McDonnell F-4(FVS)

Given the success, in terms of production numbers and duration, of the F-4 Phantom II, it's not surprising that many derivative designs were planned. The most extensive modification suggested – at least, the most extensive modification given any serious study and publication – was the F-4(FVS). This internally funded design, starting in November 1965, was described to the US Navy in an unsolicited proposal in August of 1966 as capable of fulfilling advanced Fleet Air Defense and ground attack roles in the 1969-1975 timeframe. The primary role was fleet air defense out to 100 nautical miles, from sea level to 40,000 feet. A secondary role was ground attack missions (both conventional and nuclear bombs) out to 600 nautical miles.

The F-4(FVS) shared as much commonality as possible with the F-4J. However, commonality would be strictly limited by the complete removal of the low-mounted wing of the F-4J and the addition of an all-new variable geometry shoulder mounted wing. The swing-wing design would allow the craft greater loiter capability than the standard F-4J as well as improve landing characteristics (stall speed would be reduced by 11 knots), an important point for a carrier-based aircraft.

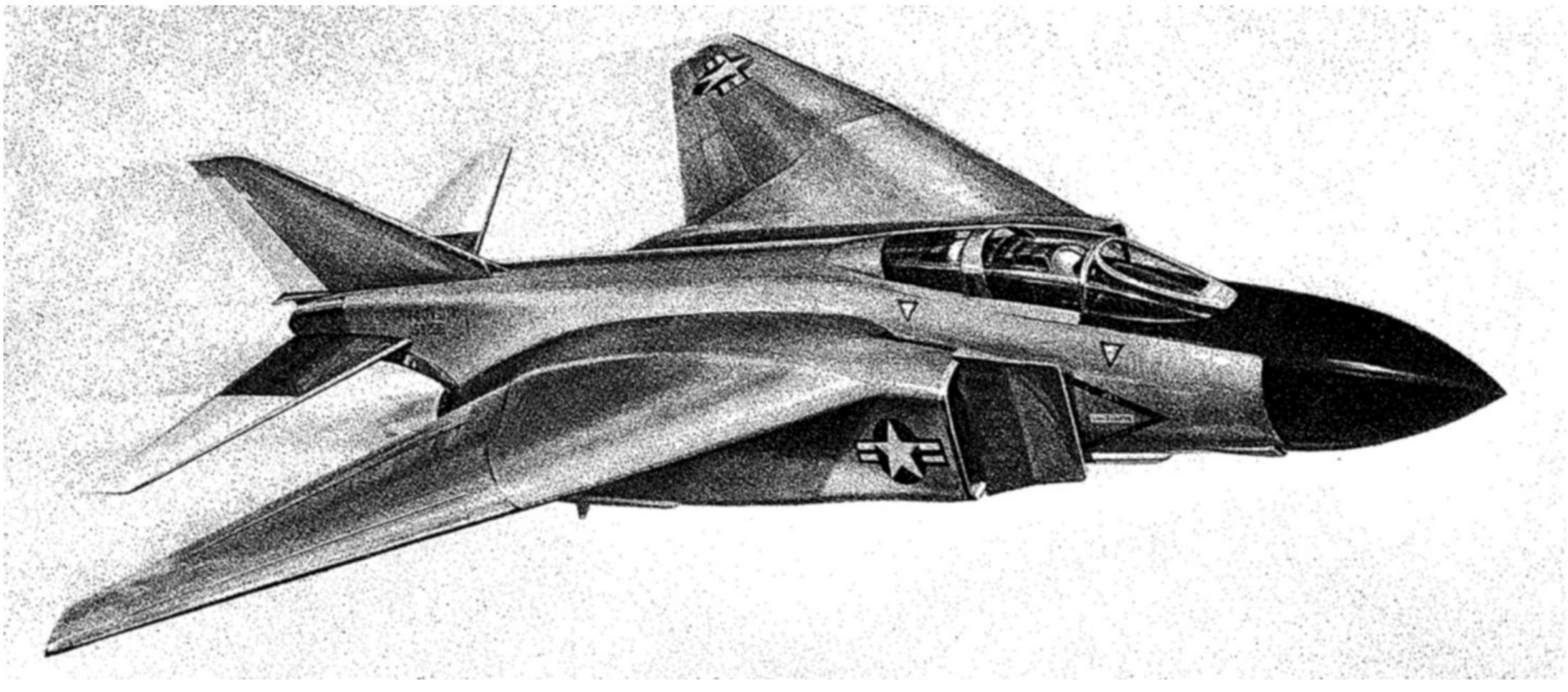
The wings pivoted at 28% span, from 23° to 70°. While on a carrier deck, the wings could be pivoted further back to 75.5° to reduce footprint (deck spotting).

As well as the wings, the horizontal stabilizers would also be modified: the distinctive anhedral of the F-4 Phantom II's stabilizers was completely eliminated. The larger stabilizers with zero dihedral provided greater supersonic maneuverability. Additionally, the main landing gear – which would fold into the F-4J's low-mounted wing – was modified to fold into the lower fuselage.

Power was provided by two General Electric J79-GE-10 turbojet engines. The F-4(FVS) was to be capable of sustained speed between Mach 2.0 and 2.4 for no more than five minutes. Beyond this, engine or structural damage may ensue.

Primary air-to-air armament for the F-4(FVS) was to be the AIM-7F Advanced Sparrow AAM. The Westinghouse AN/AGW-10 would be used and improved to provide multiple target tracking and interception capability. The analog computer would be replaced with a digital computer of increased computational capability, with the result that up to six Sparrow missiles could be managed simultaneously. A secondary terminal illumination antenna would be mounted below the AWG-10 antenna to provide terminal guidance for two missiles at the same time.

By August of 1966, more than 1,500 hours of wind tunnel testing had been carried out on the design (430 hours in the McDonnell Aircraft Corporation Polysonic tunnel, 960 hours in the McDonnell Low-Speed tunnel and 121 hours at Cornell). First flight was expected 22 months after go-ahead, with introduction to the fleet in 1969. The development program was intended to be short so that the aircraft could be introduced into the Viet Nam conflict. The F-4(FVS) designation would be replaced with a standard "F-4_" designation by the Navy once accepted for development. However, the Navy never accepted the concept for development, so no official designation was ever produced. McDonnell expected that unit price per plane, if purchased in numbers greater than three hundred, would be under $4,000,000.



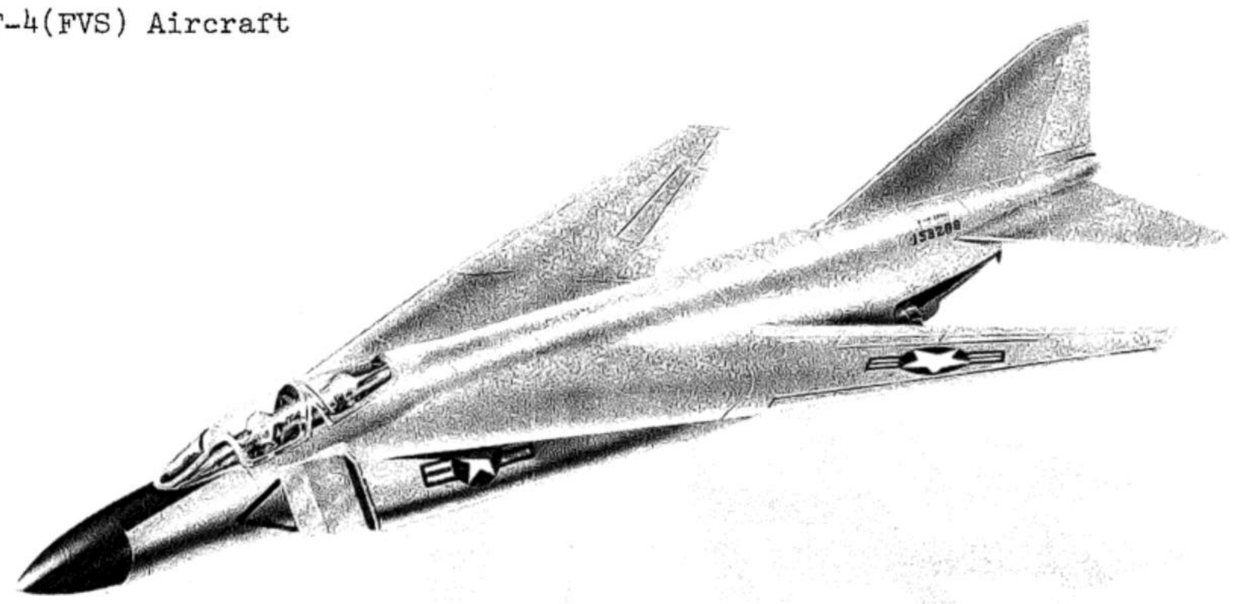
T D P SUMMARY *(Page 2.1)*
OPNAV FORM 3910-3 (8-62)

OPNAV REPORT SYMBOL 3910-3

CLASSIFICATION STAMP

1. IDENTIFICATION AND PICTURE

F-4(FVS) Aircraft



2. DESCRIPTIVE HIGHLIGHTS

Mission: Air-to-air missile combat under all weather conditions and air-to-ground attack missions with conventional and special external weapons.

Type: Fighter Aircraft

Performance:

V_{max} - 2.32 Mach
Acceleration (.8M to 1.8M) - 2.65 Minutes
Supersonic Ceiling - 59,800 Ft.
Area Intercept Radius - 1185 Miles
150 Nautical Miles CAP Mission with External Fuel (Time on Station) - 5.37 Hours
Ferry Range - 2,774 Miles
Time to Climb (0 to 35,000 Ft.) - 1.58 Minutes
Stall Speed - 102 Knots

Reliability: CAP mission (2.88 hr.) success probability goal = .91 (excludes GFAE)

Maintainability:

Total direct maintenance manhours per flight hour goal = 19.6

3. MAJOR SUB-SYSTEMS	FY 67 1 2 3 4	FY 68 1 2 3 4	FY 69 1 2 3 4	FY 70 1 2 3 4	FY 71 1 2 3 4	FY 72 1 2 3 4	FY 1 2 3 4	FY 1 2 3 4
Aircraft	Design & Devel	Test						
		Fabrication	Deliveries					
Radar	Design & Devel	Test						
		Fabrication	Deliveries					
Missile	Dsn & Dev	Test						
		Fabrication	Deliveries					

5. LEAD BUREAU
Naval Air Systems Command

6. TECHNICAL DIRECTOR

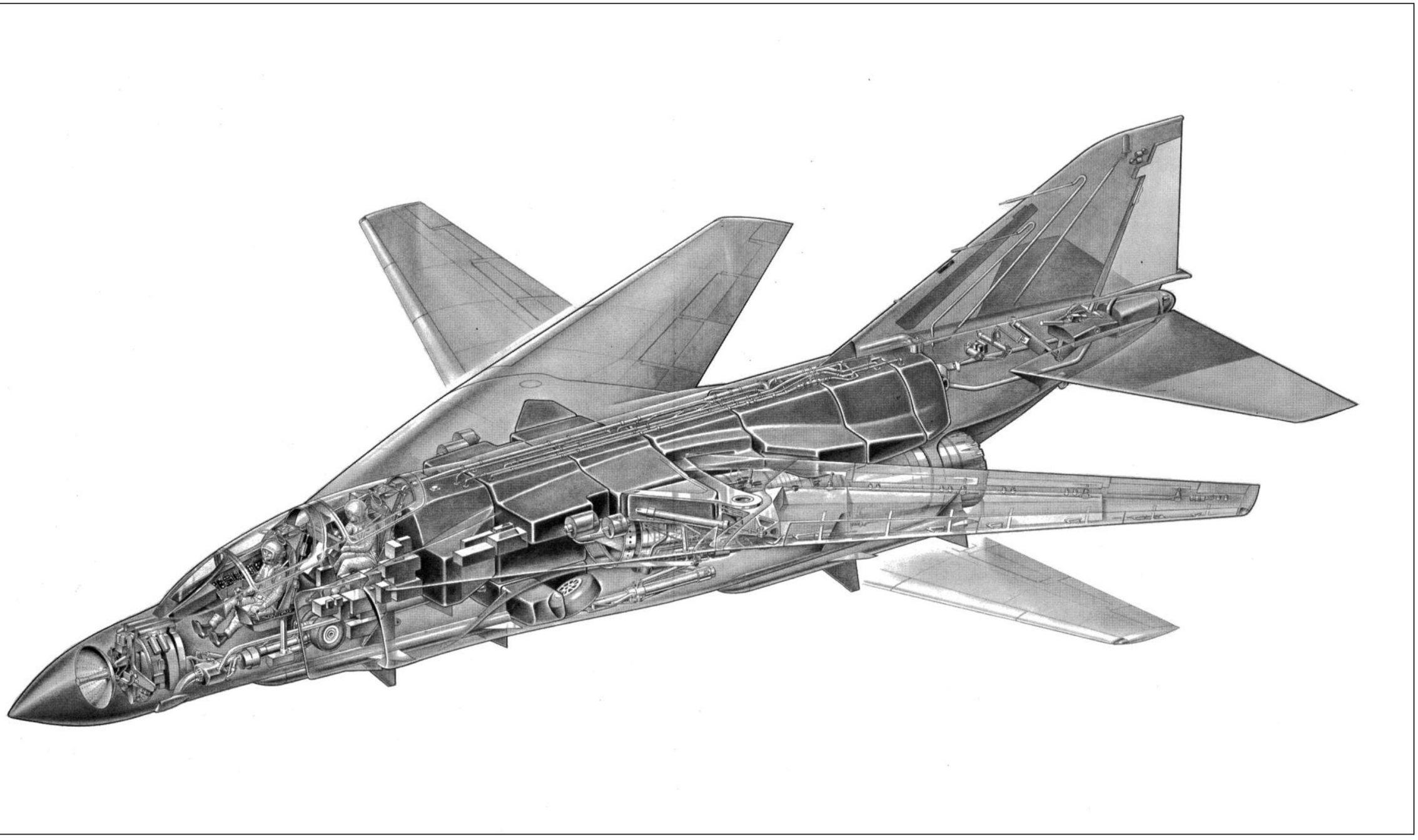
7. PRINCIPAL CONTRACTORS
Aircraft:
McDonnell Aircraft Corporation
MCS:
Westinghouse Electric Company
Missile:
Raytheon Company

4. RDT & E FUNDING (000,000)		FY (and prior)	FY (current)	FY (budget)	FY	FY	FY	FY	TO COMPLETE
FY	1. ANNUAL								
	2. CUMULATIVE								
		FY (current)	FY (budget)	FY	FY	FY	FY		TO COMPLETE
FY	3. ANNUAL								
	4. CUMULATIVE								

OP 701

CLASSIFICATION STAMP

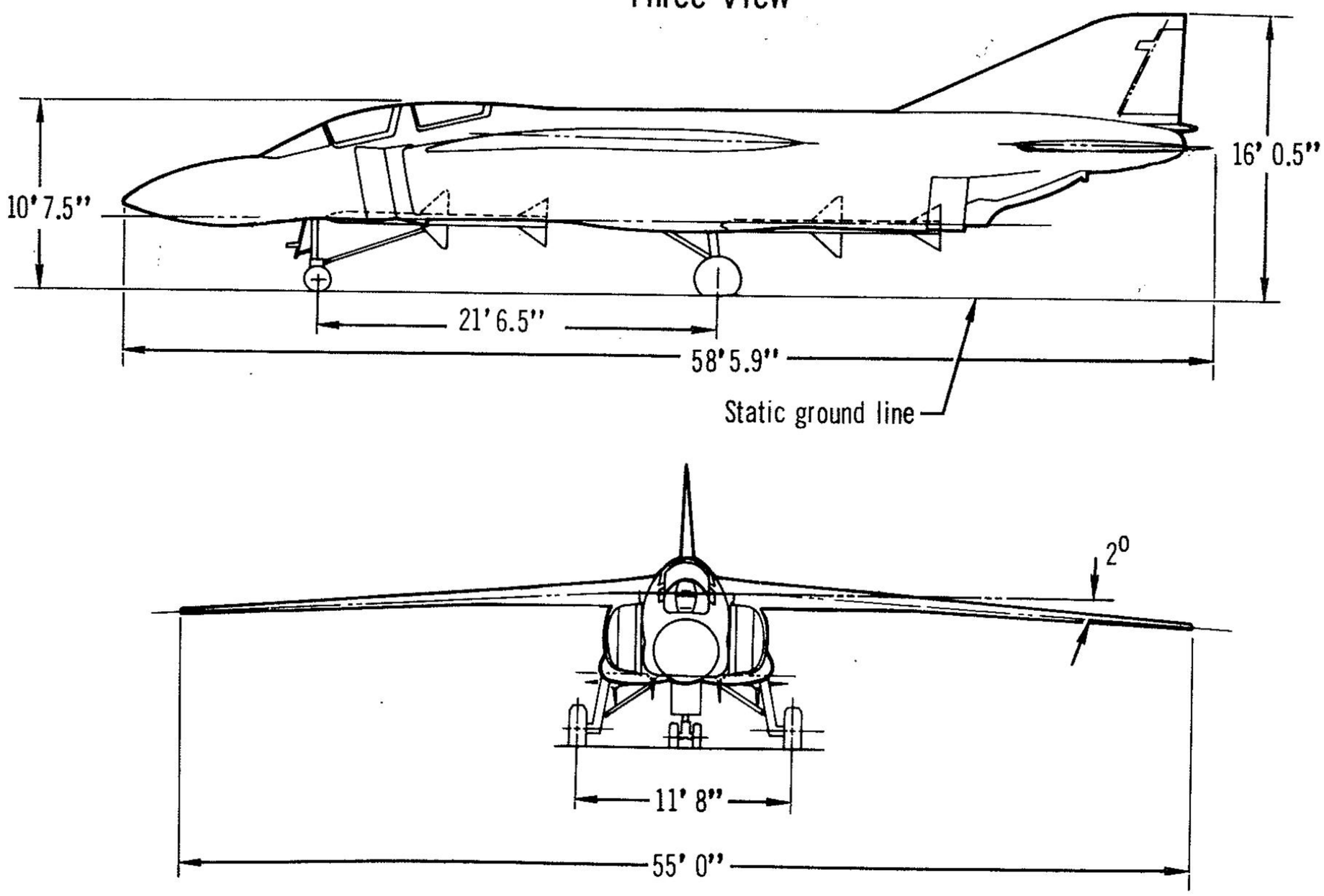
Display model reportedly from the Grumman model shop. Note that there are a number of design differences between this model – designated the "F-4(VS)" – and the F-4(FVS), including a longer nose with underslung IR sensor and horizontal stabilizers with the anhedral of the standard F-4. Available F-4(FVS) documentation from McDonnell does not mention Grumman involvement, though given Grummans experience with variable geometry aircraft it makes sense that McDonnell might have considered teaming with them. Alternatively, it may be that this model represents an entirely separate Grumman concept to retrofit F-4s. Photo courtesy John Aldaz



Cutaway illustration of the F-4(FVS)

SD–513–2

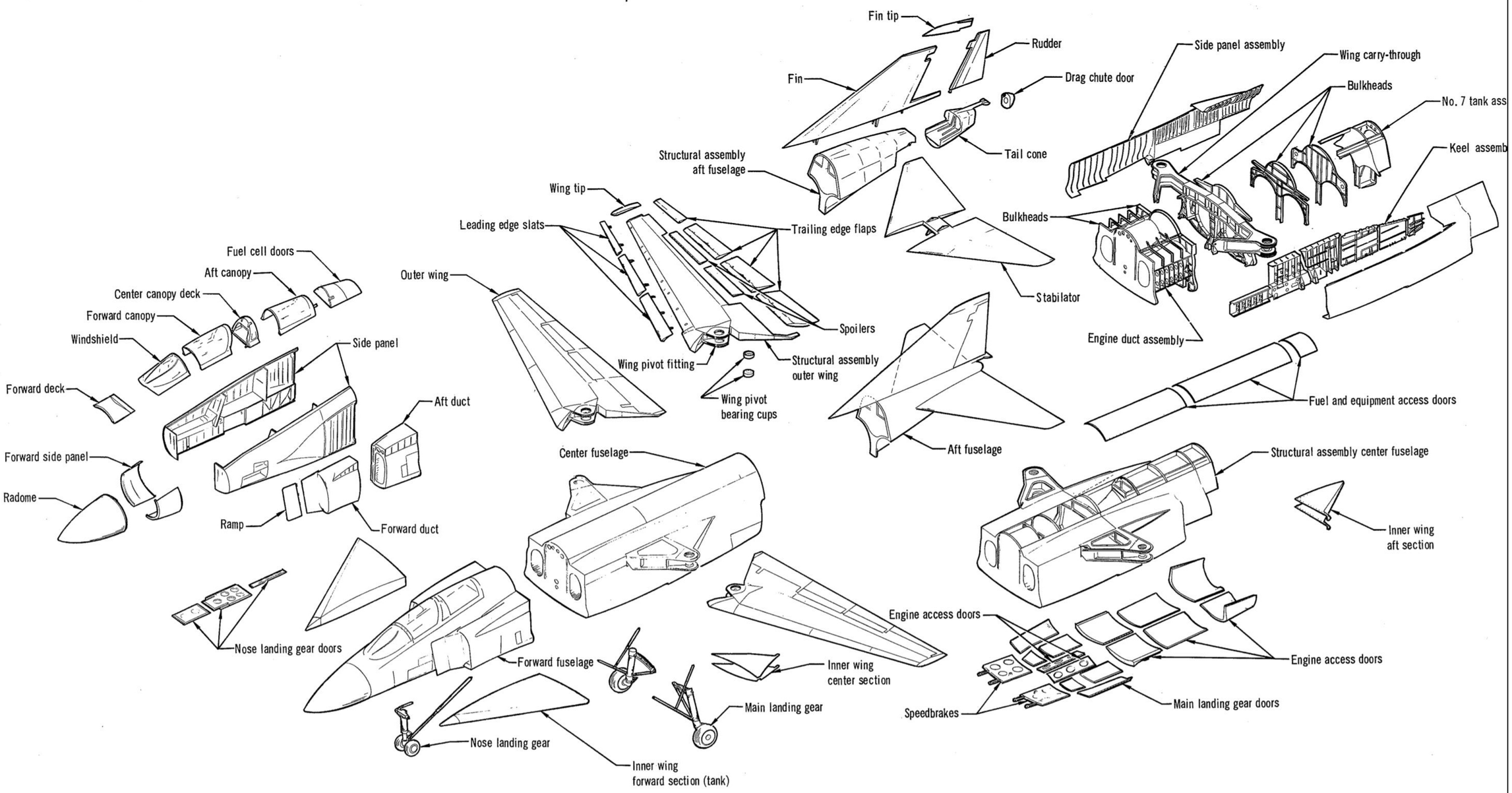
F–4(FVS)
Three View



PERFORMANCE SUMMARY

Model		F-4J	F-4(FVS)
Engine		J79-GE-10	J79-GE-10
Internal JP-5 Fuel	Gal.	1,998	2,514
Takeoff and Climb Performance			
Takeoff Gross Weight	Lb.	46,439	51,750
Takeoff Distance Over 50 Ft.	Ft.	2,550	1,720
Time to Climb to 35,000 Ft.	Min.	1.33	1.58
Speed Performance			
Combat Gross Weight (60% Int. Fuel)	Lb.	41,005	44,903
Maximum Level Flight Speed	Mach	2.27	2.32
Acceleration (.8M to 1.8M at 36,089 Ft.)	Min.	2.35	2.65
Supersonic Ceiling (Combat Weight at Maximum Thrust)	Ft.	58,700	59,800
Carrier Suitability			
Catapult Performance			
Takeoff Gross Weight	Lb.	56,000(1)	69,000(1)
W.O.D. C-7 Catapult	Knots	21	22
a/g at End of Cat.		.236	.248
Arresting Performance			
Landing Gross Weight (4,000 Lb. Fuel)	Lb.	36,852	38,655
Arresting W.O.D.-MK-7, Mod. 2	Knots	8	2
Stall Speed at Landing Gross Weight (V_{SPA})	Knots	113	102
Mission Performance(2)			
Area Intercept Radius	NM	806	1,185
Takeoff Gross Weight	Lb.	56,000(1)	65,334
External Fuel	Gal.	1,340	1,800
C.A.P. (150 NM Radius)			
Time on Station/Total Mission Time	Hr/Hr	2.61/3.71	5.37/6.62
Takeoff Gross Weight	Lb.	56,000 (1)	65,334
External Fuel	Gal.	1,340	1,800
Hi-Lo-Hi (6) MK-82 S.E., Radius	NM	343	898
Takeoff Gross Weight	Lb.	55,800	69,400
External Fuel	Gal.	740	1,800
Hi-Lo-Lo-Hi (1) MK-28 Weapon, Radius	NM	385	790
Takeoff Gross Weight	Lb.	54,146	62,968
External Fuel	Gal.	740	1,200
Q.R.I. (4) Sparrow Missiles, Radius	NM	250	333
Takeoff Gross Weight	Lb.	46,439	51,750
Ferry Range Retain/Drop Tanks	NM	1,778/1,964	2,502/2,774
Takeoff Gross Weight	Lb.	54,615	63,374
External Fuel	Gal.	1,340	1,800

NOTES: (1) Basic Catapult Design Gross Weight
(2) All Mission Performance Based on MIL-C-5011A Takeoff and Landing Reserves and a 5% Fuel Flow Safety Factor



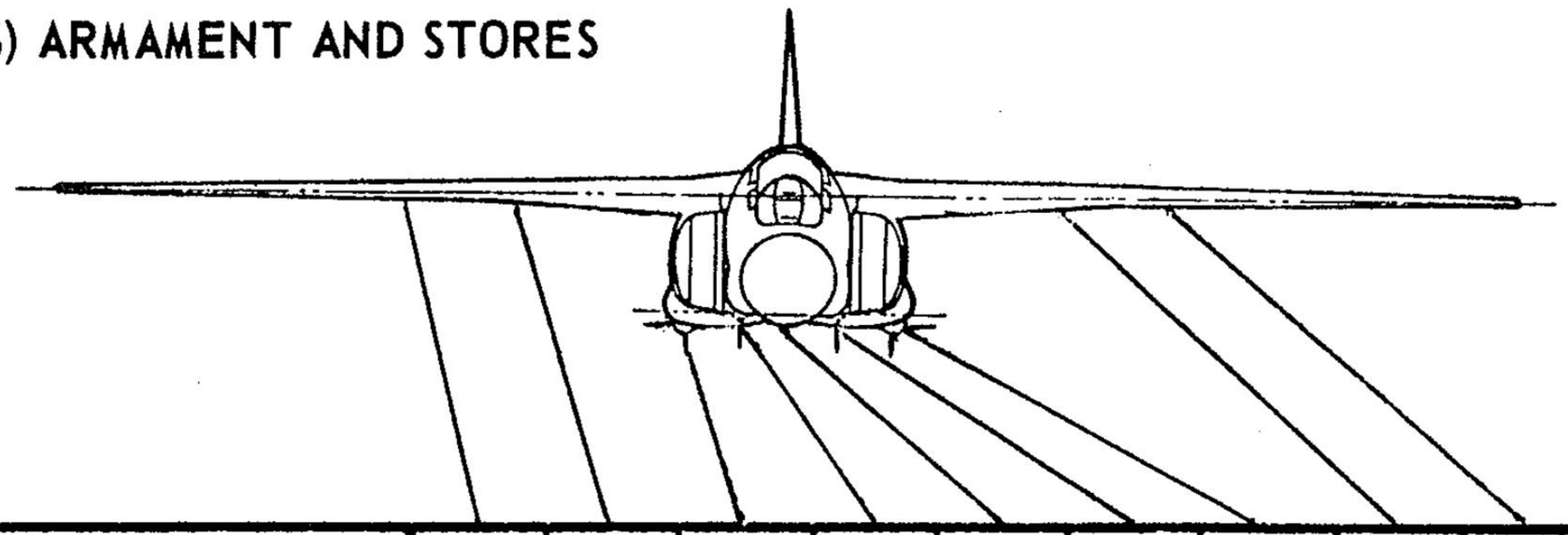
F-4 (FVS) Manufacturing Breakdown

Figure 8.2

8.3

MCDONNELL

F–4(FVS) ARMAMENT AND STORES



STORE	9	8	7	6	5	4	3	2	1
	BL 152.4	BL 91.2			℄			BL 91.2	BL 152.4
MK4 GUN POD					1				
MK81 LOW DRAG BOMB	3 (6*)	6			6			6	3 (6*)
MK82 LOW DRAG BOMB	3 (6*)	6			6			6	3 (6*)
MK83 LOW DRAG BOMB	1 (3*)	3			3			3	1 (3*)
LAU–3A/A	3	3			3			3	3
LAU 10A	3	3			3			3	3
SIDEWINDER AIM–9B/D	2								2
SPARROW III AIM–7D/E/F/F (MOD.)	1		1	1		1	1		1
MK28 MOD 0					1				
MK28 MOD 1(EX)					1				
MK43 MOD 0&1					1				
MK 57 MOD 0	1				1				1
A/A–37B–3 PRACTICE MULTIPLE BOMB RACK	1				1				1
CP–5 STARTER POD					1				
D704 REFUELING STORE					1				
600 GAL. TANK		1			1			1	

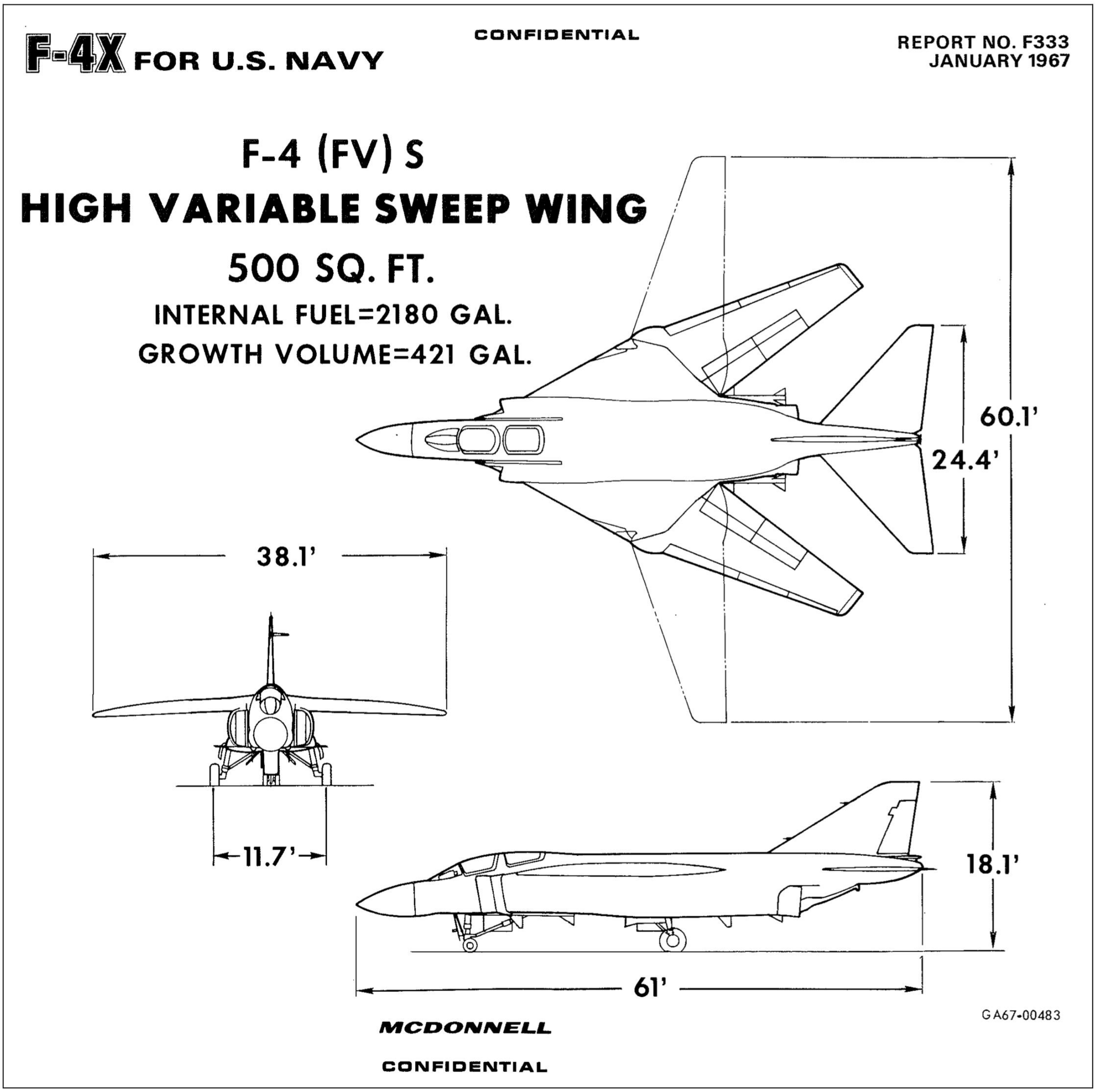
Note: This chart is intended to show physical compatibility for each listed store at that station. It does not imply that the maximum loading shown is possible. Any given combination of weights and stores requires compatibility within weight and balance limits of the airplane. Final compatibilities must be verified through flight tests.

***Alternate loadings using MER instead of TER at stations 1 and 9, resulting in catapult gross weights up to 72,475 pounds with:**

(a) Increased wind-over-deck up to 17 knots with C–13, 29 knots with C–7 catapults.

The F-4(FVS) was equipped with a number of hardpoints in order to carry a wide range of ordnance and other stores. Notable are points 1 and 9; these were under the outer wing, and, like those under the F-111's wing, would have rotated to accommodate the wing sweep. Points 2 and 8 were under the fixed portion of the wing. The MK28, MK43 and Mk 57 weapons are nuclear devices.

In January, 1967, as part of the broad F-4X proposal McDonnell put forward a slightly different design for the F-4(FVS), giving the revised design the modified designation of F-4(FV)S. This new design had a two and a half foot longer fuselage, five-foot longer span wings, two-foot longer span horizontal stabilizers and a two-foot taller vertical tail. The larger wing (500 square feet to the previous 420 square feet) led to improved maneuverability and reduced landing speed; the larger tail surfaces improved low speed trim and directional stability. A further enhancement was possible by replacing the engines with theoretical advanced engines scaled down from GE designs for the AMSA (Advanced Manned Strategic Aircraft – a long study that eventually produced the B-1 bomber).



F-4(FV)S
PERFORMANCE SUMMARY
AWG-10 SINGLE SHOT S_W = 500 FT.^{2}

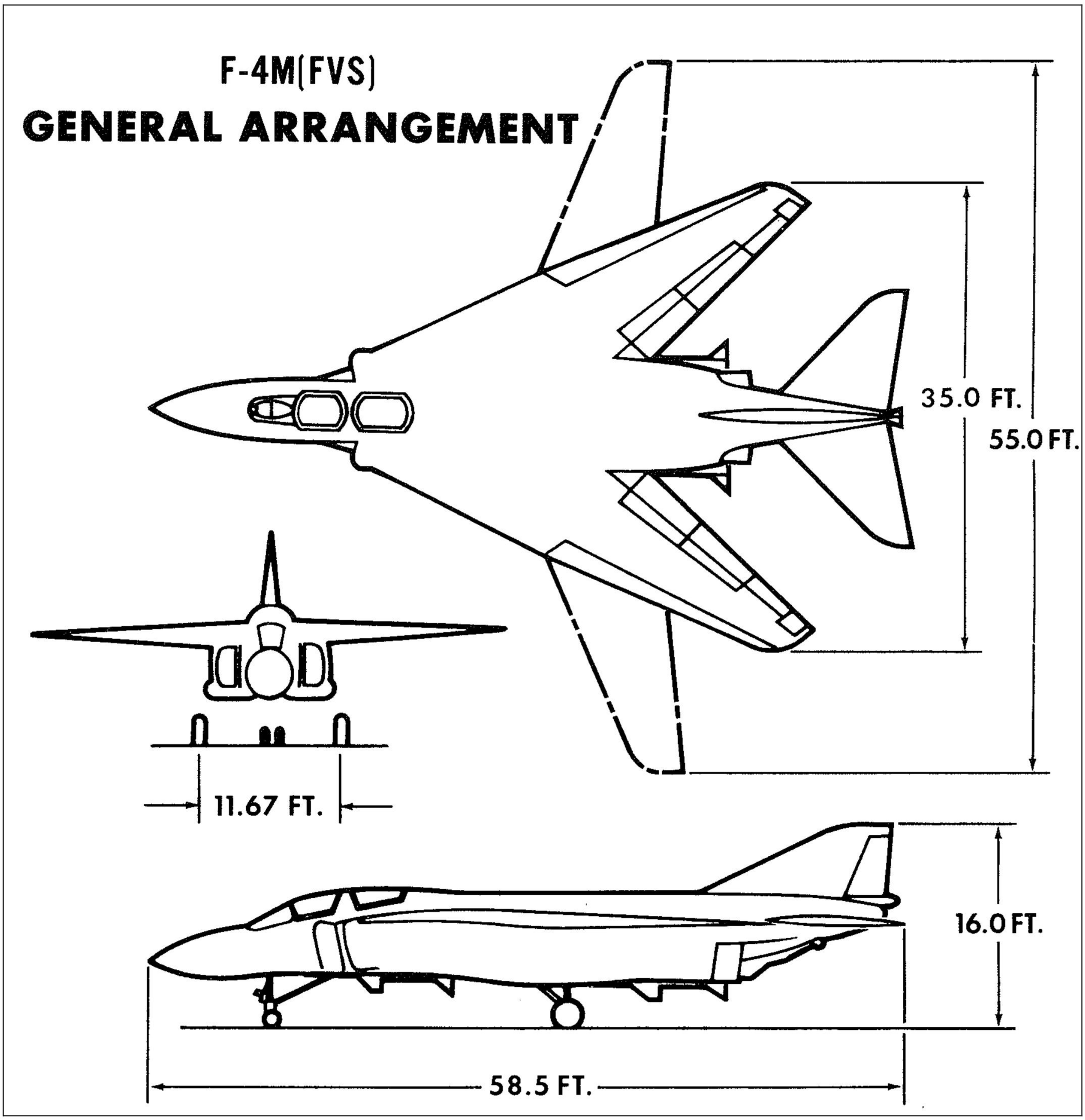
Engines Internal AVTUR/50 Fuel (1)		(2)RB168-27R 2,601	(2)GE1/10S092B 2,601	(2)J79-GE-10 2,601
TAKEOFF AND LANDING PERFORMANCE				
Takeoff Gross Weight (2)	Lb.	55,210	52,130	54,380
Takeoff Distance Over 50 Ft. Obstacle Maximum/Military Power	Ft.	1,330/3,100	1,200/3,050 (3)	1,710/3,400
Landing Gross Weight (4)	Lb.	38,974	35,695	38,399
Landing Distance Over 50 Ft. Obstacle (5)	Ft.	3,364	3,177	3,330
COMBAT PERFORMANCE				
Combat Gross Weight (60% Internal Fuel) (6)	Lb.	47,751	44,671	46,921
Maximum Level Flight Speed (Maximum Power)	M	2.37	2.53 (10)	2.27
Supersonic Combat Ceiling (Maximum Power)	Ft.	57,200	61,300	57,100
Acceleration Time (Maximum Power)				
.8M to 1.8M @ 36,089 Ft.	Min.	2.82	2.40	3.08
.9M to 2.0M @ 36,089 Ft.	Min.	3.23	2.55	3.35
MISSION PERFORMANCE				
Mission A (Lo-Lo-Lo-Lo) (7)				
Radius	N.M.	376	442	322
Takeoff Gross Weight	Lb.	56,757	53,677	55,927
Weapon Loading		(1) MK-28 + (4) AIM-7F Missiles		(1)MK-28+(4)AIM-7F Missiles
Radius	N.M.	587	679	518
Takeoff Gross Weight	Lb.	65,705	62,625	64,875
External Fuel	Gal.	1,200	1,200	1,200
Weapon Loading		(1) MK-28 + (4) AIM-7F Missiles		(1)MK-28+(4)AIM-7F Missiles
Mission B (Lo-Lo-Lo-Lo) (8)				
Radius	N.M.	152	156	148
Takeoff Gross Weight	Lb.	56,757	53,677	55,927
Weapon Loading		(1) MK-28 + (4) AIM-7F Missiles		(1)MK-28+(4)AIM-7F Missiles
Radius	N.M.	365	597	347
Takeoff Gross Weight	Lb.	65,705	62,625	64,875
External Fuel	Gal.	1,200	1,200	1,200
Weapon Loading		(1) MK-28 + (4) AIM-7F Missiles		(1)MK-28+(4)AIM-7F Missiles
Ferry Range (Retain/Drop Tanks)	N.M.	3,491/3,923	3,932/4,508	3,054/3,420
Takeoff Gross Weight (9)	Lb.	66,024	62,944	65,194
External Fuel	Gal.	1,800	1,800	1,800

See Notes on Page 3.

In February, 1967, McDonnell described the F-4M(FVS). This reverted to the size and configuration of the original F-4(FVS) but replaced the F-4J commonality with the F-4M

Armament was four Sparrow AAMs and up to four MK 83 conventional bombs.

Another history of the McDonnell F-4(FVS) has claimed that the F-4M(FV)S – yet another slightly different designation – used the same enlarged configuration as the F-4(FV)S. The F-4(FV)S was apparently pitched to the British RAF, and would be equipped with Rolls-Royce Spey 200 Turbojets and two integral 30mm Aden machine cannon located under the nose.



Engines: 2 RB168-27R
TOGW: 53,420 lbs
Empty weight: 36,383 lbs

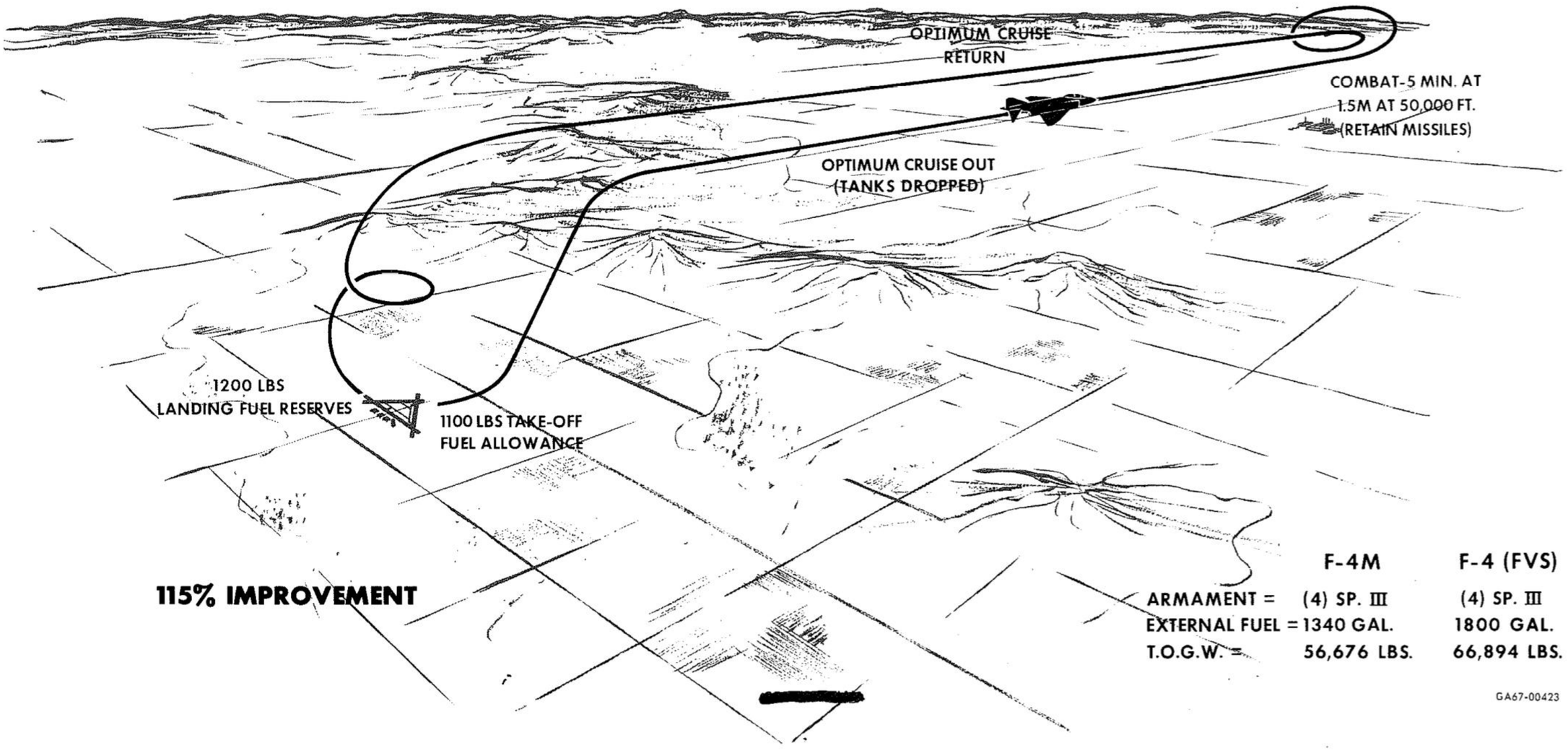
Max speed: Mach 2.41
Combat ceiling: 57,600 ft

COMBAT AIR PATROL

TIME ON STATION @ 150 NA. MI.

F-4M 3.27 HRS.

F-4M (FVS) 7.02 HRS.



	F-4M	F-4 (FVS)
ARMAMENT =	(4) SP. III	(4) SP. III
EXTERNAL FUEL =	1340 GAL.	1800 GAL.
T.O.G.W. =	56,676 LBS.	66,894 LBS.

115% IMPROVEMENT

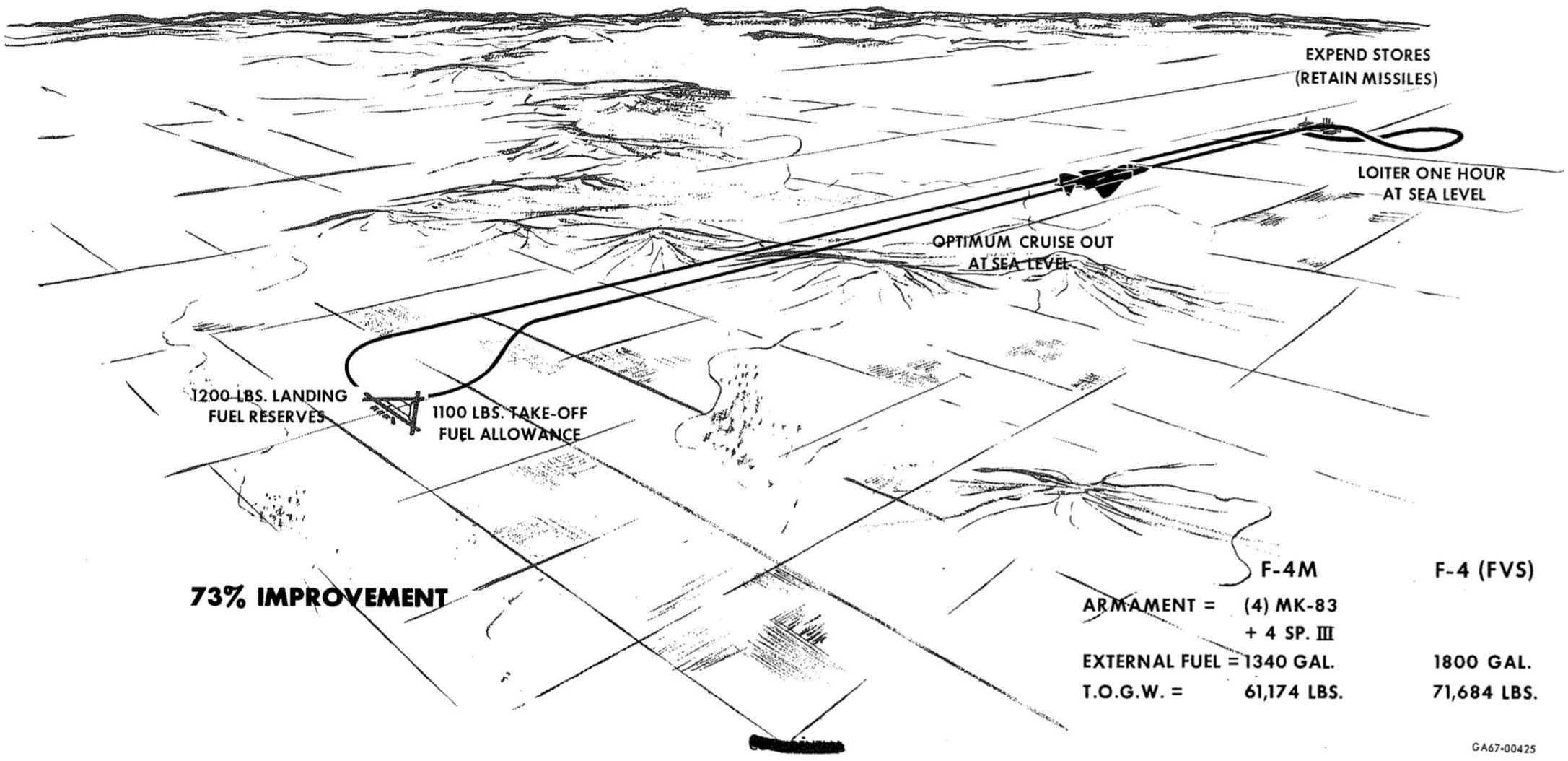
GA67-00423

LOW-LOW-LOW MISSION

RADIUS: F-4M 357 NA. MI.

F-4M (FVS) 617 NA. MI.

(LOITER ONE HOUR IN TARGET AREA)



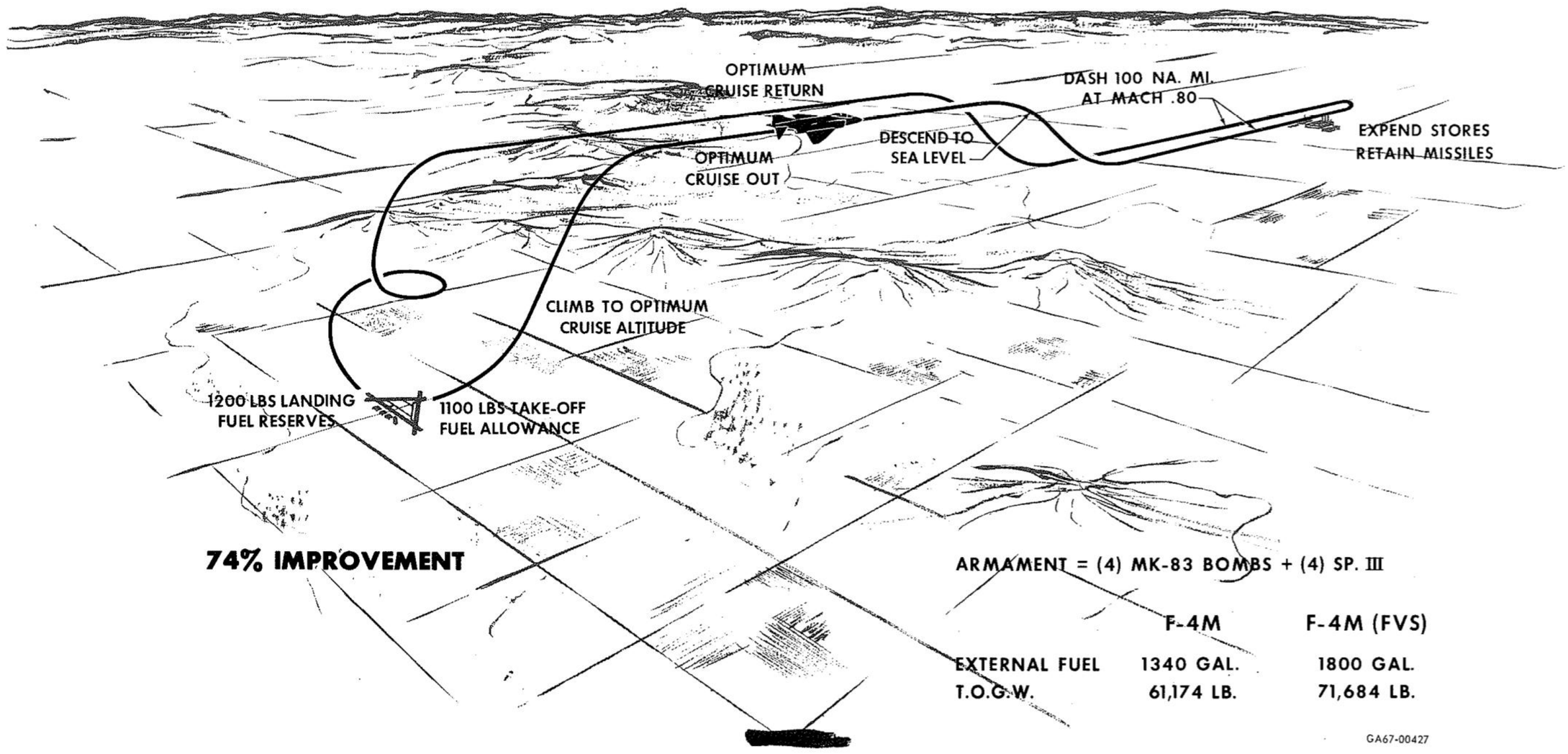
	F-4M	F-4 (FVS)
ARMAMENT =	(4) MK-83 + 4 SP. III	
EXTERNAL FUEL =	1340 GAL.	1800 GAL.
T.O.G.W. =	61,174 LBS.	71,684 LBS.

73% IMPROVEMENT

GA67-00425

HIGH-LOW-LOW-HIGH MISSION

RADIUS: F-4M 766 NA. MI.
F-4M (FVS) 1331 NA. MI.

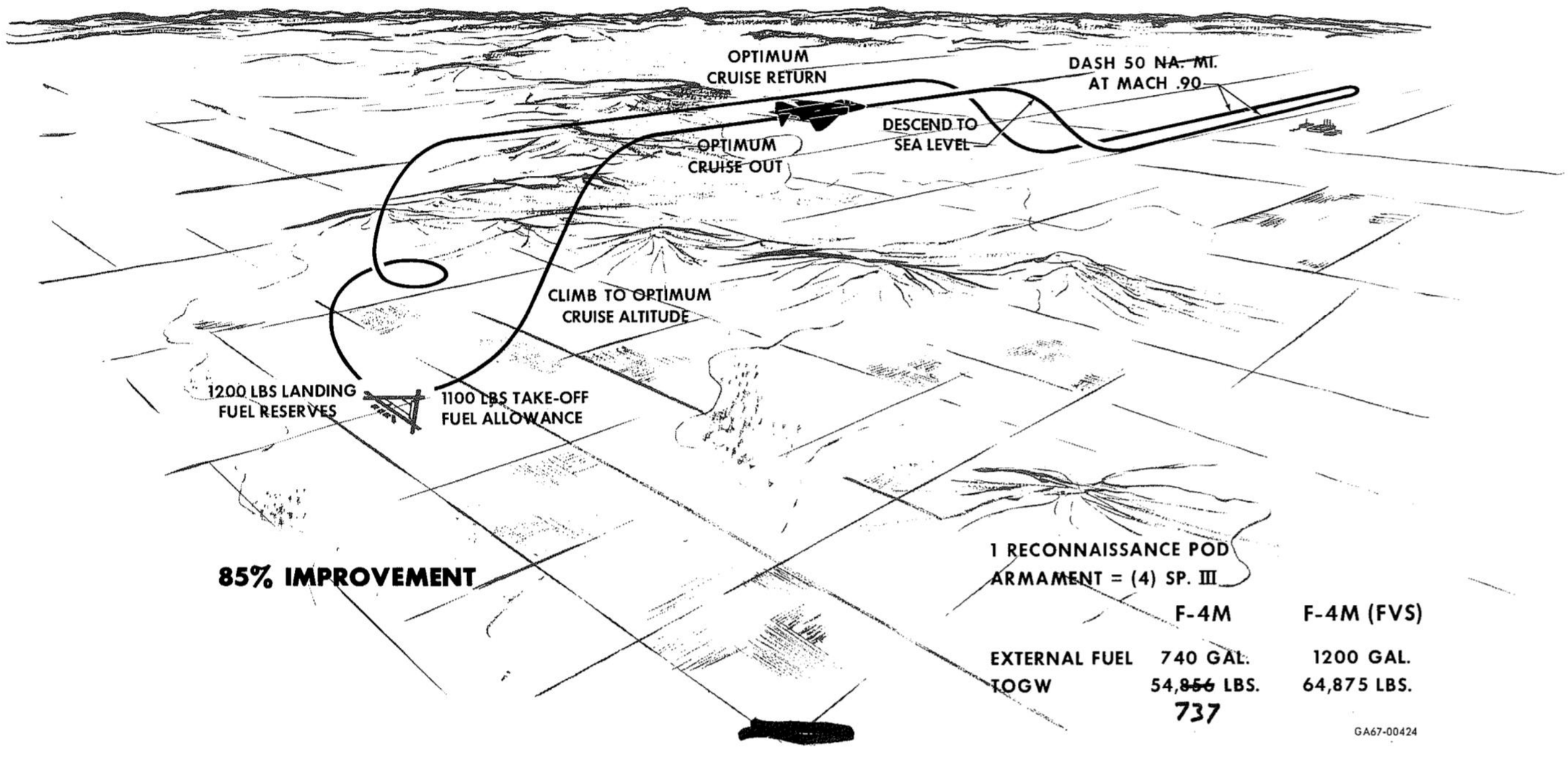


	F-4M	F-4M (FVS)
EXTERNAL FUEL	1340 GAL.	1800 GAL.
T.O.G.W.	61,174 LB.	71,684 LB.

GA67-00427

RECONNAISSANCE
HIGH-LOW-LOW-HIGH MISSION

RADIUS: F-4M 665 NA. MI.
F-4M (FVS) 1229 NA. MI.



	F-4M	F-4M (FVS)
EXTERNAL FUEL	740 GAL.	1200 GAL.
TOGW	54,~~856~~ LBS.	64,875 LBS.

737

GA67-00424

While the F-4(FVS) would have improved upon F-4 flight performance, the armament the plane could carry was not an improvement. It could not carry the AIM-54 Phoenix missile then under development, nor could it carry the required Hughes AWG-9 multi-target radar. As a result, it was not what the US Navy wanted. What the Navy wanted was not an update to an existing capability, but a wholly new aircraft with all-new weapons. As a result, the Navy was not particularly interested in the F-4(FVS) in any of its guises. Instead, in June 1968 the Navy put out the VFX Request For Proposals. The VFX program led to a competition between the all-new McDonnell-Douglas Model 225A and the Grumman Design 303E.

Normally, this is how the F-4(VFS) story would end. But it appears that the design did not simply die in 1967, but instead it evolved the Model 225A competitor. Even before the June, 1968, RFP, McDonnell-Douglas (Douglas

having merged with McDonnell in April, 1967) already had a design in development, one that looks like a halfway point between the F-4(FVS) and the Model 225A. The Model 225 was described in a January, 1968, report. The aircraft is a fundamentally new design, rather than a modification of an existing one, but there are some definite F-4 design elements to it. The wings have moved down from the F-4(FVS)s shoulder to a low position; the single large vertical fin has been split into two smaller tails mounted to the rear of a fuselage that bear no similarity to that of the F-4. The tails, while much smaller than that of the F-4, do appear to be simply scaled-down F-4 tails. The nose of the vehicle – especially the canopy - looks very much like that of the F-4. The side inlets are not standard F-4 inlets, but appear to be advanced derivatives of them with improved variable geometry for flow control at different speeds., and are in the same position. On the whole, the January 1966 Model 225 looks like a cross between an F-4 and an F-14.

The Model 225 would be able to carry Sidewinder, Sparrow and Phoenix missiles for the air defense role, and a number of bombs and air-to-ground missiles for attack. Unlike the F-4 and F-4(FVS), it would have carried an integral M-61 "Vulcan" cannon along the lower left side of the forward fuselage (in much the same location as the F-14s gun).

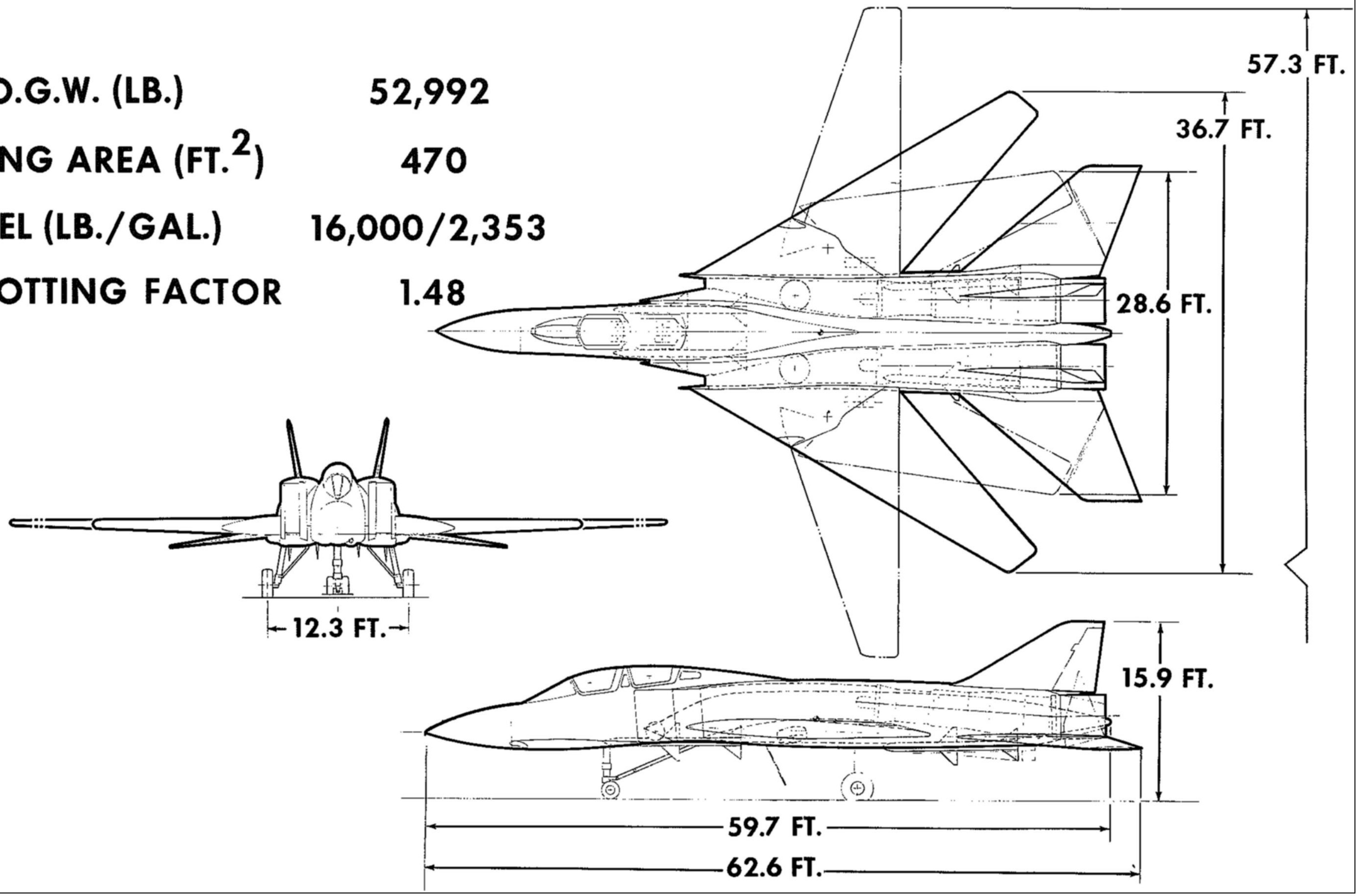
Initial fleet operational capability was to have been 1972. An advanced version, the Model 225B (with the same airframe but with advanced turbofan engines and new electronics) would be available to the fleet in 1975.

Data with 4 Sparrow missiles:
T.O.G.W.: 52,992 lbs
T.O. distance over 50 ft: 2350 ft
Landing gross weight: 44,952 lbs
Approach speed: 132 knots
Single engine rate of climb: 800 ft/min

Data with six Phoenix missiles:
T.O.G.W.: 62,946 lbs
Landing gross weight: 45,058 lbs
Approach speed: 132 knots
Max speed: Mach 2.5
Max power ceiling: 57,600 lbs
Combat air patrol (w/740 gal external fuel): 2.71 hrs
Deck launch intercept (w/740 gal): 242 n.m.
Ferry range (1800 gal external fuel): 2951/2667 n.m
(tanks dropped/retained)

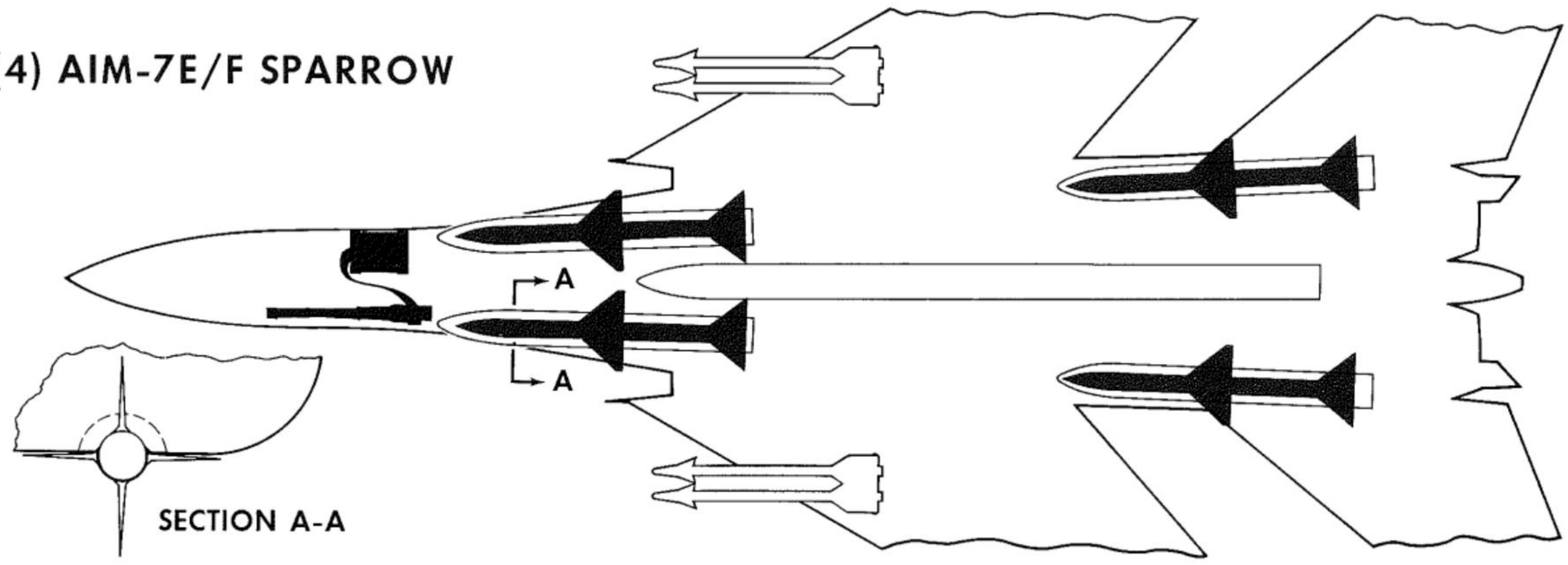
MODEL 225
GENERAL ARRANGEMENT

T.O.G.W. (LB.)	52,992
WING AREA (FT.^{2})	470
FUEL (LB./GAL.)	16,000/2,353
SPOTTING FACTOR	1.48

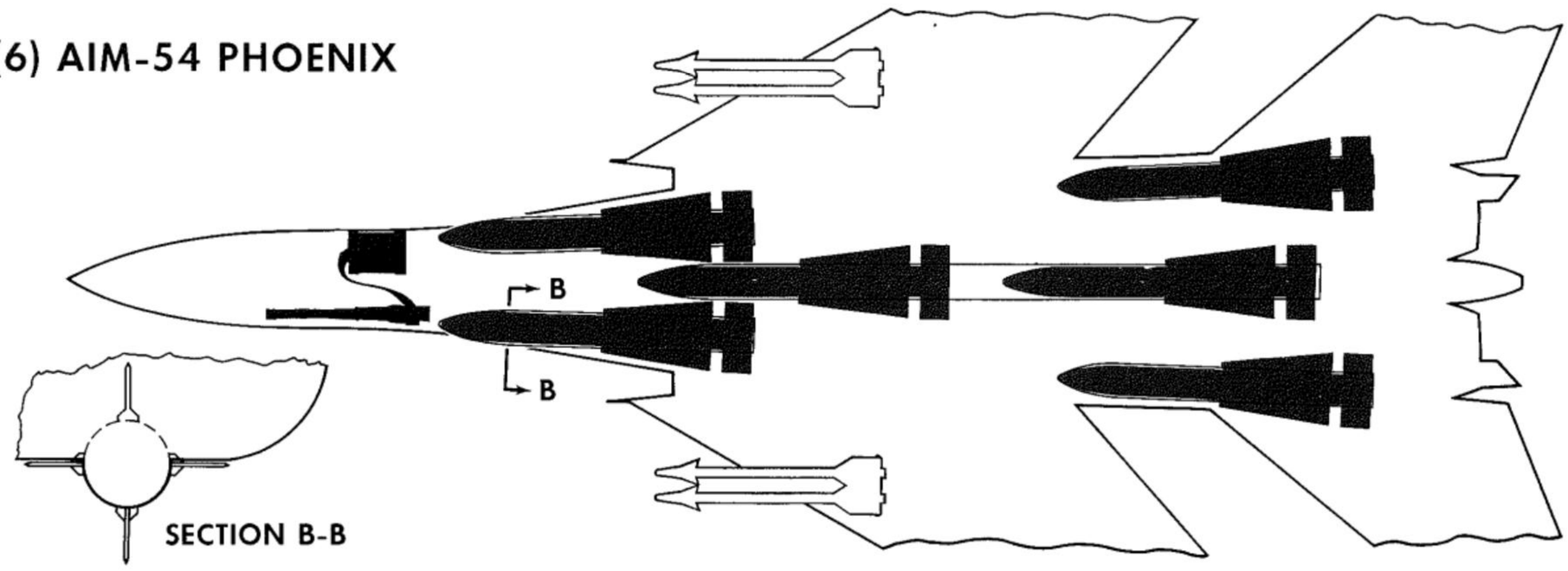


AIR-TO-AIR ORDNANCE CARRIAGE

(4) AIM-7E/F SPARROW

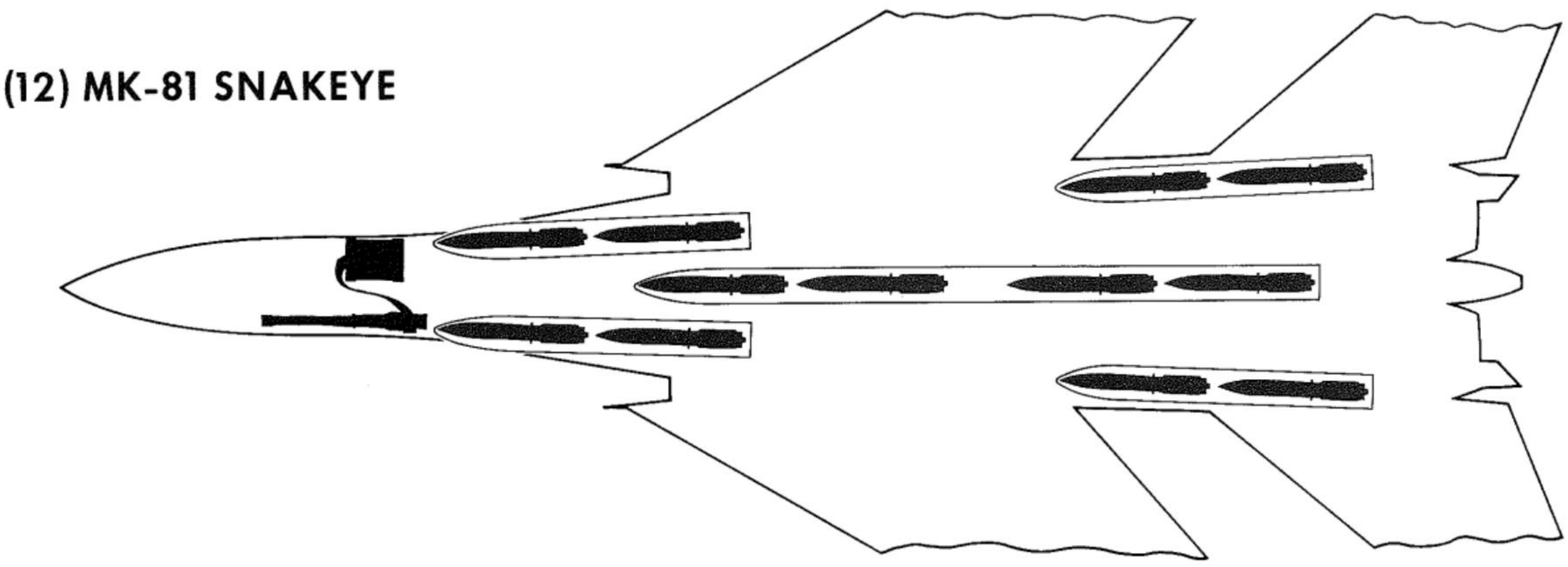


(6) AIM-54 PHOENIX

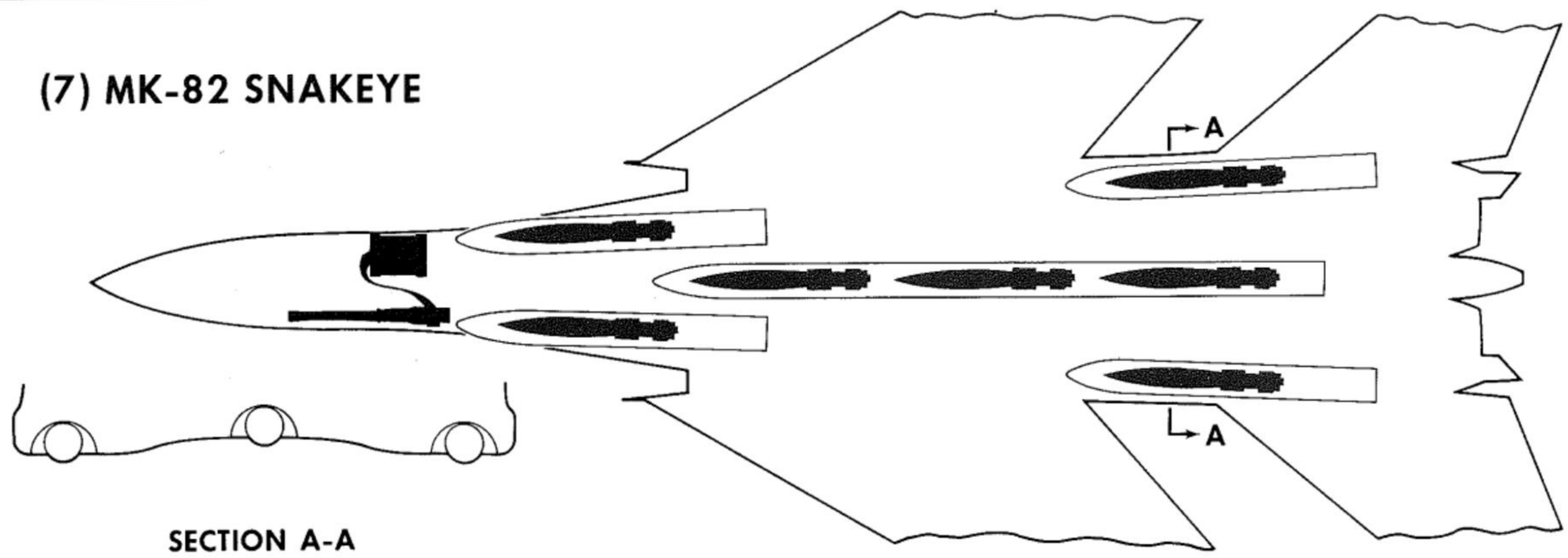


AIR-TO-GROUND ORDNANCE CARRIAGE

(12) MK-81 SNAKEYE



(7) MK-82 SNAKEYE



In June of 1968, the Navy officially released the VFX Request for proposals. In October of that year, McDonnell-Douglas responded with the Model 225A design, a refinement of their Model 225 from January. The Phantom heritage was even harder to see in the new design; the inlets were completely changed and the forward fuselage lost virtually all resemblance to that of the F-4 (although the canopy frame configuration remained similar). The vertical stabilizers still looked like miniature versions of the F-4's, but other than that, it bore no obvious Phantom heritage. On the whole, the Model 225A of October was a considerable refinement of the Model 225 from January, though retaining configuration and dimensions.

The Model 225A carried six Sparrow or Phoenix missiles, along with four Sidewinders. The long range missiles were carried semi-submerged under the fuselage. In order to reduce drag, the cavities containing the missiles were equipped with inflatable fairings which would seal the bays cleanly after missile jettison. The fairings were based on Goodyear "airmat" technology, the same developed for their Inflatoplanes. This system would seal the gaps between ordnance and bay regardless of what missile or bomb was carried, and after jettison, the result would be a fully sealed, flat surface as clean as is there was no bay at all. Pressure for the inflatable fairings would come from engine bleed. The Model 225A returned to the Phantoms gun armament… namely, no integral guns. Instead, a dedicated gun pod could be quickly attached below the fuselage centerline, containing a single M-61A1 Vulcan 20mm Gatling gun and 650 rounds of ammunition.

One unconventional new feature of the Model 225A was the High Speed Trimmer. This was a small canard located outboard of the inlets, and was variable geometry itself. But instead of changing sweep like the wing (or the Grumman F-14's functionally similar glove vane), the Trimmer folded down flush with the side of the inlet at low speed, and rotated up and high speed as the main wing swept aft and shifted the center of pressure aft. This relieved the horizontal stabilizers from much of the down force they would otherwise need to generate. The end result was lower overall drag and lower structural weight.

Forty percent of the aircraft structural weight was to be made up of titanium elements. Boron-fiber composites were to be used for the rudders and, later, the all-moving horizontal stabilizers.

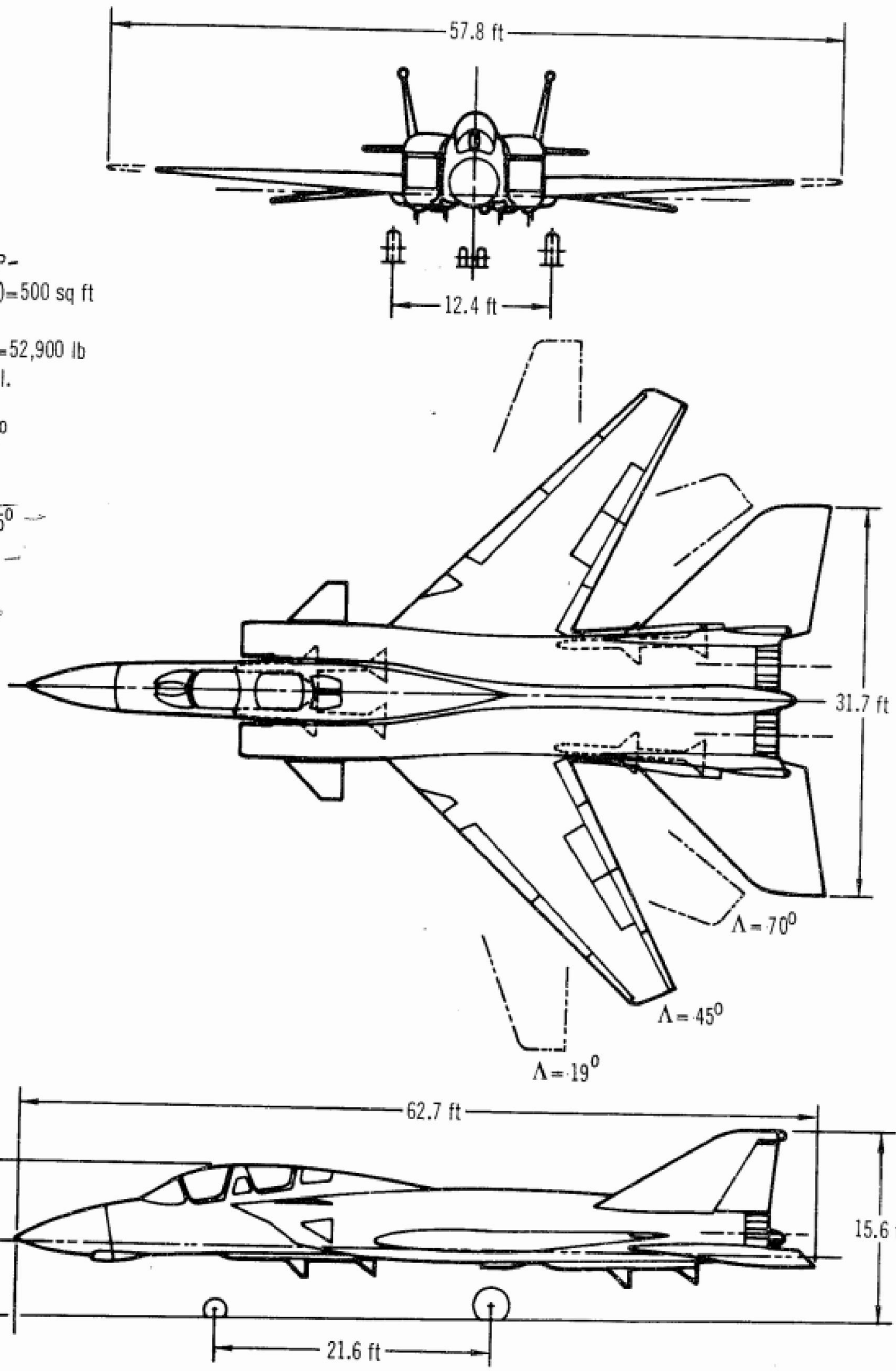
McDonnell-Douglas Model 225A display model. Photo from Tony Buttler via John Aldaz

McDonnell-Douglas artists impression of the Model 225A in flight. While the 225A was not built, echoes of its configuration can be detected within the McDonnell-Douglas F-15, designed only a few years later.

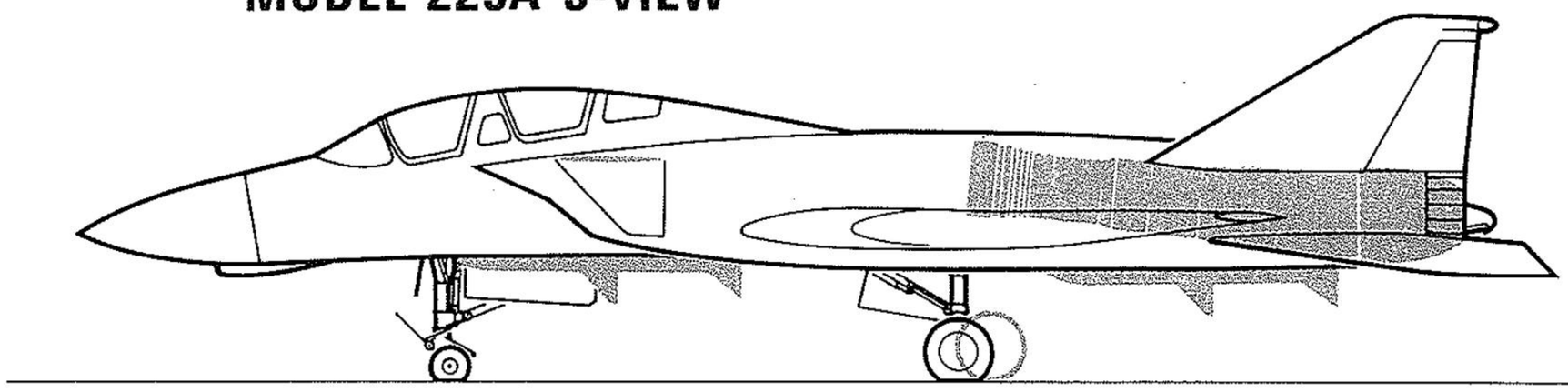
(C) FIGURE 2-1
MODEL 225A
GENERAL ARRANGEMENT

Engines: (2) TF30-P-
Wing area ($\Lambda_{LE}=19^0$)=500 sq ft
AR ($\Lambda_{LE}=19^0$) = 6.7
Takeoff gross weight=52,900 lb
Internal fuel=2247 gal.
Wing sweep positions
Flight=19^0, 45^0, 70^0
Stowed=80^0
Ground attitudes
Catapult: $\alpha_W = 7.25^0$
Taxi: $\alpha_W = 2.75^0$

4.5°



MODEL 225A 3-VIEW

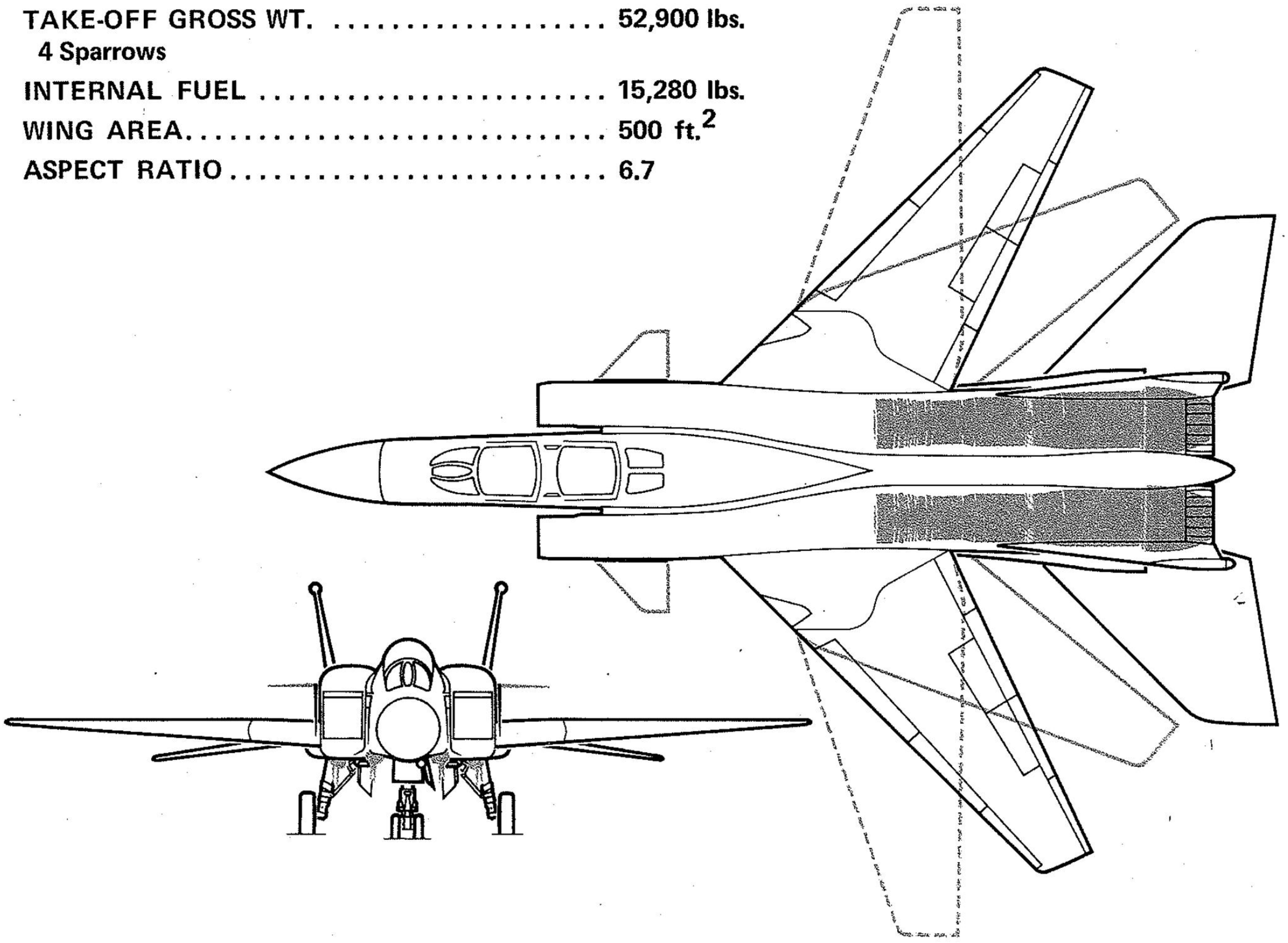


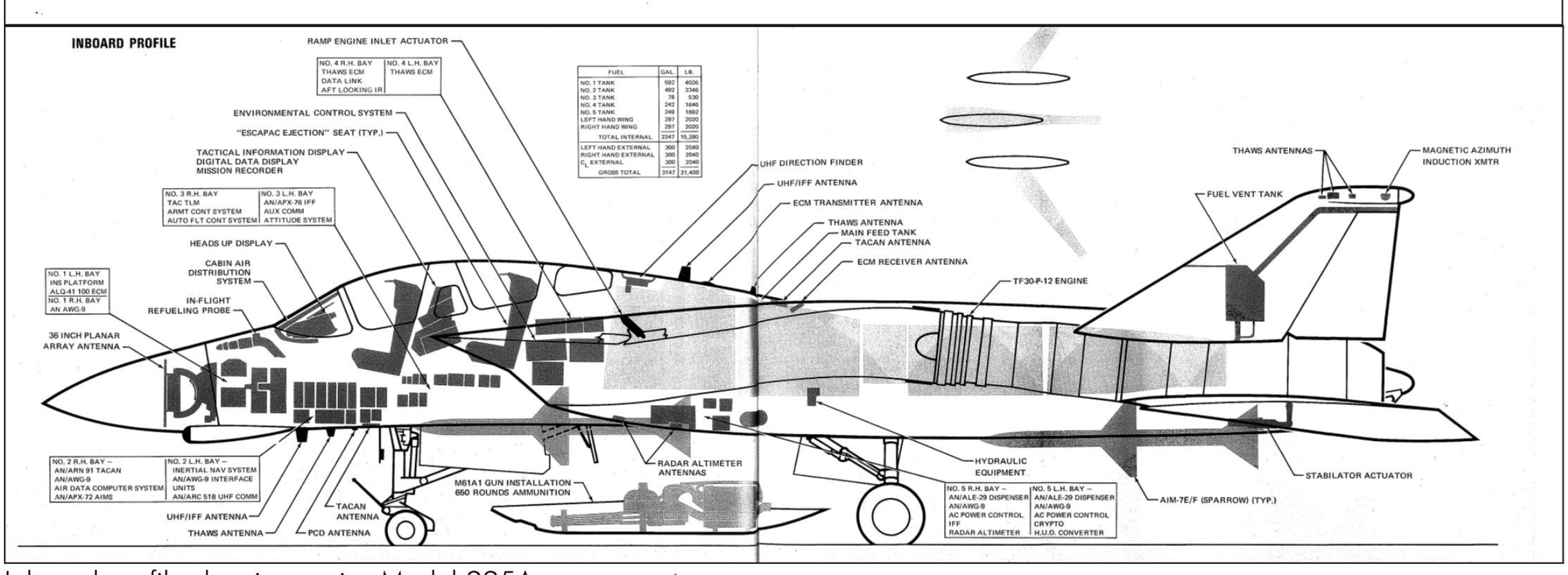
TAKE-OFF GROSS WT. ..... 52,900 lbs.
4 Sparrows

INTERNAL FUEL ..... 15,280 lbs.

WING AREA..... 500 ft.^{2}

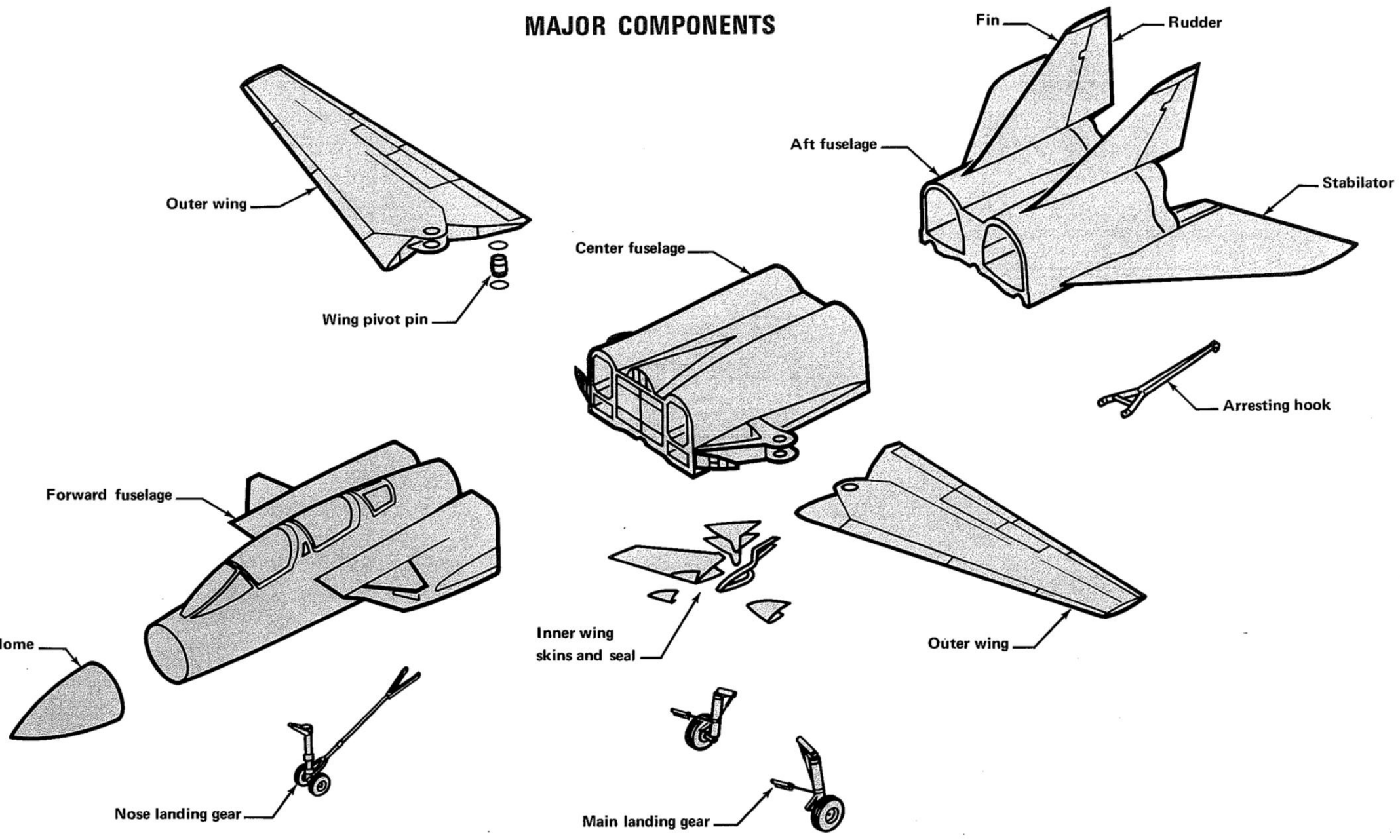
ASPECT RATIO 6.7

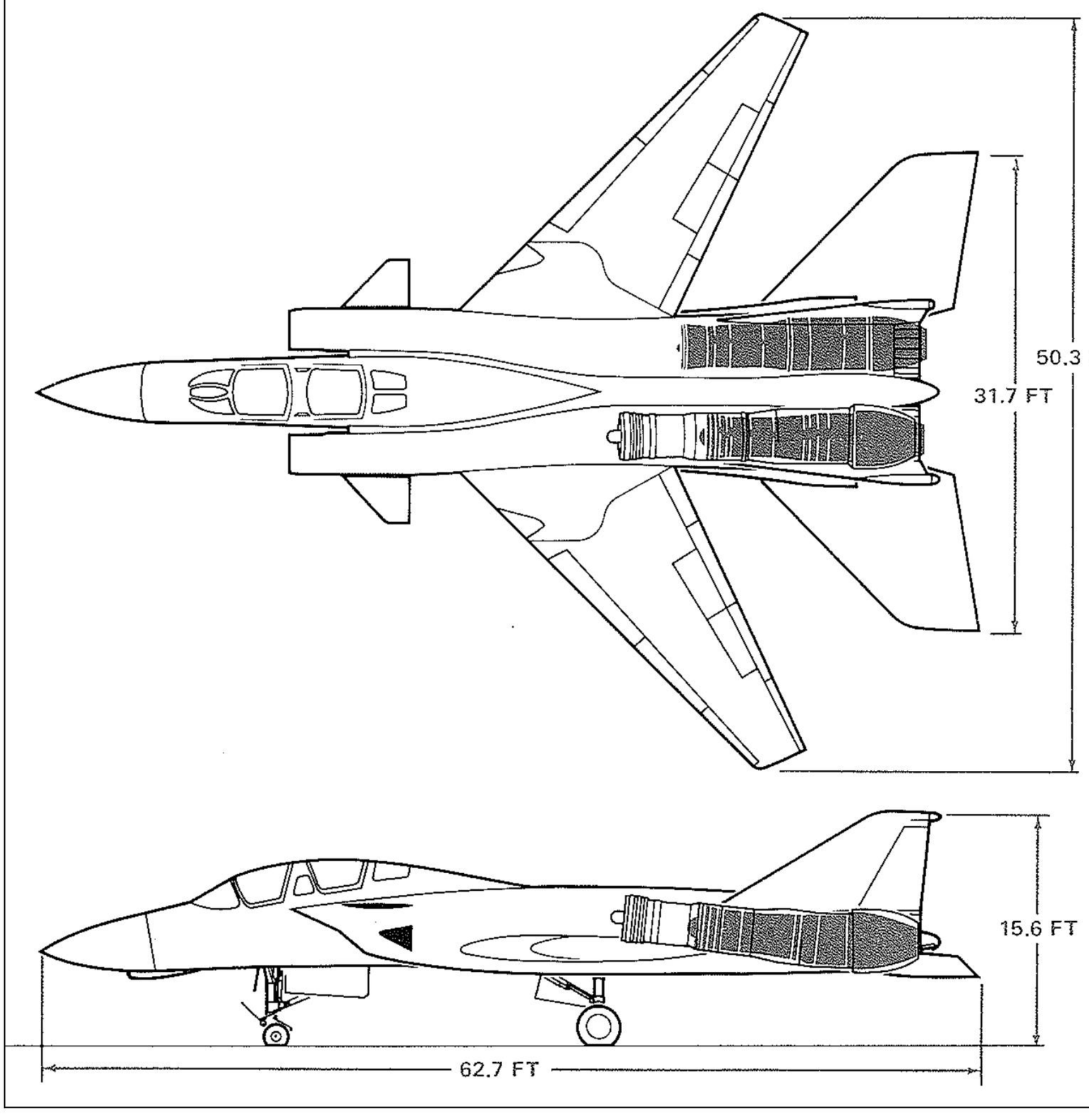




Inboard profile showing major Model 225A components

MAJOR COMPONENTS



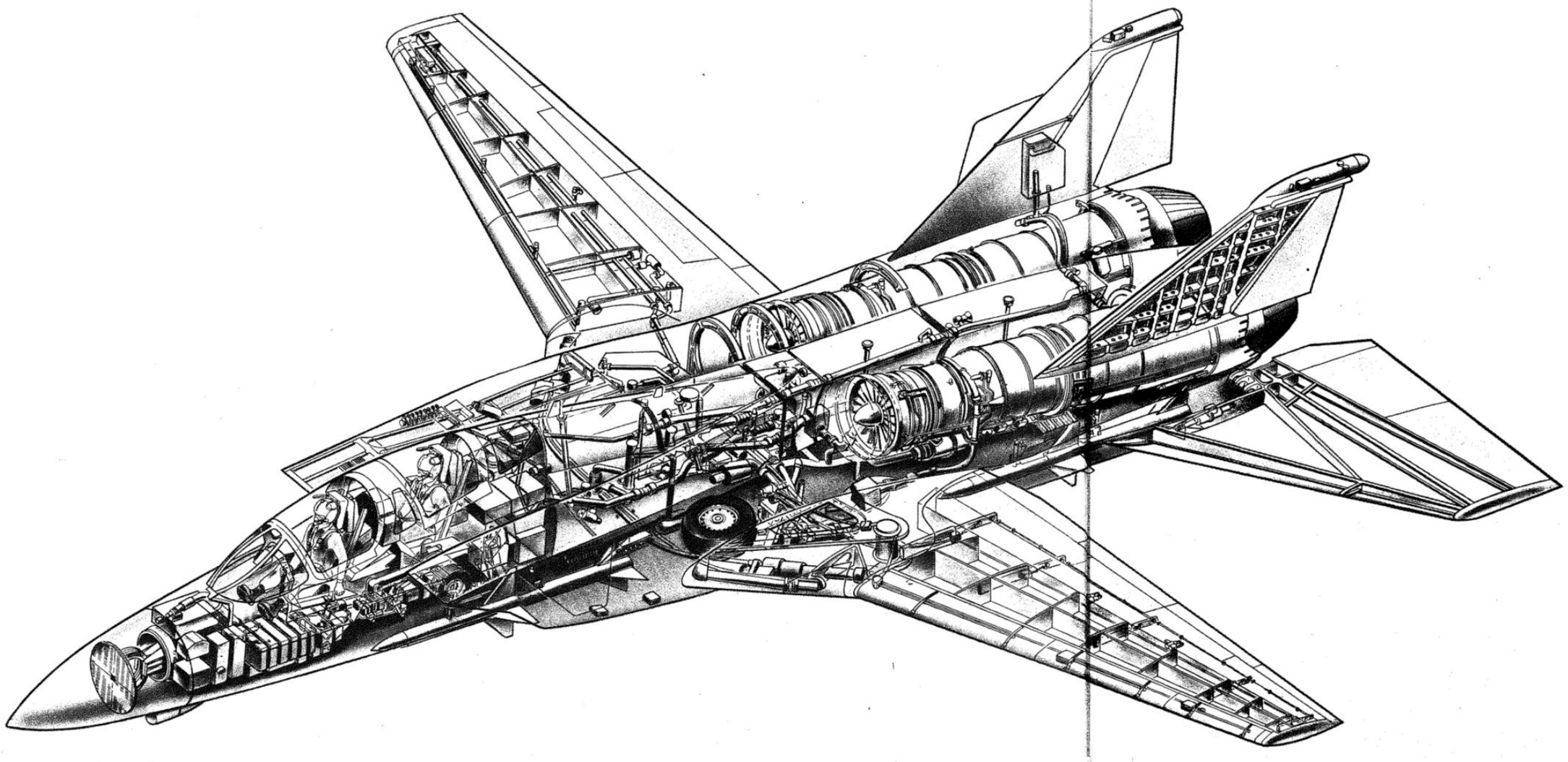


Above: major components of the Model 225A

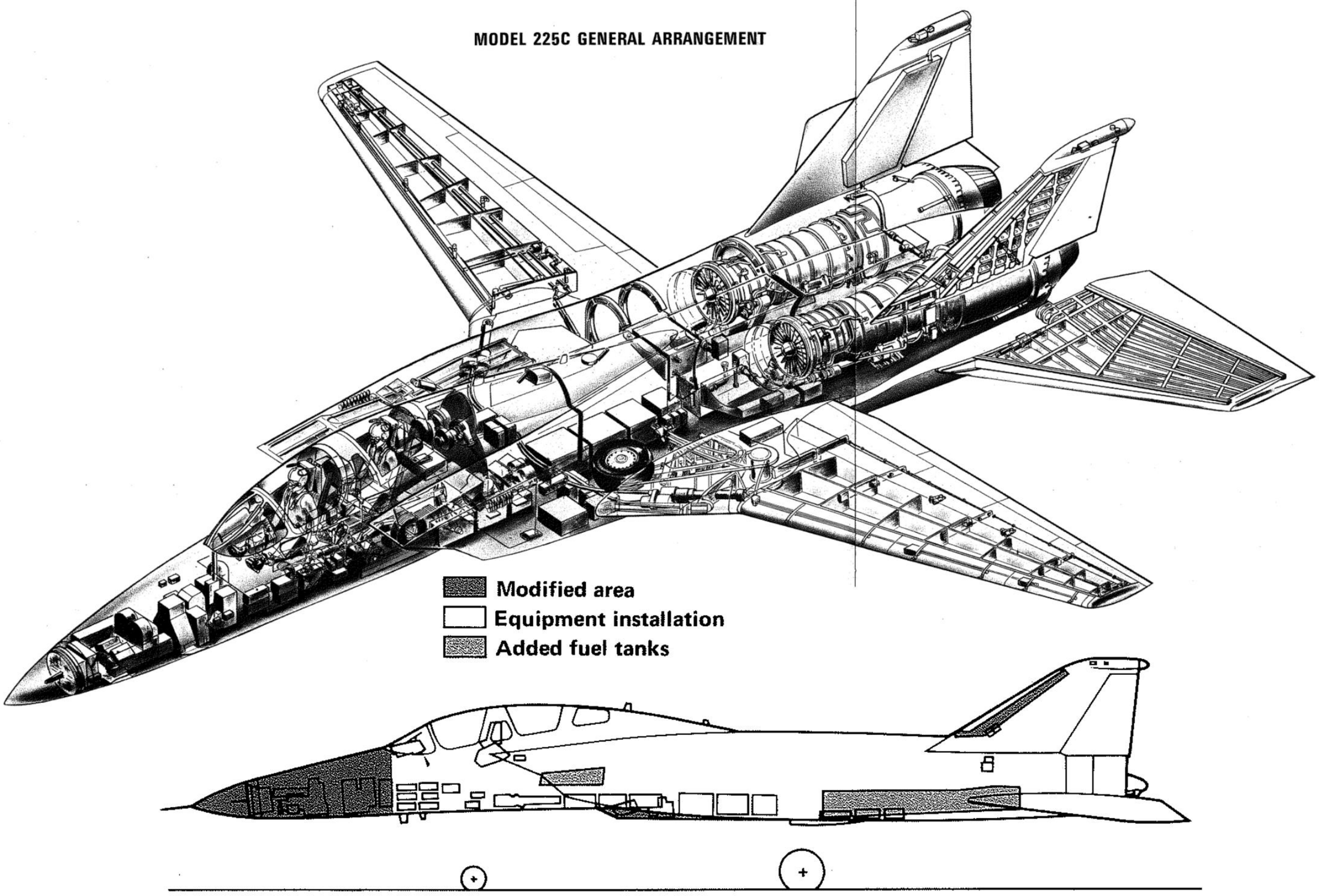
Left: the Model 225B differed from the Model 225A in having more advanced engines (shown shaded). Two engines were contemplated, the General Electric GE1/10F10B2 and the Pratt & Whitney JTF22A-22. These engines operated at higher pressures than the 225A's Pratt & Whitney TF30-P-12, resulting in improved performance, shorter lengths and lower weights. The engines could be installed within the 225A's structure with some additional inlet ducting, but otherwise no major structural changes were expected.

Max Thrust, SLS (lbs)
TF30: 20,500
P&W: 26,070
GE: 25,500

MODEL 225A GENERAL ARRANGEMENT



MODEL 225C GENERAL ARRANGEMENT



The Model 225C was a dedicated reconnaissance version of the Model 225B. Using the same advanced engines, it eliminated armament provisions and replaced them with sensors. This included removing the radar nose of the 225B and replacing it with a longer nose housing a smaller forward looking radar unit and provisions for numerous downward-looking sensors such as IR cameras, mapping cameras, multispectral scanners and covert flashers. Real-time data could be transmitted.

In the VFX competition, the McDonnell-Douglas Model 225A lost out to the Grumman Design 303E. The 303E became the F-14, while the Model 225A was the last hint of a variable geometry Phantom.

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