

F-15 AIRCRAFT DEVELOPMENT

Compiled by Jack Abercrombie & Mike de Garcia

April 1965: Air superiority type fighter plane, designated FX (Fighter Experimental) study begins.

December 1965: USAF RFP for a four-month study.

March 1966: Study awarded to North American, Lockheed and Boeing for Concept Formulation Study.

March-December 1966: McDonnell did in-house FX investigations.

June 1967: USAF rejects all designs from Concept Formulation Study because they didn't like the aerodynamic configurations and the by-pass ratio of the engine.

August 1967: USAF issues RFP for Tactical Fighter. McDonnell and General Dynamics each win a six-month Concept Formulation Study. McDonnell recommends airplane with fixed wing, two engines and a one-man crew.

May 1968: USAF issues RFP for FX Contract Definition Study to McDonnell, North American, Grumman, General Dynamics, Lockheed, LTV (old Ling-Temco-Vought), Fairchild-Hiller and Boeing (8 companies).

October 1968: USAF awards contracts to: McDonnell, North American and Fairchild-Hiller (3 companies).

January - June 1969: Contractors study and propose to develop and build the F-15 fighter. McDonnell proposal took 2.5 million man-hours and submitted a 37,500-page proposal in 382 volumes.

June - December 1969: USAF/Aeronautical Systems Division at Wright-Patterson AFB studies proposals. SPO Chief: Col. Benjamin Bellis (from the SR-71 program)

December 23, 1969 (2:30 pm CST): McDonnell announced as the winner of the prime contract for the F-15.

Notes: High (W/S) Wing Loading does not help in dogfight; high (T/W) Thrust-to-Weight creates maneuvering while high W/S decreases maneuvering ability. High load factor maneuvering point-of-view: want low W/S with high T/W. Avionics wants: beyond-visual-range weapons system.

What USAF wanted (from RFP):

- 1) Wing with high load factor, buffet-free performance at 0.9 Mach at 30 K altitude.
- 2) High T/W to achieve high energy maneuverability.
- 3) Global ferry range with or without inflight refueling.
- 4) One-man operation for all missions
- 5) Fatigue spectrum with a life of 4000 hours and a scatter factor of 4 (16 K hours without structural failure)
- 6) Cockpit layout and displays to allow heads-up during close-in combat, 360-deg. visibility.
- 7) Maintenance Man-Hours per Flight Hour (MMH/FH): 11.3
- 8) Self-contained engine starting
- 9) Highly survivable structure, fuel, hydraulic, flight control and electrical subsystems.
- 10) Air Superiority Mission Gross Weight: 40,000 lb max.

- 11) Mach 2.5 max. at altitude.
- 12) Long-range Pulse Doppler radar with look-down capability.
- 13) Low-development risk components.

Notes: F-4 Phantom: 4,287 wind tunnel hours; F-15 Eagle: 22,188 wind tunnel hours to first flight.

FX was designated by McDonnell for internal use as Model 199.

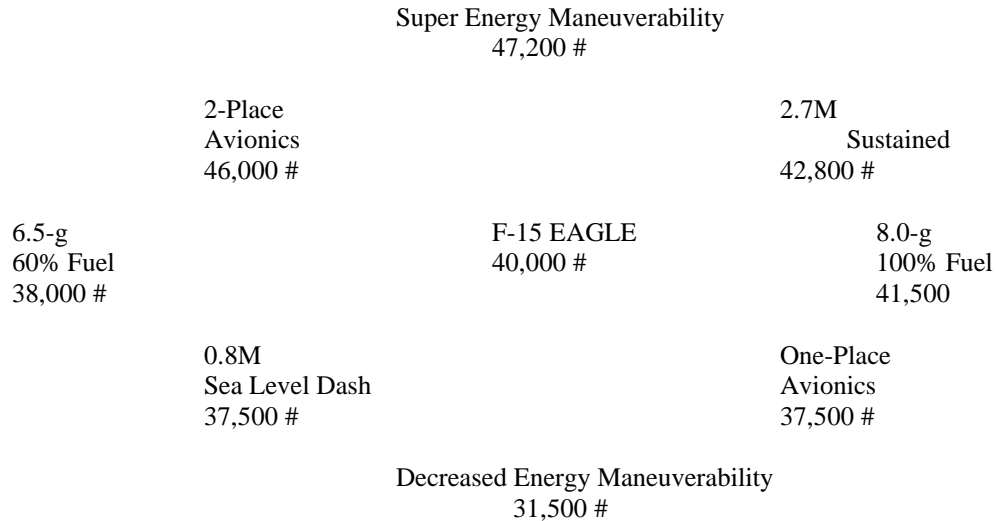
Configuration Studies:

- 1) Fixed Wing:
 - A) Two Podded Engines
 - B) Two Fuselage Mounted Engines
 - C) One Fuselage Mounted Engine
- 2) Variable Sweep Wing:
 - A) Two Podded Engines
 - B) Two Fuselage Mounted Engines

Wing Studies:

$C_{Ld} = 0.19, 0.45, 0.60, 1.2$
 $\Lambda_{LE} = 45, 47, 50, 52, 55, 57\text{-deg.}$
 $t/c = 5.8\%, 4.5\%, 3\%$
 $\lambda = 0.035, 0.135, 0.235$
 $AR = 2.08, 2.4, 3.0, 3.2$

“Snowflake” Diagram:



Directional Stability Improvement:

Proposal (July 1969)	Vertical Tails + Ventrals	61.4 sq.ft.
Final (April 1971)	Larger V-Tails (No Ventrals)	62.6 sq.ft.

December 31, 1969: F-15 Contract signed.

F-15 SPO Chief: General Benjamin Bellis
 McDonnell Chief: Don Malvern, VP and GM, F-15 Program
 20 pre-production planes for eval: 12 contractor, 8 USAF

Notes: Before 1st production: F-4 had 135 ECPs with $\Delta W = +3,050 \#$
F-15 had 38 ECPs with $\Delta W = + 188 \#$

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May 1971: MDC contract to develop composite wing made of boron, $\Delta W = +400 \#/\text{wing}$
(contract cancelled February 1975)

July 8, 1971: US Navy wants data on F-15 as potential Navy Fighter (F-15N)

July 27, 1972: F-15 First Flight: Pilot Irv Burrows

Configuration Changes:

- 1) Enlarged speed brake: 20 sq ft to 31.5 sq ft
- 2) Raked wing tips: 4 sq ft (airload/buffet problem)
- 3) Snag stabilator: flutter problem (shift of C_p and change of inertia)
- 4) Landing gear strut to improve landing characteristics in 30 knots crosswind
- 5) Control system: More than 25 mechanical and 21 CAS changes
- 6) Revised ramp schedule

August 12, 1972: LTC Wendell Shawler, first USAF pilot to fly F-15 (F-1, Flt #16)
92 flights in 43 days: 4.25 MMH/FH
Engine Change: Demo 18 min. 55 sec. (30-min. reqmt)
Combat Turnaround Time: Demo 5 min. 50 sec. (12-min. reqmt)

March 30, 1973: Deputy Secretary of Defense Clements attempted to obtain funding for a F-14 and F-15 fly off competition:

	<u>F-14A</u>	<u>F-15A</u>
TOGW	56,400 #	40,000 #
Internal Fuel	16,440 #	11,100 #
(T/W) _{TO}	0.72	1.2
(W/S) _{TO}	100 psf	66 psf

August 23, 1973: First achievement of Mach 2.5 by Pete Garrison in F-15 (F-2)

June 25, 1974: First spin with F-15 (F-1) by Denny Behm

Month (?), 1974: First flight (TF-2) with Conformal Fuel Tanks

November 1974: F-15 introduced to USAF inventory

September 18, 1975: TAC Evaluation of F-15 (TF-2) with CFTs

October 14, 1975: Luke AFB; 1st F-15 loss (F-22). Pilot, Capt. Jerry Cheney, turned off generator switches because he had smoke in the cockpit. Problem with boost pump in main fuel tank. Pilot ejected, breaking an ankle in the process.

January 9, 1976: Langley AFB, Va: Received first F-15 for the 1st Tactical Fighter wing, LTC Richard L. Craft, commander 27th TFS. Has three squadrons: 27th, 71st, 94th.

[September 1976: Russian pilot flies MiG-25 to Japan]

January 5, 1977: Bittburg, Germany: 36th TFW, USAF Europe

April 27, 1977: 23 F-15 aircraft flown en masse to Holloman AFB, New Mexico (previously had F-4Es)

January 14, 1983: LTC John Hoffman performs 1st spin of an F-15C with CFTs.

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F-15 Physical Characteristics

Wing: Area (theo.) 608 sq ft; Span 42 ft 8 in; AR 3.0; Taper Ratio 0.25; Sweep (LE) 45-deg.
Dihedral - 1 deg.

Airfoil & Chord:

(Theoretical)	Root (BL 0)	NACA 64A006.6 ($C_{Li} = 0$)	273.3"
	BL 77.0	NACA 64A(X)05.9 ($C_{Li} = 0.055$, $a = 0.8$ mod)	226.0"
	BL 155.0	NACA 64A(X)04.6 ($C_{Li} = 0.055$, $a = 0.8$ mod)	149.6"
	BL 224.73	NACA 64A 203.5 $C_{Li} = 0.20$, $a = 0.8$ mod)	94.0"
	Tip	NACA 64A203 $C_{Li} = 0.20$, $a = 0.8$ mod)	68.4"

Incidence: None

Twist: None

Modified Conical Camber: $C_{Ld} = 0.3$

Aileron Area: 26.48 sq ft

Flap Area: 35.84 sq ft

Horizontal Tail: Area (LE Snag Provision) 111.36 sq ft (55.68 each)
Area (Basic Geometry) 120.00 sq ft (60.00 each)
AR 2.05
Taper Ratio 0.34
Sweep (LE) 50-deg
Dihedral 0-deg
Airfoil & Chord:

Root	NACA 0005.3-64 (MOD)	137.2"
BL 9.0	NACA 0003.5-64 (MOD)	117.9"
Tip	NACA 0002.5-64 (MOD)	46.5"

Vertical Tail: Effective Area 125.22 sq ft (62.61 each); AR = 1.70; Taper Ratio: 0.27; Sweep (LE) 36°
34'

Airfoil & Chord:

Root	NACA 0005 -64	115.0"
Tip	NACA 0003.5-64	30.6"
Rudder Area	19.94 sq ft (9.97 each)	
Toed LE outboard	2 degrees	

Speed Brake Area: 31.5 sq ft Deflection 45 deg.

Control Surface Travel: Aileron +20-deg; Speed brake 45-deg up from ML; Rudder +30-deg
Horizontal Tail (LE) 15-deg up 26-deg dn
Trailing Edge Flap 30-deg dn

Landing Gear:

	<u>Main Gear</u>	<u>Nose Gear</u>
Tire Size	34.5x9.75-18	22.0x6.6-10
Stroke	15.13"	16.5"
Static Rolling Radius	11.6"	9.88"
Flat Rolling Radius	---	7.0"

Propulsion: (2) F100-PW-100 Engines
Weight ~3,000 #
Max. Thrust 24,000 # class
Pressure Ratio 23
Turbine Inlet Temp. 2,400°F

Air Flow 224 lb/sec
SFC 0.70

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SUMMARY: First Flights Piloted by Non-MCAIR Personnel

August 12, 1972:	LTC Wendell Shawler, USAF, in F-1, Flight #16
December 4, 1973:	CDR George White, USN, in TF-1
December 6, 1973:	CDR George White, USN, in F-1
September 19, 1974:	IAF (Israel) in TF-1
September 20, 1974:	IAF (Israel) in F-11
March 24, 1975:	FRG (Germany) in TF-2
April 1976:	RSAF (Saudi Arabia) in TF-2
April 1976:	FAF (France) in TF-2
May 1976:	JASDF (Japan) in TF-2

OVERVIEW OF FIRST INCIDENTS:

July 27, 1972:	First Landing Gear Door Malfunction First Complaint of Speed Brake Buffet
July 31, 1972:	First Failure of Rudder Wiper Strips
August 1, 1972:	First Complaint of Crosswind Landing Characteristics First Incident of Ramp Twitching First Engine Stagnation
August 2, 1972:	First Complaint of CAS on Adverse Yaw
August 3, 1972:	First Indication of Soggy Supersonic Performance First Indication of Wing tank Fuel Asymmetry First Complaint of ECS Surges
August 5, 1972:	First Recognition of Rudder Hysteresis
August 8, 1972:	First In-Flight Hydraulic Leak
August 9, 1972:	First Recognition of Directional Trim Change with Speed
August 10, 1972:	First Indication of Low Directional Stability at Mach >1.4
August 11, 1972:	First Failure of Flap Comparator
August 15, 1972:	First BLD Skin Crack
August 23, 1972:	First Nose Gear Shimmy Incident
August 25, 1972:	First Complaint of Cockpit Fumes at Engine Start First "Hard, Pounding" Airframe Buffet
August 31, 1972:	First Complaint of Lateral Sensitivity
September 7, 1972:	First complaint of Residual 1 Hz Oscillation with CAS First Incident of Over-Powered Rudder Actuators
September 13, 1972:	First Indication of Longitudinal PIO Tendency
September 14, 1972:	First CAS Drop Off
September 19, 1972:	First Incident of Pitch Ratio/Pitch Trim Compensator Interlock Transient First Backwards (Reverse Sign) CAS ARI
September 20, 1972:	First Coupling of Yaw CAS and Airframe Structure
September 27, 1972:	First Catastrophic ECS Failure with Severed Longitudinal Control Rod
October 13, 1972:	First Emergency Lakebed Landing
October 30, 1972:	First Major Wing Rock, PA Configuration
November 29, 1972:	First Incident of Bent Turkey Feathers First Inlet Skin Cracks

December 18, 1972: First Single Engine Landing
December 22, 1972: First Engine Nozzle Flap Failure
December 28, 1972: First Engine Fire
December 29, 1972: First Blown Tire
February 1973: First Failure of Pitch Ratio Changer
February 13, 1973: First Serious Incident of Rudder Hinge Moment Limit
February 15, 1973: First Incident of Tail Scraping at Touchdown
March 15, 1973: First Pitch-Up due to Partially Full External Fuel Tanks
April 25, 1973: First Boost Pump Impeller Blade Failure
June 15, 1973: First Missile Fin Buzz
July 5, 1973: First Fan Blade Failure
July 30, 1973: First In-Flight Windshield Cracks
August 7, 1973: First Lateral JC due to Undamped TF Lateral Stick

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September 20, 1974: First CAS Sustained Auto-Rotation
September 25, 1974: First Collision of Bomb & Outboard Pylon
September 26, 1974: First Streamer of Spin Recovery Chute
October 1974: First Stabilator Skin Cracks
November 5, 1974: First Emergency Jettison of Bombs
November 9, 1974: First Collision of Bomb & MER Rack

February 10, 1975: First Loss of TF Canopy
February 19, 1975: First Loss of Tail Light
March 1, 1975: First Flight of Gust Alleviation System
March 19, 1975: First In-Flight Rudder Loss
May 2, 1975: First In-Flight Turbine Failure & Fire
October 14, 1975: First Aircraft Loss
December 3, 1975: First Gear-Up (RH MLG) Landing

April 30, 1976: First Supersonic Loss of Forward Canopy
April 30, 1976: First Lightning Strike Damage
October 14, 1976: First Structural Failure of Composite Speedbrake
November 15?, 1976: First Self-Inflicted Gun Fire

February 28, 1977: Mid-Air Collision Strike