) in fourth quarter of 1999. National Aerospace Laboratory low-speed wind tunnel in the Netherlands used for testing of scale models of JSF starting in June 1998; initial trials of lift fan system's clutch, fan and gearbox rigs at Indianapolis, Indiana, in May and June 1998; and installation of engine inlet duct in assembly tool at Palmdale at beginning of July 1998. Subsequently, also in July, over 50 hours of preliminary engine testing were completed at West Palm Beach, including vibration surveys, fan and core running-in, operating performance calibration and engine control stability assessment; next key phase of engine test programme involved altitude testing at Arnold Engine Development Center, Tennessee.

Testing of first STOVL engine (designated FX662) undertaken initially at West Palm Beach; first run with lift fan engaged accomplished on 10 November 1998, with operation to 100 per cent speed following on 22 November; first series of tests included stress surveys and performance calibration and occupied about six weeks. Validation of STOVL propulsion system achieved in late August 1999, with high-power clutch engagement of shaft-driven lift fan, simulating seamless conversion from conventional wing-borne flight configuration to jet-borne flight configuration for STOVL approach ending with vertical landing.

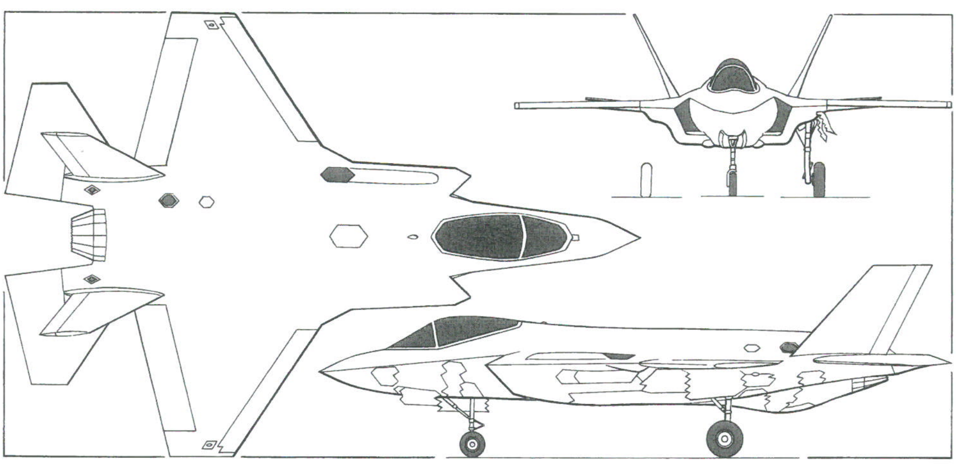
Following this, on 9 December 1999, flight engine YF001 successfully installed on the X-35A demonstrator at Palmdale, with integration tests, including plumbing connections, data communications and electrical checks, beginning immediately thereafter.

In UK, DERA vectored-thrust advanced aircraft control (VAAC) Harrier T. Mk 4 completed 20 hour, 36 sortie, flight test programme in November 1998, during which a sidestick control column was evaluated by civilian and military pilots. Two-phase programme began with initial calibration to validate STOVL control laws and stick characteristics; subsequent evaluation included pattern work, approach and transition to hover and precision and aggressive hover tasks, resulting in confirmation that side-stick provides satisfactory control of STOVL aircraft at low speeds.

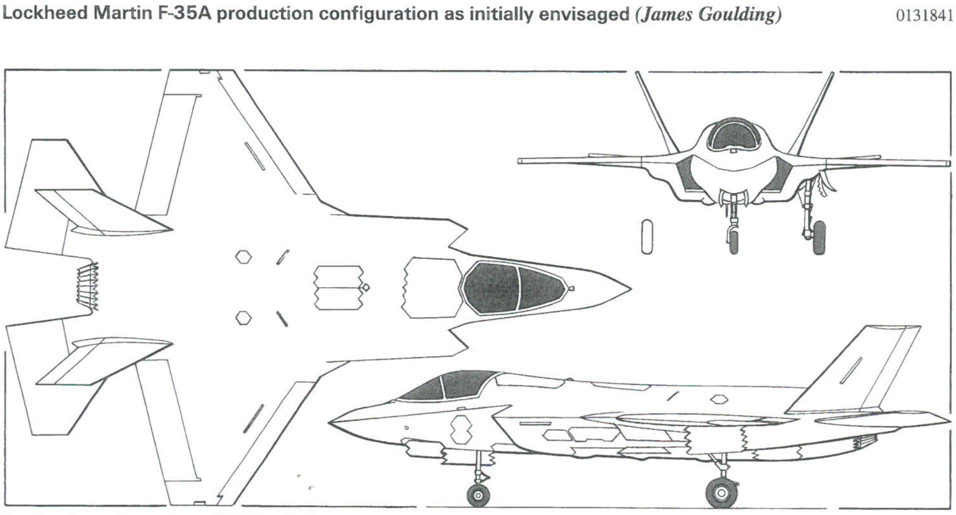
Lockheed Martin also reached preliminary agreement with partners over work-sharing arrangements to be implemented for large-scale production. Lockheed Martin has responsibility for forward fuselage, cockpit, wing edges and final assembly; Northrop Grumman to fabricate mid-fuselage and wing box, with BAE Systems producing tails and aft fuselage section.

Radar signature testing of full-scale pole model began in late 1999 at Helendale, California; this included measurement of radar cross-section, assessment of antenna performance and demonstration of the robustness of supportable low-observable materials.

Significant events in 2000 included X-35A flight readiness review in March. Subsequently, in April, testing associated with development and flight qualification of the JSF119-PW-611 engine for the X-35A and X-35C was completed after 193 hours of operating time. Final assembly and painting of X-35A in late May was followed by lengthy series of ground tests, including systems checkout, engine running at full military power and with full afterburner augmentation, and low- and medium-speed taxi tests. These extended into October and culminated in a successful first flight by X-35A Article 301 from Palmdale to Edwards on 24 October; by 6 November, further four flights had been made, including first by USAF pilot, and envelope had been expanded to 390 kt (722 km/h; 449 mph); first aerial refuelling (from KC-135) on 7 November; maiden supersonic flight 21 November, when 25 hours had been flown in 25 sorties. X-35A test programme completed on 22 November, whereupon Article 301 returned to Palmdale for conversion to X-35B. X-35C (Article 300) first flight took place on 16 December 2000 from Palmdale to Edwards AFB. Initial X-35C testing at Edwards was completed in early February 2001, with aircraft making transcontinental ferry flight via Fort Worth, Texas, to Navy test centre at Patuxent River, Maryland on 9-10 February for specialised trials.



Lockheed Martin F-35A production configuration as initially envisaged *(James Goulding)* 0131841



Revised configuration of F-35B STOVL version for US Marine Corps and United Kingdom *(James Goulding)* ***NEW***/0567294

Following installation of shaft-driven lift fan in late December 2000, X-35B STOVL version began series of hover-pit trials on 22 February 2001; these concluded 16 March and included 26 lift-fan clutch engagements from CTOL to STOVL mode at high rpm settings. Accelerated mission testing followed and was concluded on 6 April, with X-35B then being readied for flight trials; this process included installation of flight-ready lift fan. Taxi tests began 12 June 2001, followed by first brief vertical take-off and landing on 23 June, with sustained hover accomplished on next day. Initial testing at Palmdale completed successfully by 3 July, when X-35B flown to Edwards AFB for remainder of trials programme; notable events included first airborne transition from STOVL to conventional mode on 9 July; first vertical landing from wingborne flight on 16 July and 'Mission X' demonstrations involving short take-off, level supersonic dash and vertical landing on 20 and 26 July, before STOVL testing concluded on 30 July.

Both X-35 aircraft subsequently allocated to museums, with Article 300 going to the naval air museum at Patuxent River and Article 301 joining the Smithsonian collection in Washington, DC.

X-35 FLIGHT TESTS

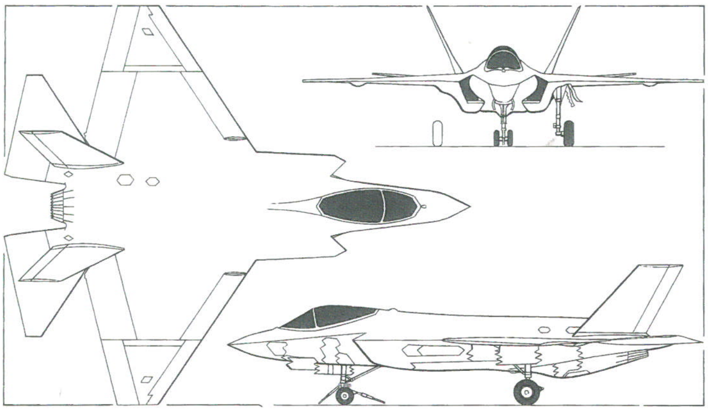
	X-35A	X-35B	X-35C
First flight	24 Oct 00	23 Jun 01	16 Dec 00
Last flight	22 Nov 00	6 Aug 01	10 Mar 01
Sorties	27	39	73
Hours	27.4	21.5	58.0
Max *g*	5.0	5.0	4.8
Max speed	M1.05	M1.2	M1.22
Max AoA	20°	20°	20°
Max alt (ft)	34,000	34,000	34,000
Dummy deck landings			252
VTOs		17	
STOs		14	
Short landings		6	
Vertical landings		27	

After study of test results and company proposals, the US Department of Defense announced on 26 October 2001 that Lockheed Martin would be awarded a US$19 billion contract to cover SDD of what now became known as the F-35. Scheduled to occupy 126 months, SDD began immediately. Simultaneously, it was revealed that Pratt & Whitney would receive a contract worth US$4 billion for development and production of the associated F135 engine. As a major partner, the UK will contribute US$2 billion towards total SDD expenditures of approximately US$30 billion. Majority of preliminary design review successfully concluded on 27 March 2003, with a few unresolved items concerning aircraft weight and weapons integration not finally resolved until end of June; next major hurdle is critical design review, scheduled for April 2004.

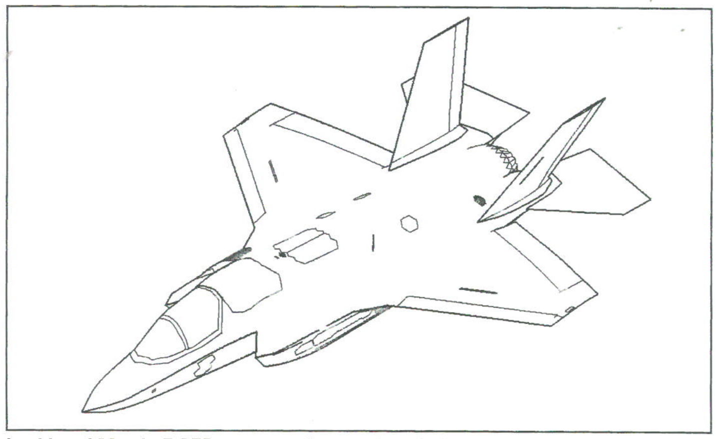
A total of 14 fully instrumented flying aircraft will be built at Fort Worth and assigned to SDD. Five will emerge as **F-35As** (USAF CTOL version); five will be **F-35Cs** (US Navy CV version); and the remaining four will be **F-35Bs** (US Marine Corps/UK STOVL version). Further eight non-flying airframes: two of each version as static test articles, plus another F-35C for drop testing and one pole-test airframe for radar signature evaluation. F-35A first flight scheduled for October 2005, 48 months into SDD, although Lockheed Martin is aiming for maiden flight on 28 August 2005. Just over 40 per cent of total planned flight testing by all JSF variants to be undertaken by F-35A. F-35B to fly after 53 months (making first vertical 'press-up' early 2006); and F-35C after 62 months (October 2006). Flight trials will be undertaken by Lockheed Martin at Fort Worth as well as joint industry/service teams at Edwards AFB, California (USAF) and NAS Patuxent River, Maryland (US Navy). Programme originally expected to involve almost 15,000 flight hours, although this reduced to 10,185 (about 5,700 sorties) according to most recent estimates.

Full funding for Low-Rate Initial Production (LRIP) is scheduled to begin in FY06 (see table), with the first delivery of an operational aircraft (an F-35A for the USAF) due in late 2008. F-35B will be first to attain IOC, in last quarter of FY10. Respective IOC dates for the F-35A and F-35C are final quarter of FY11 and final quarter of FY12, with the UK also expected to achieve IOC in FY12. Initial aircraft will be to Block 1 standard, with basic warfighting capability (including compatibility with JDAM and AIM-120 AMRAAM); additional weaponry for enhanced air-to-air, SEAD, close air support and interdiction will be added on Block 2 standard aircraft, while Block 3 will introduce more missiles and bombs and add deep strike capability. Lockheed Martin anticipates production rate of 17 aircraft per month at Fort Worth from 2011, but would like to achieve rate of 22 per month. With peak demand likely to be for about 30 a month, this could only be accomplished with second production centre. In early 2003, UK government commissioned Rand to perform feasibility study into creating second assembly line in UK.

CURRENT VERSIONS: Three variants of basic design, optimised for the mission requirements of different armed services.



Carrier-capable attack version of JSF, the Lockheed Martin F-35C in its 2002 form *(James Goulding)* 0526906



Lockheed Martin F-35B upper surface and cockpit detail 0567238

As currently envisaged, basic company designation for operational JSF is Configuration 240-1, with following variants expected to enter service with US armed forces.

F-35A: Land-based **CTOL** derivative for USAF. Evaluated by X-35A between 24 October and 22 November 2000.

F-35B: STOVL version for US Marine Corps, Royal Air Force and Royal Navy. Engine-driven lifting fan behind cockpit replaces some fuel. Wing folding originally specified on Royal Navy version only, but requirement since dropped. Broader and higher spine behind cockpit to accommodate lifting fan and air intake; shortened cockpit canopy replaces blister-type glazing of F-35A and B. Evaluated by X-35B between 23 June and 30 July 2001; final flight on 6 August 2001 was from Edwards AFB to Lockheed Martin facility at Palmdale.

F-35C: Carrier-based CTOL (CV). Wing, fin and elevator areas increased by chord extension; ailerons in addition to flaperons on wing; enlarged control surfaces and modified control system; strengthened landing gear with catapult launch bar on twin-wheel nose leg; concealed arrester hook; and folding wing. Evaluated by X-35C between 16 December 2000 and 10 March 2001 from test centres at Edwards AFB and Patuxent River, Maryland (from 10 February 2001).

EA-35B: Lockheed Martin studies into potential two-seat electronic attack version that could replace Marine Corps EA-6B from about 2015. Would retain internal weapons carriage capability, with sensors and jamming equipment embedded in fuselage and wings.

CUSTOMERS: Two X-35 demonstrators; initial planning called for some 3,000 F-35s for USA and UK, but US Navy and Marine Corps requirement cut significantly in 2003 (see table). UK confirmed on 30 September 2002 that F-35B (STOVL) version will be procured for both RAF and Royal Navy, with service introduction during 2012. Orders also expected from Australia (up to 100, possibly including some configured for long-range surveillance and reconnaissance), Canada, Denmark, Israel, Italy, the Netherlands, Norway, Singapore and Turkey.

US and UK F-35 REQUIREMENTS
(as at October 2003)

Service	Qty	Remarks
US Air Force	1,763	Replaces A-10 and F-16; complements F/A-22. IOC FY11
US Navy/Marine Corps	680	To include F-35B and F-35C versions
Royal Navy (UK)	60	Replaces Sea Harrier. IOC FY12
Royal Air Force (UK)	90	Replaces Harrier
Total	**2,593**	

COSTS: At time of down select for SDD phase, unit cost of USAF F-35A quoted as US$37.3 million, with CV/STOVL versions costing under US$50 million each. US$3.41 billion SDD funding for FY03, following US$1.52 billion appropriation in FY02; requests for FY04 and FY05 are US$4.37 billion and US$4.47 billion respectively. Fly away costs mentioned in connection with Italian involvement quoted as US$36.6 million for CTOL version, US$47.4 million for CV version and US$45.3 million for STOVL version. UK purchase of 150 F-35Bs estimated to cost around UK £10 billion.

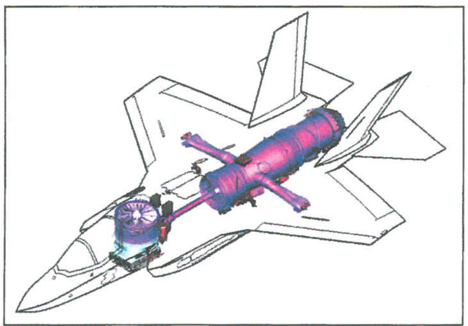
DESIGN FEATURES: Trapezoidal mid-wing configuration, optimised for low observability. Twin tailfins; internal weapon bays. Wing and tailplane leading-edges swept back approximately 33°; trailing-edges swept forward approximately 14°; fins swept back approximately 42° and canted outward at tips by approximately 25°. Twin 'divertless' fibre-placed graphite/epoxy composites engine air intakes with no moving parts produced by ATK. All-electric flight control system.

F-35 INITIAL PRODUCTION

Batch	FY	Total	F-35A	F-35B	F-35C	UK	Last Delivery
LRIP 1	06	10	6	4			2QFY08
LRIP 2	07	22	14	8			1QFY09
LRIP 3	08	54	20	20	9	5	1QFY10
LRIP 4	09	90	30	32	20	8	1QFY11
LRIP 5	10	117	44	32	32	9	1QFY12
LRIP 6	11	166	72	36	48	10	1QFY13
Totals		**459**	**186**	**132**	**109**	**32**	

Note: FY quoted is year of full funding; funding of long-lead items occurs in previous year.

Comparison of F-35B 2003 design with X-35 ***NEW***/0522478



Engine and fan system of Lockheed Martin F-35B
NEW/0567763

STOVL version employs a lifting fan behind the cockpit, driven by a shaft from the single engine; inlet and outlet are covered by doors, except when in use; original side-hinged bi-fold hatch of X-35B replaced in early 2003 by single-piece cantilever inlet door hinged at rear. Other changes related to thermal management also incorporated at this time, to satisfy requirement to operate on 49°C (120°F) day. The resultant cold air barrier prevents hot air from being reingested when on or near the ground.

FLYING CONTROLS: All-electric flight control system for movement of primary flight control surfaces (flaps, tailerons and rudder) incorporating Parker Hannifin electrohydrostatic actuators. Moog leading-edge flap drive system. Flight control computer originally to be supplied by Honeywell, but replaced by advanced Lockheed Martin unit in third quarter of 1998 to eliminate anticipated throughput problems arising from growth in flight control software.

LANDING GEAR: Retractable tricycle type; mainwheels retract inwards; nosewheel(s) forward. Single wheels on each unit, except twin nosewheels and catapult towbar on F-35C, which also has reinforced gear for deck landings. Tyres will feature embedded transponder including integrated circuit and capacitive pressure sensor to facilitate monitoring of pressure and condition. Dunlop selected to provide 34 × 11.OR16 radial main tyres for SDD phase of STOVL F-35B version; Honeywell to develop wheels and brakes, with Crane Hydro-Aire supplying brake control and anti-skid system.

POWER PLANT: One 178 kN (40,000 lb) class (111 kN; 25,000 lb st dry thrust) Pratt & Whitney F135 (formerly JSF119-PW-611; F119 derivative) turbofan. Rolls-Royce three-bearing swivel-duct nozzle on -611S version to deflect thrust downwards for STOVL, plus a Rolls-Royce engine-driven fan behind cockpit and a bleed air reaction control valve in each wingroot to provide stability at low speeds. For F-35B, total vertical lift of 177 kN (39,700 lb st) comprises some 40 per cent from main nozzle, 48 per cent from fan and 12 per cent from reaction control valves. F-35A has in-flight refuelling receptacle on spine; US Navy and Marine Corps require retractable probe on starboard side. JP-5 or JP-8 fuel. General Electric/Rolls-Royce F136 turbofan with same performance characteristics under development as alternative powerplant.

ACCOMMODATION: Pilot only; canopy by Sierracin; canopy frame assembly by Smiths Aerospace. STOVL versions have canopy of reduced length. Martin-Baker Mk 16E lightweight ejection seat in X-35s; F-35 expected to have new seat resulting from Joint Ejection Seat Program (JESP).

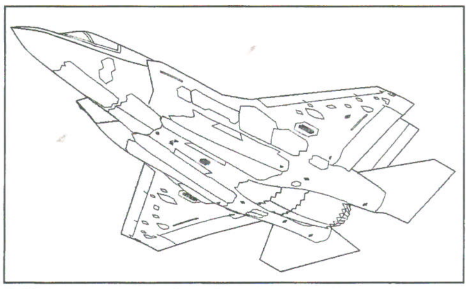
SYSTEMS: Hamilton Sundstrand 80 kW engine-driven switched-reluctance starter/generator providing two independent channels of 270 V DC electrical power; electric distribution units, power panels, power distribution centres, batteries and battery charger equipment provided by Smiths Industries; electrical wiring on SDD aircraft by Stork Aerospace of the Netherlands; Honeywell thermal- and energy-management module (T/EMM) combining functions of auxiliary and emergency power units and environmental control system; 270 V DC lithium ion emergency battery. Weapons bay door drive system by TRW Aeronautical Systems.

AVIONICS: *Comms:* TRW to provide next-generation CNI (communications, navigation and identification) avionics for F-35; package will include VHF/UHF radio, Have Quick I/II, SINCGARS/SIP, SatCom, IFF/SIF transponder, ILS, MLS, ACLS, Tacan, intra-flight data link, Link 4A, Link 16/JTIDS and weapons data link.

Radar: Northrop Grumman MIRFS/MFA (multifunction integrated RF system/multifunction nose array) combines active electronically scanned array (AESA) radar, electronic warfare and communications functions planned for production F-35.

Flight: Lockheed Martin Tactical Defense Systems Integrated Core Processor (ICP) incorporating open system architecture.

Instrumentation: Kaiser 200 × 500 mm (8 × 20 in) single flat panel MFD. Meggitt secondary flight display system. Kaiser/Vision Systems International selected in third quarter of 1999 to provide advanced integrated helmet-mounted display system.



F-35B underside, showing doors and panels
NEW/0567239

Mission: Northrop Grumman conformal array multifunction imaging IR sensor system under development for JSF; electro-optical distributed aperture system (EODAS) functions include air-to-air search-and-track, target cueing and missile warning, and air-to-ground surface-target tracking; uses six CMC Electronics conformal compact lightweight imaging IR sensors around airframe and seventh in targeting system pod, with combined data providing all-aspect multifunction imaging to pilot via wide-angle helmet-mounted display, overlaid with target and threat data information. Lockheed Martin internal Electro-Optical Targeting System (EOTS) can be used when engaging targets on the ground and in the air.

Self-defence: EW capability incorporated into MIRFS/MFA. BAE Systems is prime contractor for EW equipment and systems integration; Litton Amecom to supply low-cost ESM equipment.

ARMAMENT: Internal cannon (in port engine air intake trunk upper surface) specified by USAF and under consideration by US Navy; Boeing/Mauser BK 27 originally selected, but replaced by General Dynamics GAU-12 25 mm weapon in fourth quarter of 2002. US Marine Corps and UK variants to have 'missionised' 25 mm cannon in low-observables pod. Internal weapon bays, incorporating pneumatic weapon suspension and release equipment by EDO; USAF, USN and USMC weapons fit is two AIM-120C AMRAAMs and two GBU-31 JDAM bombs. Other weapons expected to be used by the F-35 include CBU-105 WCMD Sensor Fuzed Weapon, GBU-12 Paveway II, AGM-154 JSOW, AIM-132 ASRAAM and GBU-32 JDAM, all for internal carriage; externally carried weapons are expected to include AGM-158 JASSM, Storm Shadow cruise missile and the AIM-9X Sidewinder. Optional external stores on four hardpoints, which can accommodate fuel tanks or up to 6,800 kg (15,000 lb) additional ordnance.

Data are provisional.

DIMENSIONS, EXTERNAL (estimated):

Wing span: F-35A, F-35B	10.67 m (35 ft 0 in)
F-35C (wings spread)	13.11 m (43 ft 0 in)
F-35C (wings folded)	9.47 m (31 ft 1 in)
Length overall: F-35A, F-35B	15.57 m (51 ft 1 in)
F-35C	15.67 m (51 ft 5 in)
Height overall: F-35A, F-35B	4.57 m (15 ft 0 in)
F-35C	4.72 m (15 ft 6 in)
Tailplane span: F-35A, F-35B	7.29 m (23 ft 11 in)
F-35C	8.64 m (28 ft 4 in)
Wheel track: F-35A, F-35B	4.34 m (14 ft 3 in)
F-35C	4.22 m (13 ft 10 in)
Wheelbase: F-35A, F-35B	6.02 m (19 ft 9 in)
F-35C	6.17 m (20 ft 3 in)

AREAS:

Wings, gross: F-35A, F-35B	42.7 m² (460 sq ft)
F-35C	57.6 m² (620 sq ft)

WEIGHTS AND LOADINGS (approx):

Weight empty: F-35A	12,426 kg (27,395 lb)
F-35B	13,924 kg (30,697 lb)
F-35C	13,888 kg (30,618 lb)
Max weapon load	more than 9,072 kg (20,000 lb)
Max internal fuel weight:	
F-35A	8,391 kg (18,498 lb)
F-35B	6,045 kg (13,326 lb)
F-35C	8,901 kg (19,624 lb)
Max T-O weight: F-35A	29,710 kg (65,500 lb)
F-35B	20,803 kg (63,500 lb)
F-35C	30,322 kg (66,850 lb)
Max wing loading: F-35A	695.2 kg/m² (142.39 lb/sq ft)
F-35B	674.0 kg/m² (138.04 lb/sq ft)
F-35C	526.4 kg/m² (107.82 lb/sq ft)

PERFORMANCE (approx):

Max level speed: all	M1.6
Combat radius: F-35A	more than 600 n miles (1,111 km; 690 miles)
F-35B	more than 450 n miles (833 km; 517 miles)
F-35C	more than 700 n miles (1,296 km; 805 miles)

UPDATED

LOCKHEED MARTIN F-16 FIGHTING FALCON

Israel Defence Force names: F-16C Barak (Lightning), F-16D Brakeet (Thunderbolt) and F-16I Suefa (Storm)

Turkish Air Force name: Savaşan Şahin (Fighting Falcon)

United Arab Emirates Air Force name: Desert Falcon

TYPE: Multirole fighter.

PROGRAMME: Emerged from General Dynamics YF-16 of US Air Force Lightweight Fighter prototype programme in 1972; first flight of prototype YF-16 (72-01567) 2 February 1974; first flight of second prototype (72-01568) 9 May 1974; selected for full-scale development (FSD) 13 January 1975; day fighter requirement extended to add air-to-ground capability with multimode radar and all-weather navigation; production of FSD aircraft began July 1975; first flight of FSD aircraft 8 December 1976. F-16 achieved 5 millionth flying hour late in 1993; 10 millionth flying hour passed in March 2002. 4,000th aircraft delivered (to Egyptian Air Force) on 28 April 2000; total of 4,090 delivered as at 1 August 2003; 71 scheduled to be handed over in 2003, including 9 from KAI.

Total of 234 F-16s ordered in 2000, increasing sales to 4,285 as of 1 January 2001; Israeli and Greek decisions to exercise options on additional F-16s raised total sales to 4,347 at end of 2001. Further orders placed by Chile (10 aircraft) and Oman (12) in 2002, increasing sales to 4,369 by end of 2002; 48 aircraft to be acquired by Poland, raising total sales to 4,417 at start of 2003.

CURRENT VERSIONS: **F-16A:** First version for air-to-air and air-to-ground missions; not currently in production, but aircraft in storage available for export customers.

F-16B: Standard tandem two-seat version of F-16A; fully operational both cockpits; fuselage length unaltered; reduced fuel.

F-16C/D: Single-seat and two-seat USAF Multinational Staged Improvement Program (**MSIP**) aircraft respectively, implemented February 1980. MSIP expands growth capability to allow for precision ground attack and BVR missiles, and all-weather, night and day missions; **Stage I** applied to Block 15 F-16A/Bs delivered from November 1981; **Stage II** applied to Block 25 F-16C/Ds from July 1984 includes core avionics, cockpit and airframe changes. Block 25 aircraft originally delivered with F100-PW-200 engine, but all surviving examples now have F100-PW-220E following retrofit, as well as other improvements as detailed under Stage III of MSIP. **Stage III** involved installation of systems as they became available, beginning 1988 and extending to Block 50/52, including selected retrofits back to Block 25. Changes include Northrop Grumman AN/APG-68 multimode radar with improved range, resolution, more operating modes and better ECCM than AN/APG-66; advanced cockpit with multifunction displays and upfront controls, BAE Systems wide-angle HUD, Fairchild mission data transfer equipment and radar altimeter; expanded base of fin giving space for proposed later fitment of AN/ALQ-165 Airborne Self-Protection Jamming system (since cancelled, though now being installed in Korean aircraft); increased electrical power and cooling capacity; structural provision for increased take-off weight and manoeuvring limits; and smart weapons such as AIM-120A AMRAAM and AGM-65D IR Maverick.

Common engine bay introduced at **Block 30/32** (FMS deliveries from December 1985 and USAF deliveries from July 1986) to allow fitting of either P&W F100-PW-220 (Block 32) or GE F110-GE-100 (Block 30) Alternate Fighter Engine. Other changes include computer memory

F-16C Block 50 following CCIP Phase 1A upgrade at Hill AFB ***NEW***/0594638

Lockheed Martin F-16C of the USAF's 27th Fighter Wing at Cannon AFB ***NEW*/0554443**

expansion and seal-bonded fuselage fuel tanks. First USAF wing to use F-16C/Ds with F110 engines was 86th TFW at Ramstein AB, Germany, from October 1986. Additions in 1987 included voice message unit, doubled chaff/flare capacity, repositioning of RWR antennas to provide better coverage in forward hemisphere, Shrike anti-radiation missiles (from August 1997), crash survivable flight data recorder and modular common inlet duct ('large-mouth') allowing full thrust from F110 at low airspeeds.

Software upgraded for full Level IV multitarget compatibility with AMRAAM early 1988. Industry-sponsored development of radar missile capability for several air forces resulted in firing of AIM-7F and AIM-7M missiles from F-16C in May 1988; capability introduced mid-1991; missiles guided using pulse Doppler illumination while tracking targets in a high PRF mode of the AN/APG-68 radar.

Block 40/42 Night Falcon (deliveries from December 1988) upgrades include AN/APG-68(V)1 radar allowing 100 hour operation before maintenance, full compatibility with Lockheed Martin low-altitude navigation and targeting infra-red for night (LANTIRN) pods, four-channel digital flight control system, expanded capacity core computers, diffractive optics HUD, enhanced envelope gunsight, GPS, improved leading-edge flap drive system, improved cockpit ergonomics, high gross weight landing gear, structural strengthening, increased performance battery and provision for improved EW equipment, including advanced interference blanker. LANTIRN targeting pod gives day/night standoff target identification, automatic target handoff for multiple launch of Mavericks, autonomous laser-guided bomb delivery and precision air-to-ground laser ranging. LANTIRN navigation pod provides real-world IR view through HUD for night flight plus automatic/manual terrain following with dedicated radar sensor. Combat Edge pressure breathing system installed 1991 for higher pilot *g* tolerance.

A total of 39 Block 40 F-16C/Ds of the 31st FW was involved in a quick response capability (QRC) modification effort, known as 'Sure Strike', to install Improved Data Modem (IDM) equipment. Work was undertaken by a joint USAF/LMTAS team at Aviano AB, Italy, and was completed in December 1995, these being the first Block 40 aircraft to receive the IDM which is standard equipment on current production Block 50 F-16s. In mid-1998, a demonstration programme was conducted to adapt existing IDM with Lockheed Martin kit to provide 'Gold Strike' system capable of two-way transmission of digitised video imagery of targets and thus enhance pilot's situational awareness.

First Block 40 F-16C/Ds issued in late 1990 to 363rd FW (Shaw AFB, South Carolina); first LANTIRN pods to 36th FS/51st FW at Osan, South Korea, in 1992. USAF Block 40/42 F-16Cs unofficially designated **F-16CG**. Following retirement of F-111F, Block 40/42 F-16Cs and F-16Ds with LANTIRN comprise more than 50 per cent of USAF night/precision strike force. All USAF F-16Cs and F-16Ds to receive FLIR targeting pod capability.

Block 50/52 (deliveries began with F-16C 90-0801 in October 1991 for operational testing) upgrades include F110-GE-129 and F100-PW-229 increased performance engines (IPE), AN/APG-68(V)5 radar with advanced programmable signal processor employing VHSIC technology, Have Quick IIA UHF radio and AN/ALR-56M advanced RWR. Changes initiated at **Block 50D/52D** in 1993 include full integration of HARM anti-radiation missiles via HARM aircraft launcher interface computer (ALIC), improved data modem (IDM), upgraded programmable display generator with growth potential for colour and map, expanded data transfer cartridge, ring laser INS (Honeywell and Litton units both used) and improved VHF/FM antenna. AN/ALE-47 advanced chaff/flare dispenser fitted to all FMS Block 50 aircraft delivered after mid-1996 and incorporated as standard on USAF aircraft with effect from FY97 purchase; also retrofitted to earlier USAF Block 40/50 aircraft.

First Block 50D/52D (91-0360) delivered to USAF on 7 May 1993; optimised for defence suppression missions, having software for horizontal situation display on existing two MFDs and provision for one of 112 HARM (AGM-88 High-speed Anti-Radiation Missile) targeting systems ordered by USAF; sensor in pod on starboard side of engine inlet; AN/ASQ-213 HARM targeting system (HTS) has capability similar to F-4G 'Wild Weasel' which it replaced in SEAD role. USAF has a current programme to raise HARM targeting system inventory to 150 pods and is incorporating an upgrade that features software and hardware improvements enabling more targets to be tracked with enhanced ambiguity resolution and speedier reaction time.

Deliveries of Block 50/52 began to 4th FS of 388th FW at Hill AFB, Utah, from October 1992; others to 52nd FW at Spangdahlem, Germany, replacing Block 30 aircraft from (first delivery) 20 February 1993. Block 50D/52D aircraft initially to 309th FS (now 79th FS) of 363rd (now 20th) FW at Shaw AFB, South Carolina; followed by 23rd FS/52nd FW at Spangdahlem, Germany, from 14 January 1994, then squadrons at Mountain Home AFB, Idaho, and Misawa, Japan. Production for USAF was due to terminate with FY94 batch, but six additional F-16Cs funded in each of FY96 and FY97, plus three in FY98, one in FY99, 10 in FY00 and four in FY01; FY96 and subsequent aircraft to Block 50 standard. F-16s delivered from mid-2000 (FY97 and later) to improved configuration, incorporating modular mission computer by Raytheon (replacing three core avionics processors) that was developed for F-16A/B MLU programme, Honeywell colour liquid crystal multifunction displays (replacing monochrome CRT MFDs), Honeywell colour programmable display generator, Teac colour airborne videotape recorder, colour cockpit TV sensor and Litton onboard oxygen generating system (OBOGS). FY00 and subsequent aircraft have AN/APX-113 and associated avionics improvements. Majority of FY00 and FY01 aircraft delivered to USAF between April and December 2002, but final Block 50 will receive full CCIP upgrade before being handed over in December 2004. USAF Block 50/52 F-16Cs unofficially designated **F-16CJ**.

First Samsung-assembled F-16C Block 52D rolled out in South Korea on 7 November 1995. First flight of initial TAI-built F-16C Block 50D in late May 1996, with delivery to Turkish Air Force following on 29 July; last TAI-produced F-16 delivered October 1999. First Block 50D delivered to Greece 29 January 1997. First Block 52D delivered to Singapore 30 January 1998. First production lease (PL) Block 52D aircraft for Singapore was delivered 28 May 1998; this was under terms of commercial contract, with delivery achieved in less than 24 months from placing of order.

First delivery of F-16C Block 52 in Korea Fighter Program II in June 2003; aircraft produced under license by KAI.

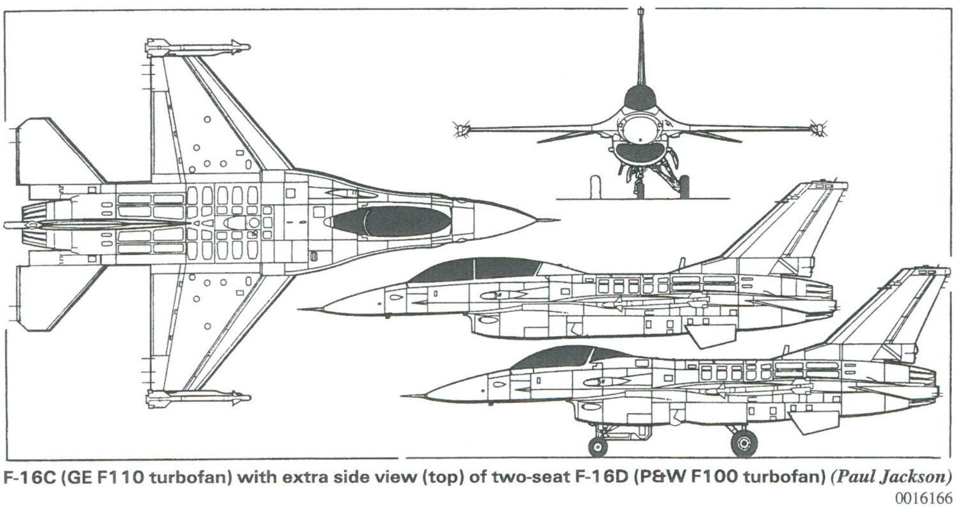
Advanced Block 50/52: Latest production version, originally referred to as Block **50+/52+**. Basic configuration includes upgraded AN/APG-68(V)9 radar with 30 per cent greater air-to-air detection range and synthetic aperture radar (SAR) mode for high-resolution mapping and target detection/recognition. Is also compatible with latest FLIR navigation and targeting pod systems and has upgraded core avionics, including an improved modular mission computer, two 102 mm (4 in) colour cockpit displays, cockpit and exterior lighting compatible with night vision goggles, helmet-mounted cueing system, a digital terrain system, IFF interrogator/transponder, high off-boresight missile compatibility. Link 16 datalink and OBOGS. Available with a choice of internal electronic countermeasures equipment and able to take various customer-unique systems. Maximum take-off gross weight increased to 21,772 kg (48,000 lb). Can be fitted with new, low-drag, conformal fuel tanks, with combined capacity of 1,705 litres (450 US gallons; 375 Imp gallons). Additional fuel in optional 2,271 litre (600 US gallon; 500 Imp gallon) auxiliary wing tanks. Two-seat aircraft have a rear cockpit configured for either a weapon system operator or instructor pilot (converted with a single switch), plus a dorsal avionics compartment that accommodates all of the systems of the single-seat aircraft, plus additional chaff/flare dispensers and specialised mission equipment.

First customer for this enhanced version was Greece, which revealed intention on 30 April 1999 to buy as many as 70 Block 52s. Contract subsequently placed for 50 aircraft, with fixed price option for up to 10 more that was converted to firm order on 14 September 2001. Aircraft deliveries began 2 April 2003 with handover of first five aircraft (three F-16C and two F-16D) at Fort Worth; both F-16Ds and one F-16C initially to be retained in USA for training and test purposes. Other customers for Advanced Block 50/52 aircraft are Chile (Block 50), Oman (Block 50) and Poland (Block 52); Israel is also to acquire Advanced Block 52 aircraft (see F-16I entry).

'GF-16C': Unofficial designation allocated to non-flying aircraft in use at Sheppard AFB for instructional purposes from 1993.

USAF F-16C/D Retrofit Programmes: F-16 originally designed to fly 8,000 hours based on specified usage spectrum, but actual usage has in most cases been more severe, with aircraft regularly flying at higher operational weights than originally predicted. USAF F-16C/D aircraft have undergone structural upgrade programme known as 'Falcon UP', but this is being superseded by 'Falcon STAR' (structural augmentation roadmap). Modifications accomplished under these two programmes will ensure that aircraft achieve 8,000 hour service life, without depot inspection. Many changes incorporated in production aircraft, but older F-16 models will need more extensive modification. USAF 'Falcon STAR' retrofit kit proofing is being conducted in 2003, with pilot production and installation to start in 2004. At least 10 other countries are involved in this programme.

ANG/AFRC Block 25/30/32 F-16C/Ds subject to combat upgrade plan integration details (CUPID) which completed by mid-2003, CUPID brought approximately 620 older F-16s to a standard close to that of the Block 50/52 aircraft. Among the improvements incorporated are situation awareness datalink (SADL), improved airborne videotape recorder, colour camera, initial NVG-compatible cockpit lighting, LANTIRN and Rafael Litening II FLIR targeting pod capability, AN/ALQ-213



F-16C (GE F110 turbofan) with extra side view (top) of two-seat F-16D (P&W F100 turbofan) ***(Paul Jackson)***
0016166

countermeasures control system and provisions for GPS/ laser gyro INS. Future improvements include expanded central computer, joint helmet-mounted cueing system, AIM-9X missile, follow-on NVIS capability, PIDS-3 pylon upgrade for smart weapon compatibility, ACES II ejection seat improvements, enhanced main battery and software upgrades.

Block 40/42 F-16C/Ds are currently being upgraded to include NVG compatibility, MD-1295/A improved data modem, digital terrain system, AN/ALE-47 chaff dispenser, towed decoy and smart weapons compatibility (including the GBU-27, JDAM, JSOW and WCMD). Block 50/52 F-16C/Ds already have these capabilities. Three squadrons of ANG Block 42 aircraft currently receiving F100-PW-229 engine as replacement for original F100-PW-220; first engines installed in mid-2002 and subsequently deployed to Middle East.

In June 1998, USAF launched an upgrade effort known as common configuration implementation program (CCIP), which is intended to provide common hardware and software capability to 648 Block 40/42/50/52 aircraft. CCIP is a multiphase effort and is being implemented in stages, based on availability of subsystems. Work is being undertaken at the Ogden Air Logistics Center, Hill AFB, Utah, to where the first eight modification kits were shipped on 29 June 2001; these Phase 1 kits include the modular mission computer and colour MFDs applicable to 107 older aircraft of the Block 50/52 versions. The first aircraft was completed ahead of schedule and delivered to the 20th FW on 11 January 2002.

Phase 1A Block 50/52 kits include the AN/APX-113 combined electronic interrogator/transponder which gives autonomous BVR intercept capability. These aircraft also capable of alternative carriage of an advanced Lockheed Martin Sniper XR FLIR targeting pod in addition to the HARM targeting system pod. The first of 251 aircraft to receive this capability was delivered in October 2002; first operational unit to get Phase 1A aircraft is 389th Fighter Squadron at Mountain Home AFB, Idaho.

Phase 2, fielded in July 2003, adds Link 16 multifunctional information distribution system (MIDS) datalink, the Vision Systems International joint helmet-mounted cueing system (JHMCS) and an electronic horizontal situation indicator to 251 Block 50/52 aircraft. Starting in 2005, total of 397 Block 40/42 Fighting Falcons are due to receive the full package of modifications detailed above in Phase 3 of CCIP upgrade.

Block 60: Future version, currently in development, and was expected to be rolled out in late 2003. Basic Block 60 has Northrop Grumman AN/APG-80 multimode radar with active electronically scanned array (AESA) antenna, offering numerous advantages, including mode interleaving. This version also has internal Northrop Grumman AN/AAQ-32 FLIR navigation and targeting system, plus advanced cockpit layout, with three 127 × 178 mm (5 × 7 in) colour liquid crystal displays having picture-in-picture and moving map capability. New core avionics suite based on advanced mission computer utilising commercial hardware and software and a high-speed fibre optic databus. Other improvements include digital fuel management system, higher-capacity environmental control system, new air data system (eliminating probe on tip of nose) and expanded digital flight control system with additional automatic modes, such as terrain following. Specialised equipment includes Northrop Grumman Falcon Edge advanced internal ECM system and Thales secure radio and datalink. Block 60 power plant is General Electric F110-GE-132 engine in the 144.65 kN (32,500 lb st) class. High-capacity tyres and brakes, allowing maximum take-off gross weight to rise to 22,679 kg (50,000 lb). Many of the features introduced by Advanced Block 50/52 aircraft also being adopted as standard on the Block 60, including conformal fuel tanks.

United Arab Emirates announced selection of the F-16 Block 60 **Desert Falcon** on 12 May 1998, although signature of contract delayed until first quarter of 2000. Total of 80 aircraft will be delivered between 2004 and 2007. Rollout of the first Block 60 F-16 expected in late 2003, with first three two-seaters to be used for flight testing. Unofficial designation **F-16F** understood to apply to these three aircraft in order to comply with FAA regulations.

Initial deliveries to UAE will be to so-called Lot 1 configuration which marries Block 50 capability to new EW suite, advanced cockpit and new radar. Lot 2 will become available in early 2006 and feature advanced EW modes as well as terrain-following radar capability and additional weaponry; definitive Lot 3 version in 2007 will include BAE Systems TERPROM digital terrain aviodance and navigation system and, possibly, a helmet-mounted cueing system.

NF-16D: Variable stability in-flight simulator test aircraft (**VISTA**) modified from Block 30 F-16D (86-0048) ordered December 1988 to replace NT-33A testbed. Features include Calspan variable stability flight control system, fully programmable cockpit controls and displays, additional computer suite, permanent flight test data recording system, variable feel centrestick and sidestick in front cockpit, with latter also available for use in F-16 mode; safety pilot in rear cockpit. Internal gun, RWR and chaff/flare equipment removed, providing space for Phase II and III growth including additional computer, reprogrammable display generator and customer hardware allowance. Dorsal avionics compartment in bulged spine. Aircraft transferred to USAF Test Pilot School at Edwards AFB in 2001 to support TPS missions and various research and development activities. Aircraft participated in USAF Auto Air Collision Avoidance System demonstration in mid-2003.

Lockheed Martin F-16CJ of 35th Fighter Wing at Misawa, Japan *(Paul Jackson)* ***NEW***/0554448

F-16I: Two-seat version, basically similar to Advanced Block 52, for Israel, featuring Pratt & Whitney F100-PW-229 engine, conformal fuel tanks and SAR. Will incorporate Northrop Grumman AN/APG-68(V)9 radar and significant amount of Israeli avionics, including EW suite, cockpit displays and helmet-mounted sight and advanced self-protection system (ASPS). EW suite, by Elisra, will include radar and missile approach warning systems plus jammers, while Elbit Systems to provide head-up display system, central mission computer, advanced display processor, DASH IV display and sight helmet system and stores management systems. RADA teamed with Smiths Aerospace to supply data acquisition system; Elop to provide HUD unit. Aircraft also to utilise Rafael Litening II targeting pod. Total of 50 initially purchased in US$2.5 billion deal, with delivery to begin in 2003 and continue until 2008; further 60 aircraft on option, of which 52 subsequently converted to firm order on 19 December 2001. First aircraft completed in June 2003, thereafter being modified to accommodate flight test instrumentation.

F-16N: US Navy supersonic adversary aircraft (SAA) modified from F-16C/D Block 30. Four of 26 were two-seat **TF-16N**. Entire fleet retired during 1994-95.

FS-X and TFS-X: F-16 design selected by Japan Defence Agency as basis for its FS-X (now F-2) requirement 19 October 1987; details under Mitsubishi in Japanese section.

F-16 Recce: Following trials with a prototype system in mid-1995, an LMTAS-designed reconnaissance pod for the US Air National Guard was flown for the first time on 29 September 1995 and subsequently tested on an F-16C (86-227) of the 149th Fighter Squadron, Virginia ANG. Four pods were built and then deployed with the 149th FS to Aviano AB, Italy, in May 1996 for operational validation in support of NATO missions over Bosnia. This successful trial culminated in decision to procure a total of 20 podded systems for service with F-16C Block 30 aircraft of five ANG squadrons, each of which will have four pods and one ground exploitation system. The core of the programme, known as the BAE Systems Theater Airborne Reconnaissance System (TARS), is the Per Udsen MRP with USAF-supplied KS-87 cameras incorporating E-O video back instead of wet film; the Lockheed Martin Fairchild Systems medium-altitude E-O (MAEO) camera; an Ampex DCRsi-240 digital data recorder and a TERMA Elektronik cockpit control device. The TARS pods were delivered in 1999 and certified for operational use by the F-16 in first half of 2000. Egypt ordered six TARS pods and two ground stations at beginning of 2003.

Elta EL/M-2060P pod also cleared for use by F-16 in 1999. System is contained in standard 300 US gallon drop tank and comprises autonomous, all-weather, day and night high-resolution reconnaissance synthetic aperture radar sensor with ability to transmit imagery to ground station via bidirectional datalink.

Most F-16s delivered since the early 1990s have provisions for a reconnaissance pod. Final 20 aircraft for South Korea (15 F-16C and 5 F-16D) will be configured for reconnaissance mission, although decision on which system to use is not expected to be made until 2004; delivery of these aircraft began in mid-2003.

F-16ES: Enhanced Strategic two-seat, long-range interdictor F-16 proposal; now defunct but provided basis for Advanced Block 50/52 and Israeli F-16I.

F-16U: Proposed two-seat version unsuccessfully offered to United Arab Emirates.

F-16 'Falcon 2000': Private venture design of early 1990s, similar to F-16U, which Lockheed Martin aimed at USAF as a follow-on to the F-16 before introduction of JSF. Also known as the **F-16X**; now defunct.

CUSTOMERS: See tables. Total 4,417 production aircraft ordered or requested by September 2003, including planned USAF procurement of 2,230 and 28 embargoed Pakistan Air Force examples that are to be distributed equally between the USAF and US Navy. Backlog of 327

Single- and two-seat Advanced Block 52 Fighting Falcons, fitted with conformal fuel tanks and in Greek Air Force livery ***NEW***/0530532

Maiden flight of the first F-16F Block 60 Desert Falcon for the United Arab Emirates, 6 December 2003 ***NEW***/0563220

aircraft at end of August 2003 ensures continued F-16 production through 2008.

COSTS: Approximately US$35 million, flyaway, depending on configuration. Sale of 48 aircraft to Poland valued at US$3.5 billion.

DESIGN FEATURES: Conceived as 'lo' complement to Boeing F-15 Eagle in hi-lo fighter mix; optimised for high agility in air combat. Cropped delta wings blended with fuselage, with highly swept vortex control strakes along fuselage forebody and joining wings to increase lift and improve directional stability at high angles of attack; wing section NACA 64A-204; leading-edge sweepback 40°; relaxed stability (rearward CG) to increase manoeuvrability; deep wingroots increase rigidity, save 113 kg (250 lb) structure weight and increase fuel volume; fixed geometry engine intake; pilot's ejection seat inclined 30° rearwards; single-piece birdproof forward canopy section; two ventral fins below wing trailing-edge.

Baseline F-16 airframe life planned as 8,000 hours with average usage of 55.5 per cent in air combat training, 20 per cent ground attack and 24.5 per cent general flying; structural strengthening programme for pre-Block 50 aircraft was required during 1990s.

FLYING CONTROLS: Four-channel digital fly-by-wire (analogue in earlier variants); pitch/lateral control by pivoting monobloc tailerons and wing-mounted flaperons; maximum rate of flaperon movement 52°/s; automatic wing leading-edge manoeuvring flaps programmed for Mach number and angle of attack; flaperons and tailerons interchangeable left and right; sidestick control column with force feel replacing almost all stick movement.

STRUCTURE: Wing, mainly of light alloy, has 11 spars, five ribs and single-piece upper and lower skins; attached to fuselage by machined aluminium fittings; leading-edge flaps are one-piece bonded aluminium honeycomb and driven by rotary actuators; fin is multispar, multirib with graphite epoxy skins; brake parachute or ECM housed in fairing aft of fin root; tailerons have graphite epoxy laminate skins, attached to corrugated aluminium pivot shaft and removable full-depth aluminium honeycomb leading-edge; ventral fins have aluminium honeycomb and skins; split speedbrakes in fuselage extensions inboard of tailerons open to 60°. Nose radome by Brunswick Corporation.

LANDING GEAR: Goodrich (formerly Menasco) hydraulically retractable type, nose unit retracting rearward and main units forward into fuselage. Nosewheel is located aft of intake to reduce the risk of foreign objects being thrown into the engine during ground operation, and rotates 90° during retraction to lie horizontally under engine air intake duct. Oleo-pneumatic struts in all units. Aircraft Braking Systems mainwheels and brakes; Goodyear or Goodrich tubeless mainwheel tyres, size 27.75×8.75-14.5 (or 27.75×8.75R14.5) (24 ply), pressure 14.48 to 15.17 bar (210 to 220 lb/sq in) at T-O weights less than 13,608 kg (30,000 lb). Steerable nosewheel with Goodyear, Goodrich or Dunlop tubeless tyre, size 18×5.7-8 (18 ply), pressure 20.68 to 21.37 bar (300 to 310 lb/sq in) at T-O weights less than 13,608 kg (30,000 lb). All but two main unit components interchangeable. Brake-by-wire system on main gear, with Aircraft Braking Systems anti-skid units. Runway arresting hook under rear fuselage; Irvin 7.01 m (23 ft 0 in) diameter braking parachute fitted in Greek and Turkish (Block 30/40 only) F-16s. Israeli (F-16C/D models only) and Singaporean (F-16Ds) aircraft have braking parachute compartment configured for electronic equipment. Landing/taxying lights on nose landing gear door.

POWER PLANT: One 131.6 kN (29,588 lb st) General Electric F110-GE-129, or one 129.4 kN (29,100 lb st) Pratt & Whitney F100-PW-229 afterburning turbofan as alternative standard. These Increased Performance Engines (IPE) installed from late 1991 in Block 50 and Block 52 aircraft and are being retrofitted to about 50 Block 42 aircraft of the Air National Guard. Pratt & Whitney has proposed F100-PW-229A version, with new fan module among other radical improvements that will raise airflow by more than 10 per cent, lower turbine temperatures by almost 50°C (122°F) and permit inspection intervals to rise from 4,300 cycles to 6,000. New version offers potential to increase maximum augmented thrust rating to about 142 kN (31,860 lb st), although this would require larger inlet on F-16. General Electric also engaged in improvement efforts, using company funding to begin development of F110-GE-129 EFE (Enhanced Fighter Engine) in October 1997; EFE initially to be rated at up to 151.0 kN (33,945 lb st), with further growth potential to 160.0 kN (35,970 lb st); alternatively, improved thrust levels can be sacrificed for up to a 50 per cent increase in TBO and servicing intervals. Production derivative known as F110-GE-132 rated at 144.6 kN (32,500 lb st) installed in F-16 Block 60 aircraft for UAE. Immediately prior standard was 128.9 kN (28,984 lb st) F110-GE-100 or 105.7 kN (23,770 lb st) F100-PW-220 in Blocks 40/42.

Of 1,446 F-16Cs and F-16Ds ordered by USAF, 556 with F100 and 890 with F110. Fixed geometry intake, with boundary layer splitter plate, beneath fuselage. Apart from first few, F110-powered aircraft have intake widened by 30 cm (1 ft 0 in) from 368th F-16C (86-0262); Israeli second-batch F-16D-30s have power plants locally modified by Bet-Shemesh Engines to F110-GE-110A with provision for up to 50 per cent emergency thrust at low level.

Standard fuel contained in wing and five seal-bonded fuselage cells which function as two tanks; 3,986 litres (1,053 US gallons; 876 Imp gallons) in single-seat aircraft; 3,297 litres (871 US gallons; 726 Imp gallons) in two-seat aircraft. Halon inerting system. In-flight refuelling receptacle in top of centre-fuselage, aft of cockpit. Auxiliary fuel can be carried in drop tanks: one 1,136 litre (300 US gallon; 250 Imp gallon) under fuselage; 1,402 litre (370 US gallon; 308 Imp gallon) under each wing. Optional Israel Military Industries 2,271 litre (600 US gallon; 500 Imp gallon) underwing tanks initially adopted only by Israel, but have since been selected by one or two other operators; also adopted for F-16 Block 60 version. Latter will have conformal fuel tanks (CFTs) with a combined capacity of 1,703 litres (450 US gallons; 375 Imp gallons). CFTs to be fitted as option on Advanced Block 50/52.

ACCOMMODATION: Pilot only in F-16C, in pressurised and air conditioned cockpit. Boeing (formerly McDonnell Douglas) ACES II zero/zero ejection seat. Bubble canopy made of polycarbonate advanced plastics material. Inside of USAF F-16C/D canopy coated with gold film to dissipate radar energy. In conjunction with radar-absorbing materials in air intake, this reduces frontal radar signature by 40 per cent. Windscreen and forward canopy are an integral unit without a forward bow frame, and are separated from the aft canopy by a simple support structure which serves also as the breakpoint where the forward section pivots upward and aft to give access to the cockpit. A redundant safety lock feature prevents canopy loss. Windscreen/canopy design provides 360° all-round view, 195° fore and aft, 40° down over the side, and 15° down over the nose.

To enable the pilot to sustain high *g* forces, and for pilot comfort, the seat is inclined 30° aft and the heel line is raised. In normal operation the canopy is pivoted upward and aft by electrical power; the pilot is also able to unlatch the canopy manually and open it with a back-up handcrank. Emergency jettison is provided by explosive unlatching devices and two rockets. A limited displacement, force-sensing control stick is provided on the right-hand console, with a suitable armrest, to provide precise control inputs during combat manoeuvres.

The F-16D has two cockpits in tandem, equipped with all controls, displays, instruments, avionics and life support systems required to perform both training and combat missions. The layout of the F-16D second station is similar to the F-16C, and is fully systems-operational. A single-enclosure polycarbonate transparency, made in two pieces and spliced aft of the forward seat with a metal bow frame and lateral support member, provides outstanding view from both cockpits.

Advanced Block 50/52 and Block 60 F-16Ds are configured with weapon system operator station in rear cockpit, plus a large dorsal equipment compartment extending from the rear of the canopy to the leading edge of the fin; compartment houses avionics unique to each operator, plus additional chaff/flare dispensers and an in-flight refuelling receptacle.

SYSTEMS: Regenerative 12 kW environmental control system, with digital electronic control, uses engine bleed air for pressurisation and cooling of crew station and avionics compartments. Two separate and independent hydraulic systems supply power for operation of the primary flight control surfaces and the utility functions. System pressure (each) 207 bar (3,000 lb/sq in), rated at 161 litres (42.5 US gallons; 35.4 Imp gallons)/min. Bootstrap-type reservoirs, rated at 5.79 bar (84 lb/sq in).

Electrical system powered by engine-driven 60 kVA main generator and 10 kVA standby generator (including ground annunciator panel for total electrical system fault reporting), with Hamilton Sundstrand constant speed drive and powered by a Hamilton Sundstrand accessory drive gearbox. 17 Ah battery. Four dedicated, sealed cell batteries provide transient electrical power protection for the fly-by-wire flight control system.

An onboard Hamilton Sundstrand/Solar jet fuel starter is provided for engine self-start capability. Simmonds fuel measuring system. AlliedSignal emergency power unit automatically drives a 5 kVA emergency generator and emergency pump to provide uninterrupted electrical and hydraulic power for control in the event of the engine or primary power systems becoming inoperative.

AVIONICS: *Comms:* Magnavox AN/ARC-164 UHF transceiver (AN/URC-126 Have Quick IIA in Block 50/52); provision for Magnavox KY-58 secure voice system; Rockwell Collins AN/ARC-186 VHF AM/FM transceiver, ARC-190 HF radio, government-furnished AN/AIC-18/25 intercom and SCI advanced interference blanker, Teledyne Electronics AN/APX-101 IFF transponder with government-furnished IFF control, government-furnished National Security Agency KIT-1A/TSEC cryptographic equipment. F-16C/D Block 52 aircraft of Singapore and South Korea have Litton AN/APX-109+ advanced interrogator/transponder. AN/APX-113 advanced interrogator/transponder installed in Greek Block 50,

F-16 TABLES

Table 1 provides a rapid reference to customers and quantities; more detailed information on F-16C/D production block numbers appears in Table 2.

TABLE 1: F-16 CUSTOMERS

Operator	Total	Single-seat	Qty	Two-seat	Qty	Power plant	First aircraft A/C	First aircraft B/D	First delivery	Squadrons (or base)
Bahrain	22	F-16C-40	18	F-16D-40	4	F110-GE-100	101	150	March 1990	1, 2
Belgium	160[1]	F-16A-10	55	F-16B-10	12	F100-PW-200	FA01	FB01	January 1979	
		F-16A-15	41	F-16B-15	8	F100-PW-200	FA56	FB13	October 1982	1, 2, 23, 31, 349, 350
		F-16A-15OCU	40	F-16B-15OCU	4	F100-PW-220	FA97	FB21	January 1988	
Chile	10	F-16C-50 (Adv)	6	F-16D-50 (Adv)	4	F100-GE-129			2006	
Denmark	70	F-16A-10	30[1]	F-16B-10	8[1]	F100-PW-200	E-174	ET-204	January 1980	723, 727, 730
		F-16A-15	16[1]	F-16B-15	4[1]	F100-PW-200	E-596	ET-613	May 1982	723, 727, 730
		F-16A-15OCU	8[3]	F-16B-15OCU	4[3]	F100-PW-220	E-004	ET-197	December 1987	726
Egypt	220	F-16A-15	34	F-16B-15	8[2]	F100-PW-200	9301	9201	March 1982	72, 74
		F-16C-32	34	F-16D-32	6	F100-PW-220	9501	9401	August 1986	68, 70
		F-16C-40	34	F-16D-40	7	F110-GE-100	9901	9801	October 1991	60, 64
		F-16C-40	1	F-16D-40	5	F110-GE-100	9935	9808	1994	
		F-16C-40	34[7]	F-16D-40	12[7]	F110-GE-100	9951	9851	March 1994	75, 77
		F-16C-40	21			F110-GE-100B	(96-0086)	–	May 1999	71, 73
		F-16C-40	12	F-16D-40	12	F110-GE-100B	(99-0105)	(99-0117)	June 2001	
Greece	140	F-16C-30	34	F-16D-30	6	F110-GE-100	110	144	November 1988	330, 346
		F-16C-50	32	F-16D-50	8	F110-GE-129	045	077	January 1997	341, 347
		F-16C-52 (Adv)	40	F-16D-52 (Adv}	20	F110-PW-229	500	534	Late 2002	
Indonesia	12	F-16A-15OCU	8	F-16B-15OCU	4	F100-PW-220	S-1605	S-1601	December 1989	3
Israel	312	F-16A-10	67	F-16B-10	8	F100-PW-200	100	001	January 1980	140, 147, 253
		F-16C-30	51	F-16D-30	24	F110-GE-100A	301	020	December 1986	101, 105, 109, 110, 117
		F-16C-40	30	F-16D-40	30	F110-GE-100A	502	601	July 1991	101, 105, 109, 110, 117
				F-16D-52 (Adv)	102	F100-PW-229			2003	
Korea, South	180	F-16C-32	30	F-16D-32	10	F100-PW-220	85-574	84-370	March 1986	161, 162, 155
		F-16C-52	95[8]	F-16D-52	45[8]	F100-PW-229	92-000	92-028	December 1994	
Lockheed Martin	12[12]	F-16C-52	4	F-16D-52	8	F100-PW-229	96-5033	96-5025	June 1998	Singapore (lease in USA)
Netherlands	213[3]	F-16A-10	46	F-16B-10	13	F100-PW-200	J-212	J-259	June 1979	306, 311, 312, 313,
		F-16A-15	84	F-16B-15	18	F100-PW-200	J-258	J-649	May 1982	315, 322, 323
		F-16A-15OCU	47	F-16B-15OCU	5	F100-PW-220	J-141	J-065	1988	
Norway	74	F-16A-10	28[3]	F-16B-10	7[3]	F100-PW-200	272	301	January 1980	332, 338
		F-16A-15	32[3]	F-16B-15	5[3]	F100-PW-200	300	690	June 1982	331, 334
				F-16B-15OCU	2	F100-PW-220	–	711	July 1989	331
Oman	12	F-16C-50 (Adv)	8	F-16D-50 (Adv)	4	TBD			2005	
Pakistan	68	F-16A-15	28	F-16B-15	12	F100-PW-200	82-701	82-601	January 1983	9, 11, 14
		F-16A-15OCU	13	F-16B-15OCU	15	F100-PW-220	91-729	91-613	-	See note 10
Portugal	20	F-16A-15OCU	17	F-16B-15OCU	3	F100-PW-220E	15101	15118	February 1994	201
Poland	48	F-16C-52 (Adv)	36	F-16D-52 (Adv)	12	F100-PW-229			2006	
Singapore	58	F-16A-15OCU	4	F-16B-15OCU	4	F100-PW-220	880	884	February 1988	140
		F-16C-52	18	F-16D-52	12	F100-PW-229	608	624	January 1998	
		F-16C-52	20[11]			F100-PW-229			Late 2003	
Taiwan	150	F-16A-20	120	F-16B-20	30	F100-PW-220	6601	6801	July 1996	12, 14, 17, 21, 22, 23, 26, 27
Thailand	36	F-16A-15OCU	14	F-16B-15OCU	4	F100-PW-220	10305	10301	June 1988	103
		F-16A-15OCU	12	F-16B-15OCU	6	F100-PW-220	07020	07032	September 1995	403
Turkey	240[4]	F-16C-30	34	F-16D-30	9	F110-GE-100	86-0066	86-0191	May 1987	142, Oncel Flight
		F-16C-40	102	F-16D-40	15	F110-GE-100	88-0033	88-0014	July 1990	141, 161, 162, 191, 192, 181, 182
		F-16C-50	60	F-16D-50	20	F110-GE-129	93-0657	93-0691	July 1996	141, 151, 152
UAE	80	F-16C-60	55	F-16D-60	25	F110-GE-132	00-6001	00-6056	2004	
USAF	2,230[9]	F-16A-10	255	F-16B-10	74	F100-PW-200	78-0001	78-0077	August 1978	See note A
		F-16A-15	409[5]	F-16B-15	46[6]	F100-PW-200	80-0541	80-0635	September 1981	See note A
		F-16C-25	209	F-16D-25	35	F100-PW-200	83-1118	83-1174	July 1984	See note B
		F-16C-30/32	360/56	F-16D-30/32	48/5	both (100/220)	85-1398	85-1509	July 1986	See note B
		F-16C-40/42	234/150	F-16D-40/42	31/47	both (100/220)	87-0350	87-0391	December 1988	See note B
		F-16C-50/52	189/42	F-16D-50/52	28/12	both (129/229)	90-0801	90-0834	October 1991	See note B
US Navy	26	F-16N-30	22	TF-16N-30	4	F110-GE-100	163268	163278	June 1987	withdrawn
Venezuela	24	F-16A-15	18	F-16B-15	6	F100-PW-200	1041	1715	September 1983	161, 162
Totals	**4,417**		**3,497**		**920**					

Notes:

[1] Built by Sabca (Belgium); 222nd and last Sabca F-16 (BAF FA-136) delivered 22 October 1991
[2] One built by Fokker (Netherlands)
[3] Built by Fokker; 300th and last Fokker F-16 (RNethAF J-021) delivered 27 February 1992
[4] Two F-16Cs and six F-16Ds built by GD; remainder by TAI
[5] Two built by Fokker
[6] Four built by Sabca
[7] TAI production
[8] 12 built by GD, 36 CKD kits and 92 produced locally by Korea Aerospace Industries (formerly Samsung Aerospace)
[9] Deliveries completed December 2002, except for last Block 50 which will be handed over in December 2004 with full CCIP modifications. Table excludes full-scale development (FSD) aircraft (six F-16A and two F-16B)
[10] 28 aircraft embargoed, placed in storage at Davis-Monthan AFB, Arizona and are being distributed between US Navy Strike and Air Warfare Center (10 F-16A and four F-16B) as adversary aircraft for tactics training and US Air Force (three F-16A and 11 F-16B) for test support duties
[11] Includes unspecified number of F-16D-52 aircraft
[12] New production aircraft leased to Singapore for training in the USA

Note A: Currently operated by US Air Force Flight Test Center/412th Test Wing, Edwards AFB, California; US Air Force Air Armament Center/46th Test Wing, Eglin AFB, Florida; 56th Fighter Wing (FW), Luke AFB, Arizona (Taiwan AF training squadron); Air National Guard.

Note B: Currently operated by US Air Force Flight Test Center/412th Test Wing, Edwards AFB, California; US Air Force Air Armament Center/46th Test Wing, Eglin AFB, Florida; 8th FW, Kunsan AB, South Korea; 20th FW, Shaw AFB, South Carolina; 27th FW, Cannon AFB, New Mexico; 31st FW, Aviano AB, Italy; 35th FW, Misawa AB, Japan; 51st FW, Osan AB, South Korea; 52nd FW, Spangdahlem AB, Germany; 53rd W, Eglin AFB, Florida; 56th FW, Luke AFB, Arizona; 57th W, Nellis AFB, Nevada; 354th FW, Eielson AFB, Alaska; 366th W, Mountain Home AFB, Idaho; 388th FW, Hill AFB, Utah; and also five fighter squadrons of the Air Force Reserve Command and more than 25 Air National Guard fighter squadrons.

Blocks 1 and 5 retrofitted to Block 10 standard 1982-84; Block 15 retrofitted to Block 15OCU (avionics standard only) from 1987. New-build F-16As are Block 15OCU from November 1987.

Export programme codenames are: Bahrain – Peace Crown I-II; Chile – Peace Puma; Egypt – Peace Vector I, II, III, IIIA, IV, V and VI; Greece – Peace Xenia I-III; Indonesia – Peace Bima-Sena; Israel – Peace Marble I-V; Italy – Peace Caesar; Jordan – Peace Falcon I-II; South Korea – Peace Bridge I-II and Korean Fighter Program I-II; Oman – Peace A'sama A'safiya; Pakistan – Peace Gate I-IV; Poland – Peace Sky; Portugal – Peace Atlantis I-II; Singapore – Peace Carvin I-IV; Taiwan – Peace Fenghuang; Thailand – Peace Naresuan I-III; Turkey – Peace Onyx I-II (and CAE-Link simulator, Peace Onyx III); and Venezuela – Peace Delta.

Recent orders: Greek option for 10 aircraft (six F-16C and four F-16D) converted to firm order in 2001; Israel also converted option in 2001, when further 52 F-16I added to outstanding order. USAF resumed procurement of F-16C with batch of six aircraft in FY96 plus six in FY97, three in FY98, one in FY99, 10 in FY00 and four in FY01; further orders unlikely. Chile placed order for 10 aircraft (six F-16C and four F-16D) in March 2002; Oman also placed order in 2002, for 12 aircraft (eight F-16C and four F-16D). Poland selected F-16 at beginning of 2003 and will receive 48 aircraft (36 F-16C and 12 F-16D) in 2006-08.

Notes continued:

Transfers: Israel received 36 F-16As and 14 F-16Bs from surplus USAF stocks August 1994 to March 1995 for 140, 144 and 253 Squadrons. **Denmark** received three ex-USAF F-16As in July 1994, plus three F-16As and one F-16B in 1997. **Jordan** accepted initial batch of ex-USAF ADF aircraft (12 F-16As and four F-16Bs) on lease basis in December 1997/April 1998 and took delivery of eight more ex-USAF aircraft (seven F-16As and one F-16B) in January 2003, with further nine due for delivery by end of 2003. **Portugal** received 25 second-hand aircraft (21 F-16As and four F-16Bs, of which five F-16As to be broken-down for spares, with the rest receiving F-16 Mid-Life Update improvements); **Thailand** request for surplus USAF aircraft approved by US Congress at beginning of 2000, with delivery of 15 F-16As and one F-16B drawn from storage beginning in August 2002; **Italy** to receive 30 F-16A and four F-16B ADF aircraft in 2003-04 (including four non-flyable aircraft for spares) on five-year lease arrangement, with five-year follow-on option; first aircraft rolled out at Hill AFB, Utah on 9 May 2003.

TABLE 2: F-16C/D PRODUCTION

Block	USAF		USN		Bahrain		Egypt		Greece		Israel		Korea		Singapore		Turkey		United Arab Emirates		Lockheed Martin		Chile		Oman		Poland	
	F-16C	F-16D	F-16N	TF-16N	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
25	7	4																										
25A	16	3																										
25B	25	5																										
25C	35	5																										
25D	40	4																										
25E	47	4																										
25F	39	10																										
Subtotal	**209**	**35**																										
30	16	2									4	–																
32							1	4					2	6														
30A	40	2									15	1																
32A							13	2					4	–														
30B	47	3	4	–							15	–					17	6										
32B							20	–					4	–														
30C	35	2	8	–							16	–																
32C	20	3											4	–														
30D	42	4	8	–							1	4																
32D	13	–											4	–														
30E	55	5	2	4							–	10					17	3										
32E													4	–														
30F	51	6									–	9																
32F	2	1											4	–														
30H	34	12							2	4																		
32H	11	1											4	–														
30J	25	8							12	2																		
32J	10	–																										
30K	15	3							16	–																		
30L									4	–																		
32Q													–	4														
30VISTA	–	1																										
Subtotal	**625**	**88**	**22**	**4**			**34**	**6**	**34**	**6**	**51**	**24**	**30**	**10**			**34**	**9**										
40	2	–																										
40A	6	3															17	3										
42A	5	3																										
40B	22	–																										
42B	7	13																										
40C	38	3																										
42C	17	2																										
40D	38	2			2	4											17	3										
42D	17	3																										
40E	37	–			6	–																						
42E	18	5																										
40F	33	4															17	3										
42F	15	8																										
40G	31	5					2	–																				
42G	21	3																										
40H	14	5					–	4			6	4																
42H	27	6																										
40J	7	5					9	2			8	8					16	3										
42J	21	4																										
40K	6	4					15	1			8	8																
42K	2	–																										
40L							8				8	10					17	3										
40M							1	1																				
40N							–	8																				
40P																	18	–										
40Q							3	3																				
40R							12	5																				
40S							19																					
40T							5																					
40U							8																					
40V							8																					
40W					10																							
40							12	12																				
Subtotal	**1,009**	**166**	**22**	**4**	**18**	**4**	**136**	**42**			**81**	**54**					**136**	**24**										
50	4	–																										
50A	7	7																										
52A	1	1																										
50B	24	8																										
50C	21	4																										
50D	133	9							32	8							60	20										
52D	41	11											95	45	38	12					4	8						
50 (Adv)																							6	4	8	4		
52 (Adv)									40	20		102															36	12
Subtotal	**1,240**	**206**	**22**	**4**	**18**	**4**	**136**	**42**	**106**	**34**	**81**	**156**	**125**	**55**	**38**	**12**	**196**	**44**			**4**	**8**	**6**	**4**	**8**	**4**	**36**	**12**
60																			55	25								
Totals	**1,240**	**206**	**22**	**4**	**18**	**4**	**136**	**42**	**106**	**34**	**81**	**156**	**125**	**55**	**38**	**12**	**196**	**44**	**55**	**25**	**4**	**8**	**6**	**4**	**8**	**4**	**36**	**12**
Grand total											**2,681**																	

Taiwanese Block 20 and Turkish Block 50 aircraft and is standard equipment on USAF aircraft procured in FY00 and FY01; is being retrofitted to earlier USAF aircraft as part of CCIP upgrade.

Radar: Northrop Grumman AN/APG-68(V) pulse Doppler range and angle track radar, with mechanically scanned planar array in nose. Provides air-to-air modes for range-while-search, uplook search, velocity search with ranging, air combat, track-while-scan (10 targets), raid cluster resolution, single target track and pulse Doppler track to provide target illumination for AIM-7 missiles, plus air-to-surface modes for ground-mapping, Doppler beam-sharpening, ground moving target, sea target, fixed target track, target freeze after pop-up, beacon, and air-to-ground ranging. Improved AN/APG-68(V)9 radar installed on Advanced Block 50/52 aircraft and Northrop Grumman plans to offer an upgrade kit enabling existing radars to be brought to latest standard, which has synthetic aperture radar (SAR) mapping and terrain following (TF) modes, plus interleaving of all modes; if internal FLIR targeting system is selected, this could share processor with ABR. Block 60 aircraft for UAE to have Northrop Grumman AN/APG-80 active electronically scanned array (AESA) radar.

Flight: Litton LN-39 standard inertial navigation system (ring laser Litton LN-93 or Honeywell H-423 in Block 50/52: LN-93 for Egypt, Indonesia, Israel, South Korea, Pakistan, Portugal and Taiwan, plus Netherlands retrofit and Greek second batch); Rockwell Collins AN/ARN-108 ILS, Rockwell Collins AN/ARN-118 Tacan, Rockwell Collins GPS, Honeywell central air data computer, Elbit Fort Worth enhanced stores management computer, Gould AN/APN-232 radar altimeter. Fairchild digital terrain system (incorporating BAE Systems Terprom algorithms) to be installed in all new USAF F-16s and USAF Reserve F-16C/Ds. Optional equipment includes Rockwell Collins VIR-130 VOR/ILS.

Instrumentation: Marconi wide-angle holographic electronic HUD with raster video capability (for LANTIRN) and integrated keyboard; data entry/cockpit interface and dedicated fault display by Litton Canada and Elbit Fort Worth; Astronautics cockpit/TV set. Cockpit lighting and external strip lighting compatible with night imaging systems.

Mission: Honeywell multifunction displays. Lockheed Martin LANTIRN package comprises AN/AAQ-13 (navigation) and AN/AAQ-14 (targeting) pods. Turkish aircraft (150+ modified by 1996) to share 60 LANTIRN pod systems; LANTIRN also purchased by Greece, South Korea and Singapore, although Singapore now seeking a replacement system. Sharpshooter pod (down-rated export version of AAQ-14 LANTIRN targeting system) acquired by Bahrain and Israel, but latter obtained indigenous Rafael Litening IR targeting and navigation pod as replacement. Total of 168 Litening II navigation/targeting pods ordered from Rafael and Northrop Grumman to equip Block 25/30/32/40/42 F-16C/Ds of the Air National Guard (136) and Air Force Reserve Command (32); programme called Precision Attack Targeting System, with first AFRC unit (457th FS at Fort Worth, Texas) receiving initial batch of four pods in February 2000; this and three more AFRC squadrons equipped by end of 2000. ANG accepted first pods during 2000; goal is to allocate eight pods to each 15-aircraft squadron. Litening ER (Extended Range) targeting and navigation pod system also being supplied to ANG, which received first eight (of 16) in fourth quarter of 2002; all delivered by end of year. Under CCIP modification programme, Block 40/42/50/52 aircraft of USAF to adopt new Lockheed Martin Sniper XR advanced FLIR targeting pod system from late 2002 onwards.

Raytheon AN/ASQ-213 HARM Targeting System (HTS) pod introduced on Block 50D/52D aircraft and subsequently retrofitted to entire Block 50/52 fleet. Entered service 1994 and currently deployed by USAF units in USA, Japan and Germany.

Self-defence: Dalmo Victor AN/ALR-69 radar warning system replaced in USAF Block 50/52 by BAE Systems AN/ALR-56M advanced RWR, which also ordered for USAF Block 40/42 retrofit and (first export) Korean Block 52s. Korean aircraft retrofitted with the ITT Avionics/Northrop Grumman AN/ALQ-165 Airborne Self-Protection Jammer (ASPJ) from mid-2000. Provision for Northrop Grumman AN/ALQ-131 or Raytheon AN/ALQ-184 jamming pods. AN/ALQ-131 supplied to Bahrain and Egypt. Israeli Air Force F-16s extensively modified with locally designed and manufactured equipment, as well as optional US equipment to tailor them to the IAF defence role. This includes Elisra SPS 3000 self-protection jamming equipment in enlarged spines of F-16D-30s and Elta EL/L-8240 ECM in third batch of F-16C/Ds, replacing AN/ALQ-178(V)1 Rapport ECM in Israeli F-16As. Chilean aircraft will have ITT Industries Advanced Integrated Defensive Electronic Warfare Suite (AIDEWS), incorporating radar warning and RF countermeasures.

BAE Systems AN/ALQ-178(V)3 Rapport III integral self-protection system in Turkish F-16C/Ds will almost certainly be replaced by improved AN/ALQ-178(V)5 system. In March 1993, Greece ordered Raytheon ASPIS (Advanced Self-Protection Integrated Suite) self-defence system, comprising Northrop Grumman AN/ALR-93 RWR, BAE Systems AN/ALE-47 chaff/flare dispensers and Raytheon AN/ALQ-187 I-DIAS jammer; enhanced version known as ASPIS II is being installed on Advanced Block 52 aircraft.

USAF Air National Guard procured Terma PIDS wing weapon pylon with additional chaff/flare dispensers.

BAE Systems AN/ALE-40(V)-4 chaff/flare dispensers (AN/ALE-47 in FY97 Block 50, FMS Block 20/50 since mid-1996 and for retrofit to Block 40/42 and 50/52 of USAF). Raytheon AN/ALE-50(V)2 towed decoy installed in AMRAAM missile pylons and adopted by USAF for all Block 40/42/50/52 aircraft was widely fielded in 1999; USAF to buy total of 961. USAF Air National Guard participating in wing weapon pylon upgrade programme (to be fielded in 2004) that adds MIL-STD-1760 interface to existing PIDS pylons. This programme also includes provisions for future incorporation of a passive missile approach warning system.

ARMAMENT: General Dynamics M61A1 20 mm multibarrel cannon in the port side wing/body fairing, equipped with a General Dynamics ammunition handling system and an enhanced envelope gunsight (part of the head-up display system) and 511 rounds of ammunition. There is a mounting for an air-to-air missile at each wingtip, one underfuselage centreline hardpoint, and six underwing hardpoints for additional stores. For manoeuvring flight at 5.5 *g* the underfuselage station is stressed for a load of up to 1,000 kg (2,200 lb), the two inboard underwing stations for 2,041 kg (4,500 lb) each, the two centre underwing stations for 1,587 kg (3,500 lb) each, the two outboard underwing stations for 318 kg (700 lb) each, and the two wingtip stations for 193 kg (425 lb) each. For manoeuvring flight at 9 *g* the underfuselage station is stressed for a load of up to 544 kg (1,200 lb), the two inboard underwing stations for 1,134 kg (2,500 lb) each, the two centre underwing stations for 907 kg (2,000 lb) each, the two outboard underwing stations for 204 kg (450 lb) each, and the two wingtip stations for 193 kg (425 lb) each. There are mounting provisions on each side of the inlet shoulder for the specific carriage of sensor pods (electro-optical, FLIR and so on); each of these stations is stressed for 408 kg (900 lb) at 5.5 *g*, and 250 kg (550 lb) at 9 *g*.

Typical stores loads can include two wingtip-mounted AIM-9L/M/P Sidewinders, with up to four more on the outer underwing stations; Rafael Python 3 on Israeli F-16s from early 1991 and Python 4 from mid-1997; centreline GPU-5/A 30 mm cannon; drop tanks on the inboard underwing and underfuselage stations; HARM targeting system pod along the starboard side of the nacelle; and bombs, air-to-surface missiles or flare pods on the four inner underwing stations. Stores can be launched from Aircraft Hydro-Forming MAU-12C/A bomb ejector racks, Hughes LAU-88 launchers, Orgen triple or multiple ejector racks and Lucas Aerospace Flight Structures Twin Store Carrier (TSC). New BRU-57 bomb racks fitted to Block 50/52 aircraft of USAF from fourth quarter of 2001; installed at mid-span hardpoint, each BRU-57 will be able to carry two smart munitions such as JSOW, JDAM and WCMD.

Weapons launched successfully from F-16s, in addition to AIM-9 Sidewinder and AIM-120A AMRAAM, include radar-guided AIM-7 Sparrow, Rafael Derby and Sky Flash BVR air-to-air missiles, AIM-132 ASRAAM and Magic 2 IR homing air-to-air missiles, AGM-65A/B/D/G Maverick air-to-surface missiles, AGM-88 HARM and AGM-45 Shrike anti-radiation missiles, AGM-84 Harpoon anti-ship missiles (clearance trials 1993-94) and, in Royal Norwegian Air Force service, the Penguin Mk 3 anti-ship missile. LGBs include GBU-10, GBU-12, GBU-22, GBU-24 and GBU-27; F-16 can also deliver GBU-15 glide bomb, which used in conjunction with datalink pod. Israeli IMI STAR-1 anti-radiation weapon has also begun carriage trials on F-16D, although full-scale development is dependent upon receipt of a firm order; IMI runway attack munition (RAM) introduced into IDF/AF service in about 2000. CMS Defense Systems Autonomous Free-flight Dispenser System (AFDS) was tested at Eglin AFB, Florida, during 1992-93 and can be loaded with a variety of submunitions, including cratering bombs, shaped charge bomblets, anti-tank mines, area denial submunitions and general purpose bomblets.

Newest capability, introduced on Block 50/52 aircraft of USAF, incorporates 50T5 software upgrade, allowing F-16 to carry and deliver latest family of precision munitions; release to service occurred in mid-2000. New weapons comprise GBU-31 Joint Direct Attack Munition (JDAM), AGM-154 Joint StandOff Weapon (JSOW) and CBU-103, CBU-104 and CBU-105 wind-corrected munitions dispensers (WCMDs). First operational unit with JSOW and WCMD was 20th FW at Shaw AFB, South Carolina. AGM-158 Joint Air-to-Surface Standoff Missile (JASSM) tested on F-16 and expected eventually to be deployed operationally.

DIMENSIONS, EXTERNAL (F-16C, D): *Data applicable to Block 50/52 versions:*

Wing span: over missile launchers — 9.45 m (31 ft 0 in)
over missiles — 10.00 m (32 ft 9¾ in)
Wing aspect ratio — 3.2
Length overall — 15.03 m (49 ft 4 in)
Height overall — 5.09 m (16 ft 8½ in)
Tailplane span — 5.58 m (18 ft 3¾ in)
Wheel track — 2.36 m (7 ft 9 in)
Wheelbase — 4.00 m (13 ft 1½ in)

AREAS (F-16C, D):

Wings, gross — 27.87 m^2 (300.0 sq ft)
Flaperons (total) — 2.91 m^2 (31.32 sq ft)
Leading-edge flaps (total) — 3.41 m^2 (36.72 sq ft)
Fin, incl dorsal fin — 4.00 m^2 (43.10 sq ft)
Rudder — 1.08 m^2 (11.65 sq ft)
Horizontal tail surfaces (total) — 5.92 m^2 (63.70 sq ft)

WEIGHTS AND LOADINGS:

Weight empty:
F-16C: F100-PW-229:
with CFTs — 9,358 kg (20,631 lb)
without CFTs — 8,910 kg (19,643 lb)
F110-GE-129:
with CFTs — 9,466 kg (20,868 lb)
without CFTs — 9,017 kg (19,880 lb)
F-16D: F100-PW-229
with CFTs — 9,760 kg (21,517 lb)
without CFTs — 9,312 kg (20,529 lb)
F110-GE-129:
with CFTs — 9,867 kg (21,754 lb)
without CFTs — 9,419 kg (20,766 lb)
Max internal fuel (JP-8): F-16C — 3,228 kg (7,116 lb)
Max external fuel (JP-8), F-16C/D (with 300 US gallon centreline tank):
normal: with CFTs — 4,569 kg (10,072 lb)
without CFTs — 3,208 kg (7,072 lb)
optional: with CFTs — 5,879 kg (12,962 lb)
without CFTs — 4,519 kg (9,962 lb)
Max external load (full internal fuel):
F-16C: F100-PW-229:
with CFTs — 9,635 kg (21,241 lb)
without CFTs — 8,855 kg (19,522 lb)
F110-GE-129:
with CFTs — 9,190 kg (20,260 lb)
without CFTs — 8,742 kg (19,272 lb)
Typical combat weight (two AAMs, 50% fuel):
F-16C: F100-PW-229:
with CFTs — 12,254 kg (27,015 lb)
without CFTs — 11,125 kg (24,527 lb)
F110-GE-129:
with CFTs — 12,367 kg (27,265 lb)
without CFTs — 11,239 kg (24,777 lb)
Max T-O weight with two AAMs, no tanks:
F-16C: F100-PW-229:
with CFTs — 14,548 kg (32,073 lb)
without CFTs — 12,723 kg (28,050 lb)
F110-GE-129:
with CFTs — 14,661 kg (32,323 lb)
without CFTs — 12,852 kg (28,335 lb)
with full external load:
F-16C/D Block 50/52 — 21,772 kg (48,000 lb)
Wing loading: at 12,927 kg (28,500 lb) AUW — 463.8 kg/m^2 (95.00 lb/sq ft)
at 19,187 kg (42,300 lb) AUW — 688.4 kg/m^2 (141.00 lb/sq ft)
at 21,772 kg (48,000 lb) AUW — 781.2 kg/m^2 (160.00 lb/sq ft)
Thrust/weight ratio (clean, without CFTs) — 1.03 to 1

PERFORMANCE:

Max level speed at 12,200 m (40,000 ft) — above M2.0
Service ceiling — more than 15,240 m (50,000 ft)
Radius of action:
F-16C Block 50, with CFTs, two 907 kg (2,000 lb) bombs, two Sidewinders, 3,940 litres (1,040 US gallons; 867 Imp gallons) external fuel, tanks retained, hi-lo-lo-hi — 735 n miles (1,361 km; 845 miles)
F-16C Block 50, with CFTs, armament as above, 5,542 litres (1,464 US gallons; 1,219 Imp gallons) external fuel, tanks retained, hi-lo-lo-hi — 845 n miles (1,565 km; 972 miles)
F-16C Block 50, two BVR missiles, two Sidewinders, 3,940 litres (1,040 US gallons; 867 Imp gallons) external fuel, not including CFTs, tanks dropped when empty, combat air patrol mission — 950 n miles (1,759 km; 1,093 miles)
Ferry range:
F-16C Block 50, with CFTs and 3,940 litres (1,040 US gallons; 867 Imp gallons) external fuel — 2,150 n miles (3,981 km; 2,474 miles)
F-16C Block 50, with 5,542 litres (1,464 US gallons; 1,219 Imp gallons) external fuel, not including CFTs — 2,415 n miles (4,472 km; 2,779 miles)
Symmetrical *g* limit with full internal fuel — +9

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