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AFFDL TR 73-93 (VOL I)

INVESTIGATION OF A MICRO-FIGHTER / AIRBORNE AIRCRAFT CARRIER CONCEPT (U)

SUMMARY

B.D. NELSON, ET. AL.

TACTICAL COMBAT AIRCRAFT PROGRAMS
THE BOEING AEROSPACE COMPANY

SEPT. 1973

Classified by Chief, Flight Mechanics Division/FX
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Executive Order 11652. Automatically downgraded at
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FOREWORD

(U) This report was prepared by the Tactical Combat Aircraft Project of the Boeing Aerospace Company, Seattle, Washington under contract F33615-73-C-3012, Project 1431, "Aerodynamic Synthesis and Flight Research" Task 143101. Inclusive dates of research were 15 November 1972 through 17 September 1973. The program was sponsored by the Air Force Flight Dynamics Laboratory. The Air Force Project Engineer for this investigation was Mr. W. Dudley Fields, AFFDL/FXS. The authors express their appreciation to Mr. Alfred C. Draper, AFFDL/FX, for his guidance throughout this effort.

(U) Significant contributions were made to the study by the following personnel:

- B. D. Nelson - Program Manager
- W. M. Brennan - Flight Systems Design
- G. R. Root - Configuration Design
- E. T. O'Neill - Configuration Design
- P. T. Palmer - Aerodynamics
- W. B. Sutherland - Aerodynamics
- W. L. Mannick - Weights Analysis
- A. L. Brown - Structures Analysis
- M. McKinney - Structures Design
- G. L. Letsinger - Configuration Analysis
- J. C. Goodboy - Operations Analysis
- A. D. Connot - Operations Analysis
- J. B. Miller - Model Design
- R. A. Day - Model Design

(U) Classified information has been extracted from (asterisked) documents listed under references.

(U) This Technical Report has been reviewed and is approved.

for PHILIP P. ANTONA
Chief, Flight Mechanics Division
AF Flight Dynamics Laboratory

UNCLASSIFIED ABSTRACT

(U) The report presents the results of an exploratory investigation to determine the size, performance and feasibility of a Micro-fighter design such that a number of vehicles could be transported or air launched and recovered by a C-5 class carrier aircraft. Emphasis was placed on; identification of potential applications for a Micro-fighter airborne aircraft carrier system, determination of technology requirements for airborne launch and recovery, and the technology requirements for the Micro-fighter airborne aircraft carrier system, determination of technology requirements for airborne launch and recovery, and the technology requirements for the Micro-fighter. The scope of investigation included evaluation of five fighter concepts and two carrier aircraft. Trade studies were performed to assess launch and recovery schemes and technology applications. Evaluation led to the definition of 1980 IOC and 1985 IOC concepts for Micro-fighter Airborne Aircraft Carrier Systems.

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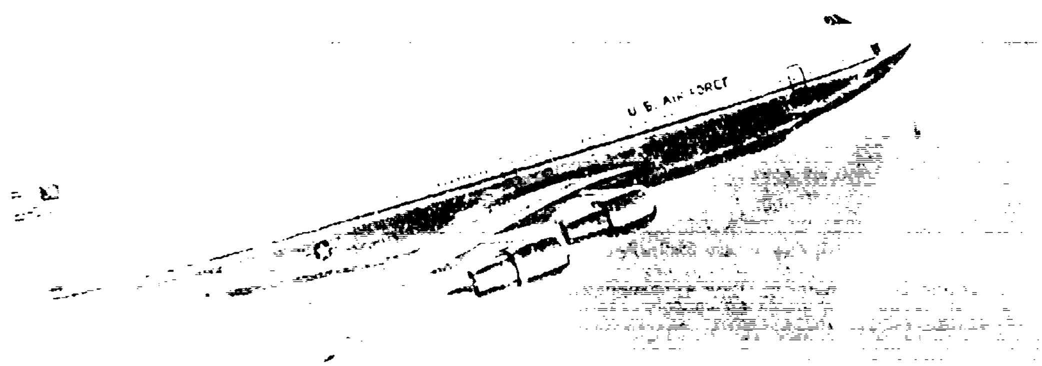

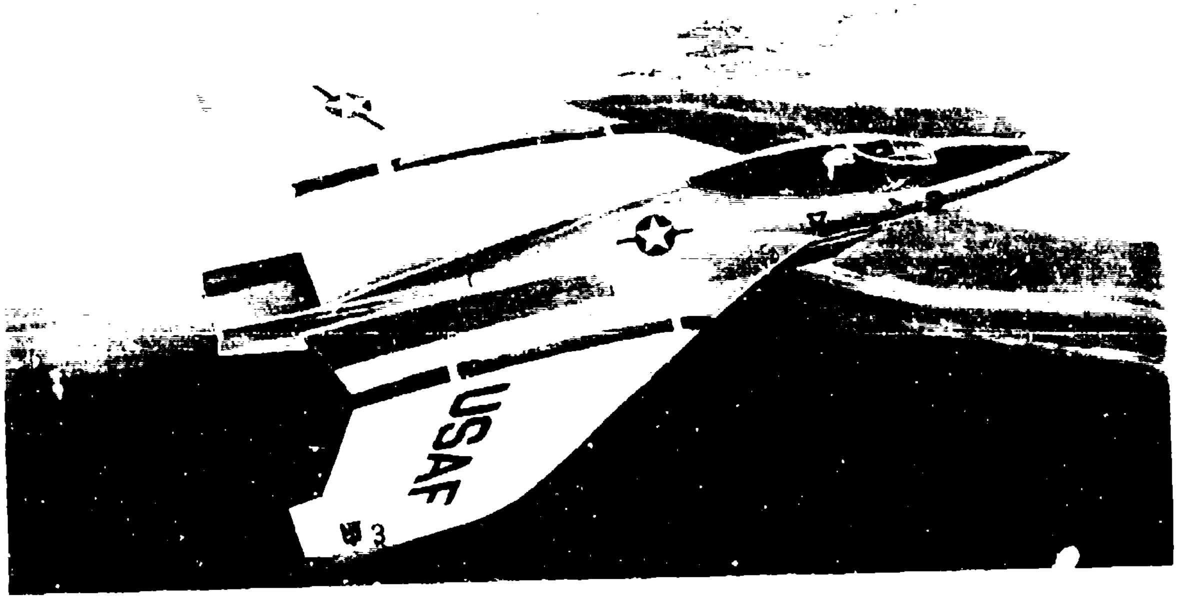

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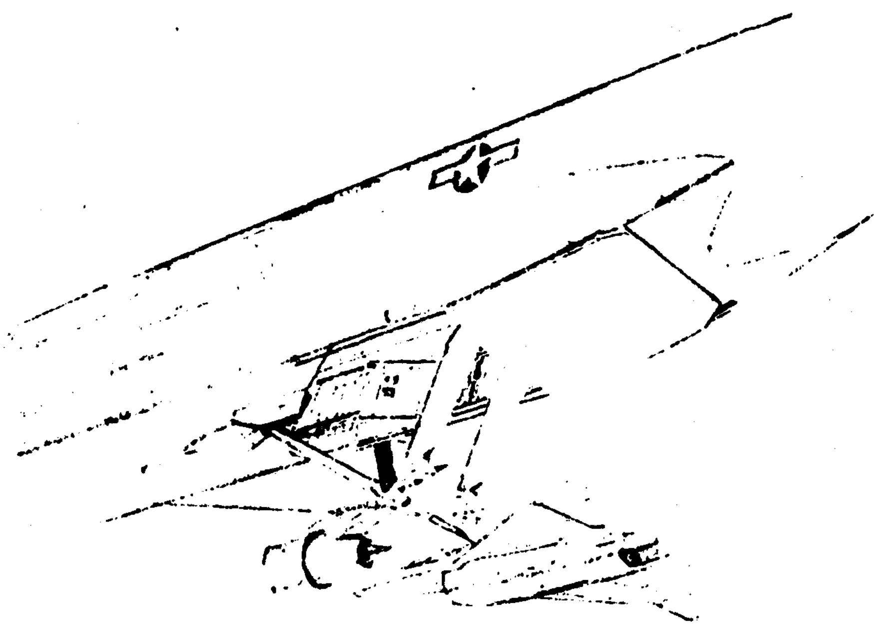
1.0 INTRODUCTION



(U) This volume summarizes study results. Volume II contains the technical report.

(C) This concept feasibility study has provided the initial step toward development of an advanced concept of operation - the Micro-fighter/Airborne Aircraft Carrier. The operational employment of strike fighters operating from airborne aircraft carriers is indicated by this study to be technically feasible. Furthermore, the system concept offers the potential of great national benefit in a political world that leans toward a low profile American exposure overseas while being responsive to diverse needs of our allies.

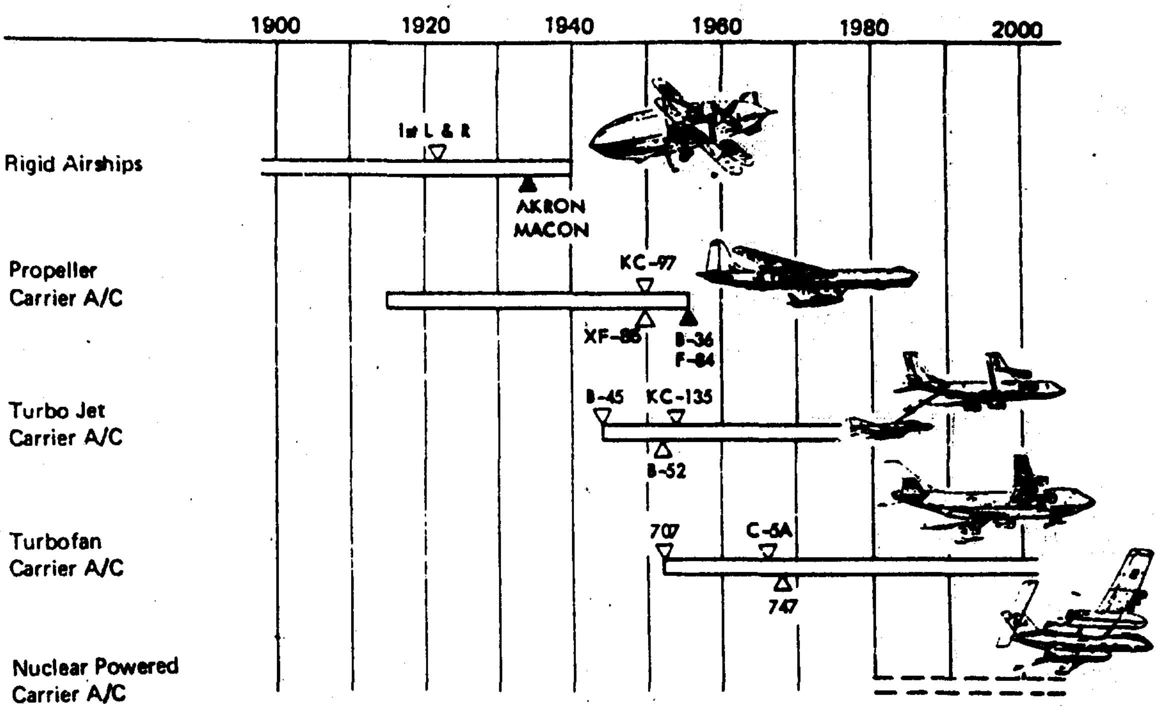


Figure 1: Background (U)

1.1 BACKGROUND

(U) Past efforts to make operational use of airborne launch and recovery systems are shown in Figure 1. The U.S. Navy made operational use of fighter squadrons aboard the airships Akron and Macon (1935-1937). Vulnerability to weather limited the operational concept. Subsequent attempts by the U.S. Air Force were the XF-85 and RF-84F to be carried by the B-36. Launch and recovery proved to be major problems in these two programs while fighter and carrier capability limited operational usefulness. In-flight refueling of fighters and bombers became a competitive solution for extended range and ultimately B-36 obsolescence terminated all effort.

(U) It is with this background that the present study has focused on the feasibility of small fighters sized to be carried internally and configured to be air launched and recovered.

(U) The modern concept for airborne launch and recovery (Figure 2) combines new transport technology and emerging fighter technology to produce a system concept that goes beyond in-flight refueling to add in-flight rearming and multi-sortie capability for each fighter. Understanding these capabilities

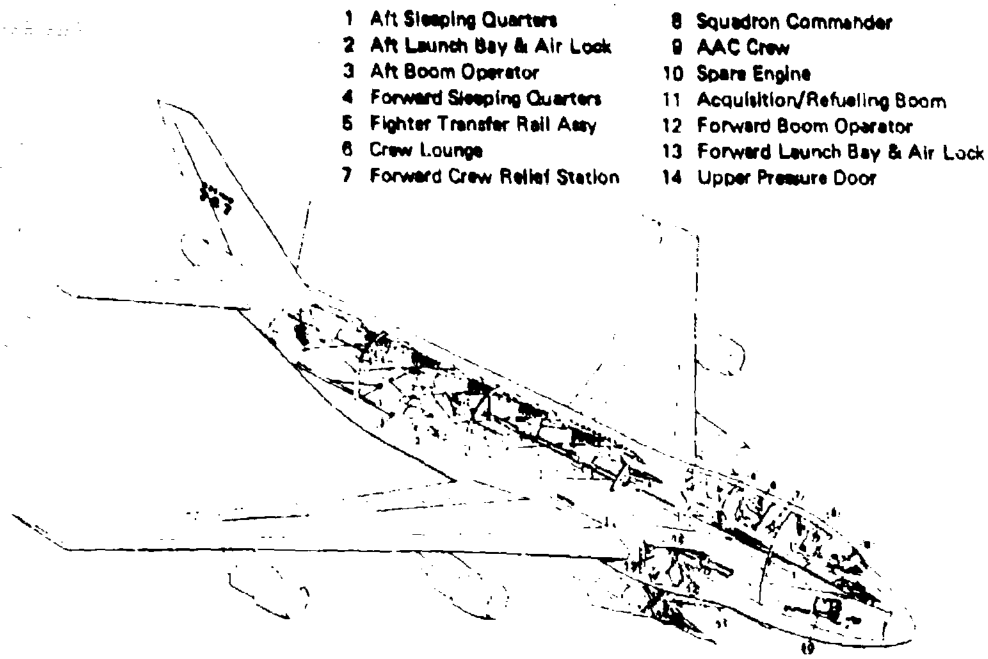


Figure 2: Modern Concept - Airborne Aircraft Carrier (U)

(U) early in the life of the 747 and C-5A can preclude the problem of carrier obsolescence - instead growth versions can be predicted that provide useful life beyond the year 2000.

(C) This investigation has studied the feasibility and usefulness of an airborne airbase and has found it to be technically feasible and potentially valuable to the nation as a rapid deployment multi-purpose strike system. It has the potential for intercontinental response, with large combat forces, before an aggressor can fully mobilize for invasion of neighboring countries.

1.2 OBJECTIVES

(U) The study had three primary objectives:

(1) Investigate feasibility and potential operational applications of the carrier/Micro-fighter concept.

(2) Develop a Micro-fighter point design such that a number of airplanes can be transported intact with a 747/C-5 class carrier aircraft and have a capability of being air launched and recovered from the carrier.

(3) Design and construct a wind tunnel model of the selected Micro-fighter design suitable for wind tunnel testing.

2.0 OPERATIONAL ANALYSIS

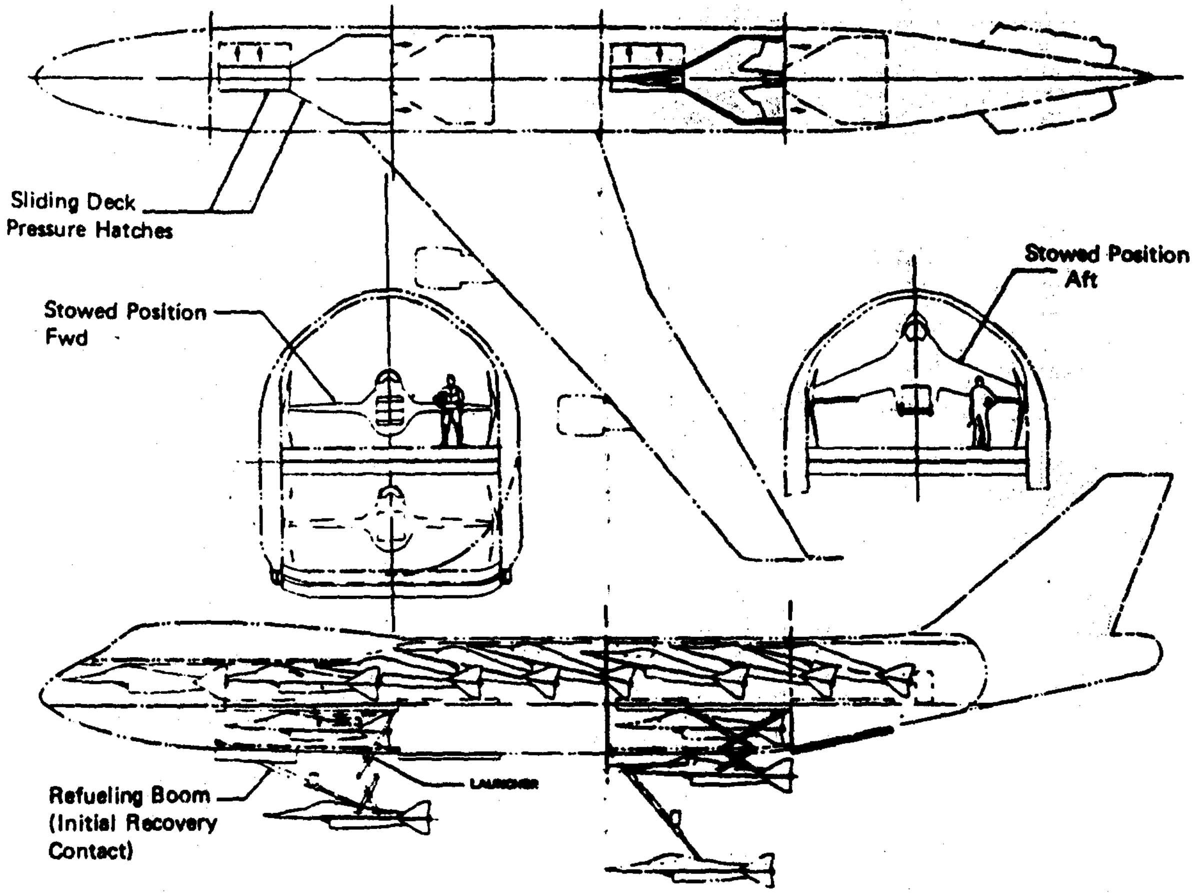


Figure 3: Baseline - Microfighter/Airborne Aircraft Carrier (U)

(U) For carrier loading, on-board handling and operational analysis the baseline system (Figure 3) represents 1975 technology. The 747 AAC has a maximum weight of 883,000 pounds employing growth available in the current structure. Fighters, fuel and air-to-ground weapons for three sorties each, represent a carrier expendable load of approximately 200,000 pounds.

(U) Fighter designs employ 1975 technology. The subsystems are primarily off the shelf. Geometry is constrained by carrier limits to a wing span of 17.5 feet. A Basic Launch Weight (internal fuel and internal armament) of 10,000 pounds was determined from earlier design studies. An overload capability of 40% was determined practical for air-to-ground applications.

(U) Operational deployment was investigated for scenarios in the European Theater, the Middle East, Indian Ocean and CONUS Air Defense.

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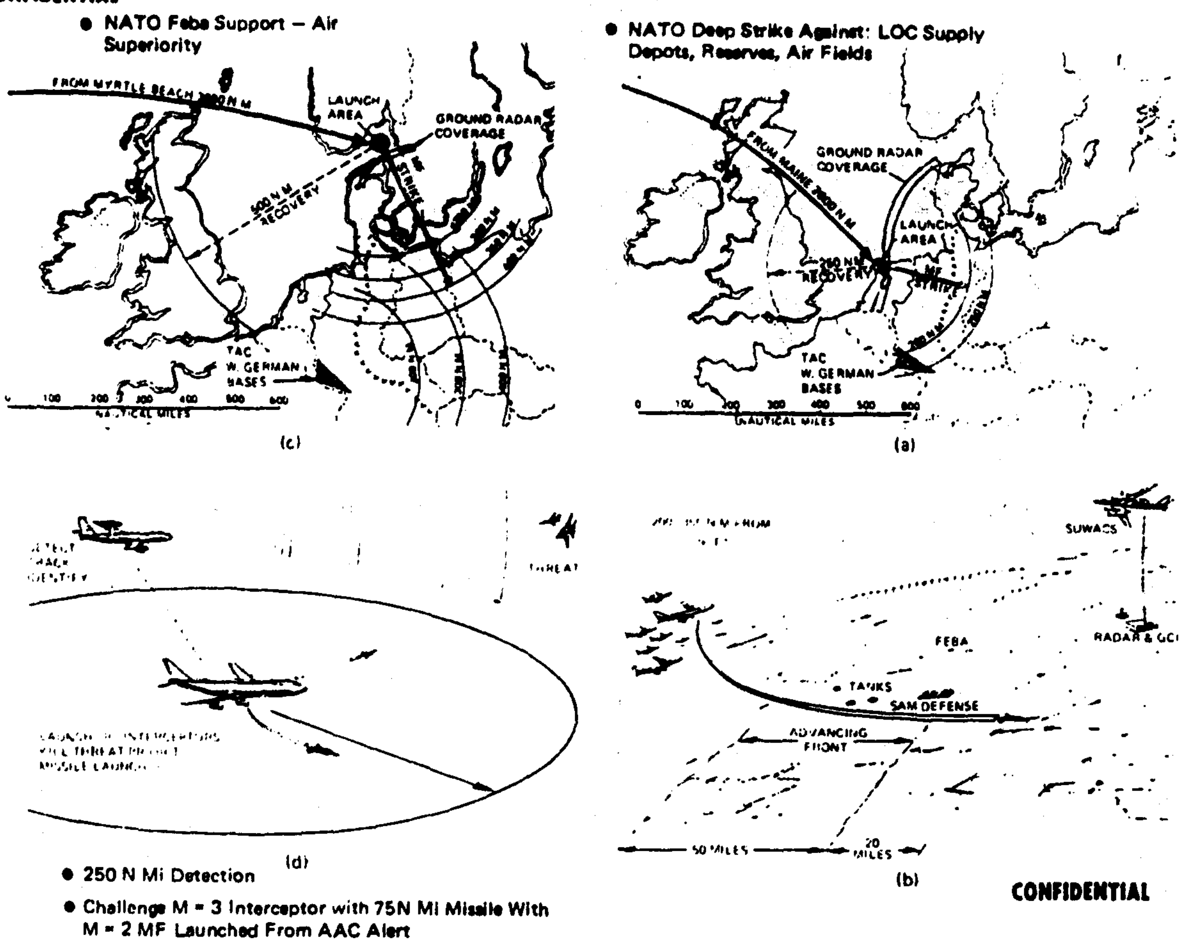

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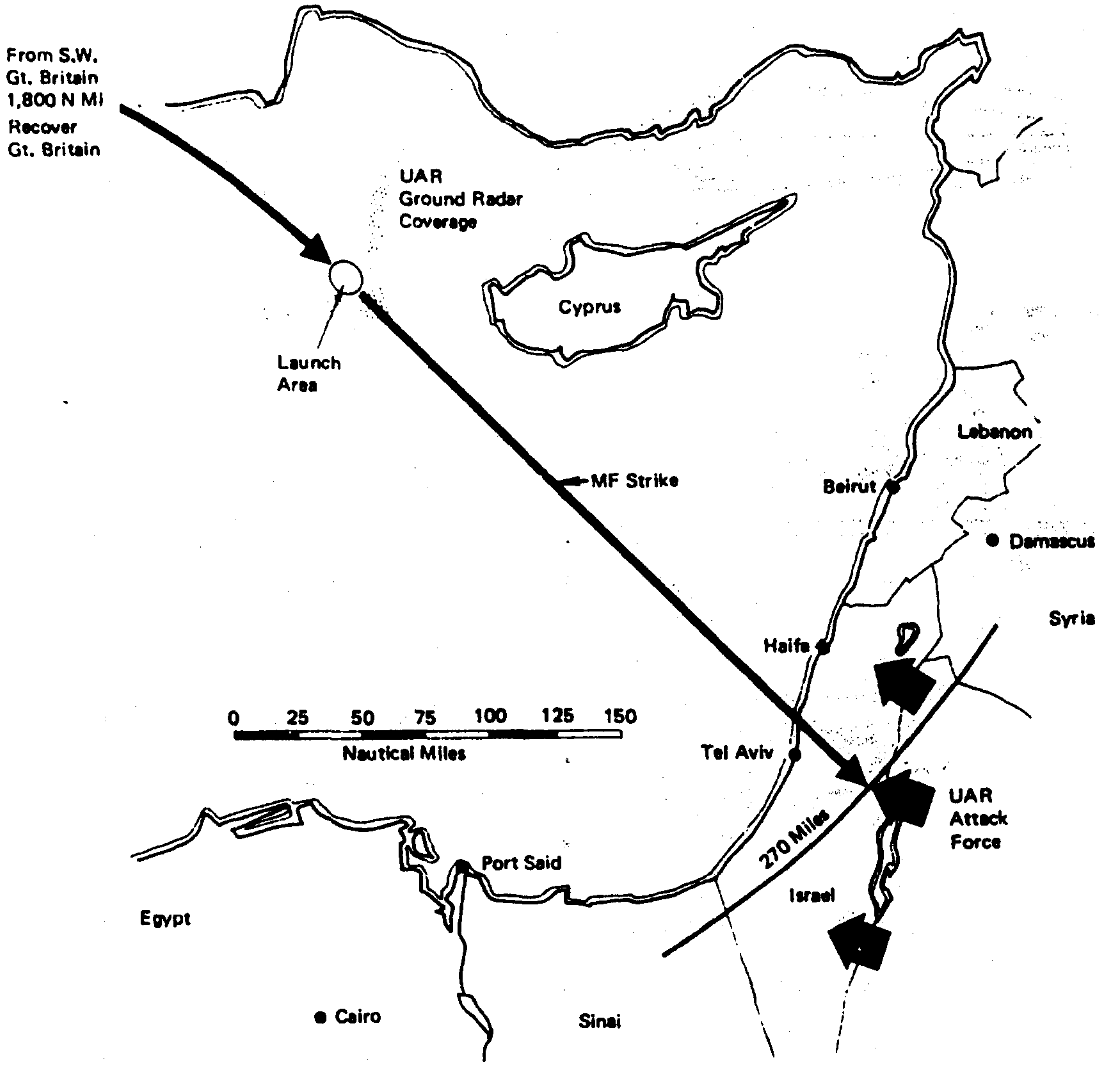
(C) Figure 4: European Scenario (U)

(C) The high level conflicts possible in Europe (Figure 4) indicate a high potential for a rapid deployment system. The MF/AAC force can be deployed in 1/10 the time with 1/3 the manpower required for a current CASF squadron.

(C) Launch stations located outside the ground radar coverage require fighter interdiction radii of 100 to 300 n.mi. High intensity combat against many types of Soviet aircraft would require air superiority roles for the fighter both as CAP for interdiction missions and fleet air defense.

(C) Command and control by AWACS would allow mobility for the total strike force while providing radar defense and MF interceptor control.

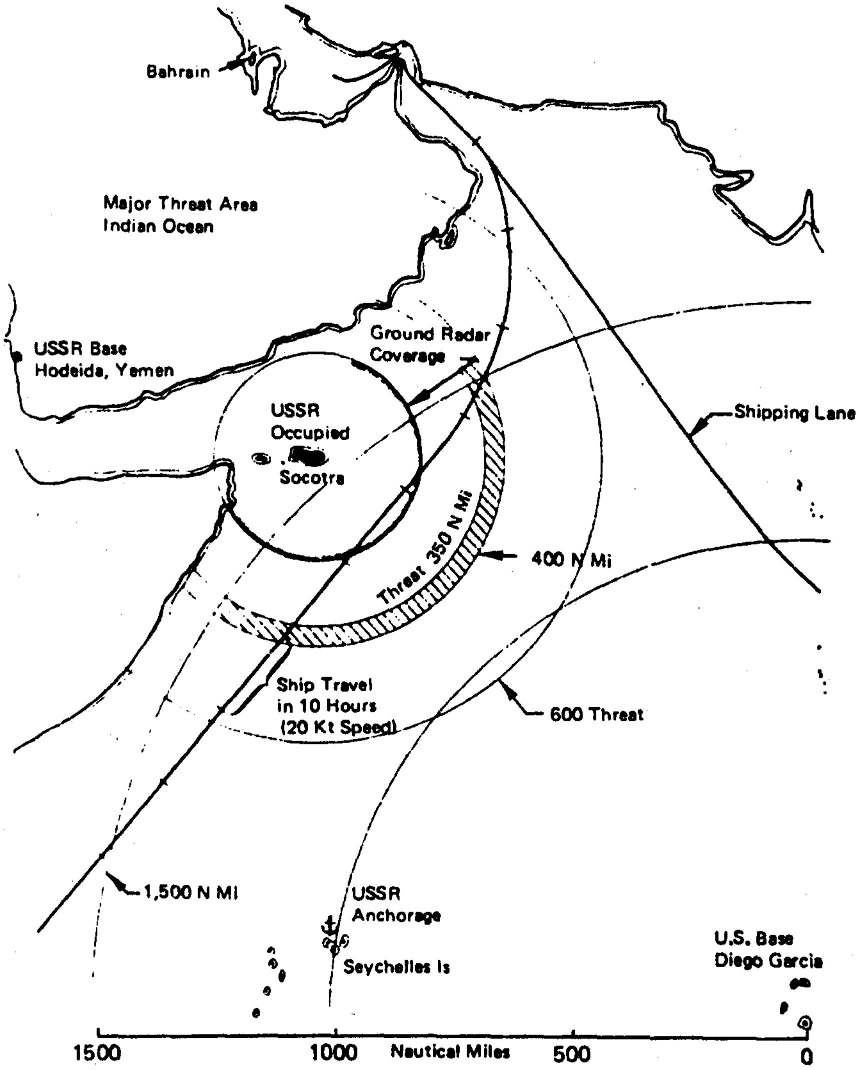
(C) Middle East deployment (Figure 5) represents a typical fast reaction for show of force or real support through battlefield interdiction.



(C) Figure 5: Middle East Deployment (U)

The presence of a MF/AAC strike force in the Middle East would best be accomplished by basing in Great Britain. In a strike role the fighters would encounter enemy aircraft with capability at least equal to MIG-21PF. Self defense capability should include maneuver performance equal to MIG-21 without salvo of external stores. This requirement was found to be very sensitive to MF wing loading and thrust to weight ratio.

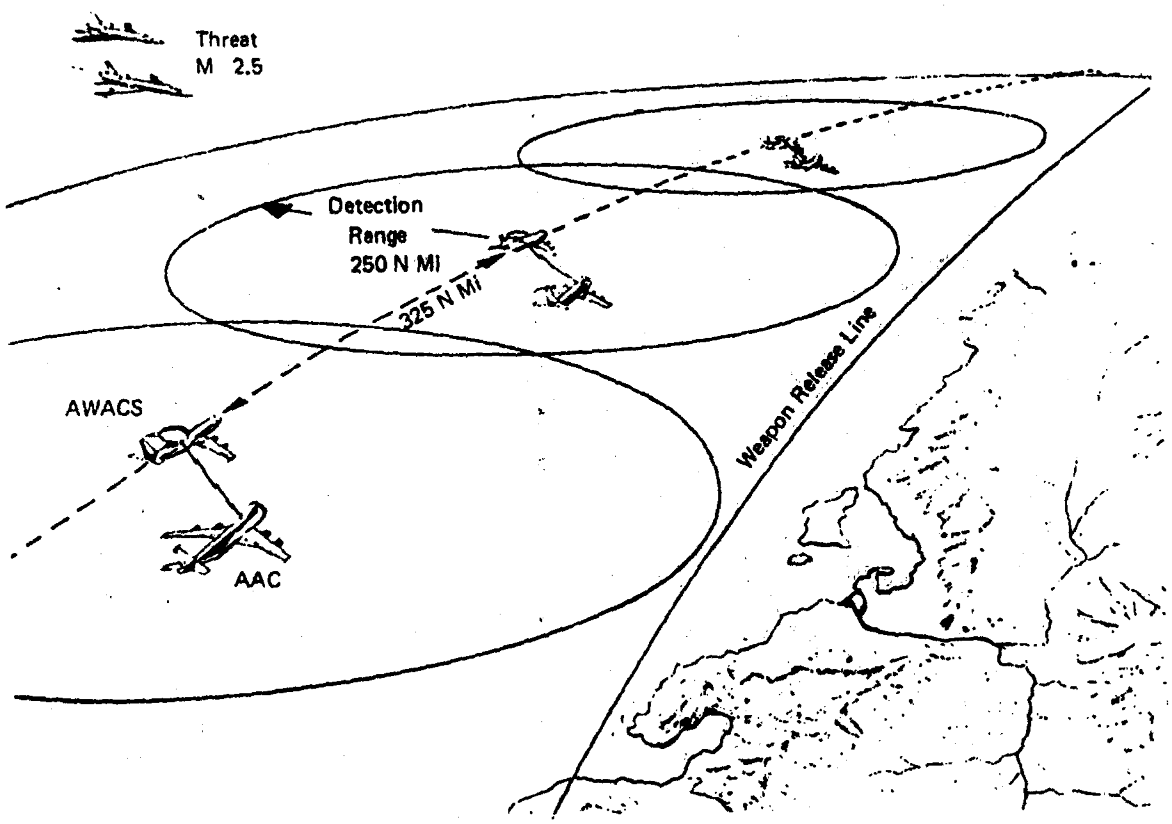
(C) The Indian Ocean island of Diego Garcia provides an alternate base for Middle East deployment (Figure 6) and for protection of vital shipping lanes. Soviet presence at Socotra Base could be challenged by MF/AAC while providing sea surveillance of the Indian Ocean and Persian Gulf areas.



(C) Figure 6: Indian Ocean Scenario (U)

(C) Endurance of the carrier plus speed and endurance of MF patrols are prime requirements for operating in the Indian Ocean.

(C) The Conus Air Defense deployment (Figure 7) employs Barrier patrol operations in time of world tension. Deployment and patrol of AWACS and AAC is from Z.I staging bases. In one concept AAC's shuttle to AWACS line, launch fighters on alert patrol, refuel AWACS, continue fighter operations for 8 hours until replacement AAC shows on line. The long range afforded by the AAC allows the MF to go all out when required to intercept.



(C) Figure 7: Conus Air Defense (U)

(C) The summary of requirements on Figure 8 illustrates the need for a versatile system with global range and supersonic performance. Rapid deployment of the system in a combat status positions the fighters where their performance capability can be used effectively to surprise or deter hostile action while providing ample protection for carriers and AWACS. These requirements were used as goals for further trade studies of carriers and fighters.

REQUIREMENTS	OPERATIONAL SCENERIOS			
	Western Europe	Indian Ocean	Middle East	CONUS
. Carrier Stand-off Range (N.Mi.)	200-300	300-400	200-300	N.A.
. Fighter Combat Radius (N.Mi.)	150-350	200	270	
. Fighter Intercept Capability	75 n.m@M=2	M2.0/1 Min.	75n.m.@M=2	M2.0/10 Min.
. Fighter Maneuver @ 20,000 Ft.-W/Overload	≥5g@M=.9		≥5g@M=.9	
Clean	>7g@M=.9		≥7g@M=.9	
30,000 Ft.-AI Load		≥2.5@M=.8		
. Carrier Self Defense Requirements	M=2.0 M.F.	→	→	→
. Carrier Deployment Range	2600-3000	1900-4700	1800-	1000-1500
. Carrier T.O.S. Capability	8 hrs.max.	8 hrs-2 days	3-4 hrs.	8 hrs.
. Fighter Weapon/Equip. Complements	Mixed	AIM & AI Radar	Mixed	AIM & AI Radar
. Fighter Launch Cycle Time	1 min/2 MF	→	→	→
. Fighter Weather Capability	All Weather	→	→	→
POTENTIAL APPLICATIONS				
MF/AAC WEAPON SYSTEM				
. Fast Deployment Strike Force	●	●	●	
. Convoy Escort		●		
. Air Defense	●	●	●	●
. Bare Base Deployment	●			
. CASF Deployment	●	●	●	
MICRO-FIGHTER ROLES				
. Initial Air Superiority	●		●	
. Carrier Defense (Intercept)	●	●	●	●
. Combat Air Patrol	●	●	●	
. Intercept	●	●		●
. Reconn	●	●	●	●

(C) Figure 8: Requirements Summary (U)

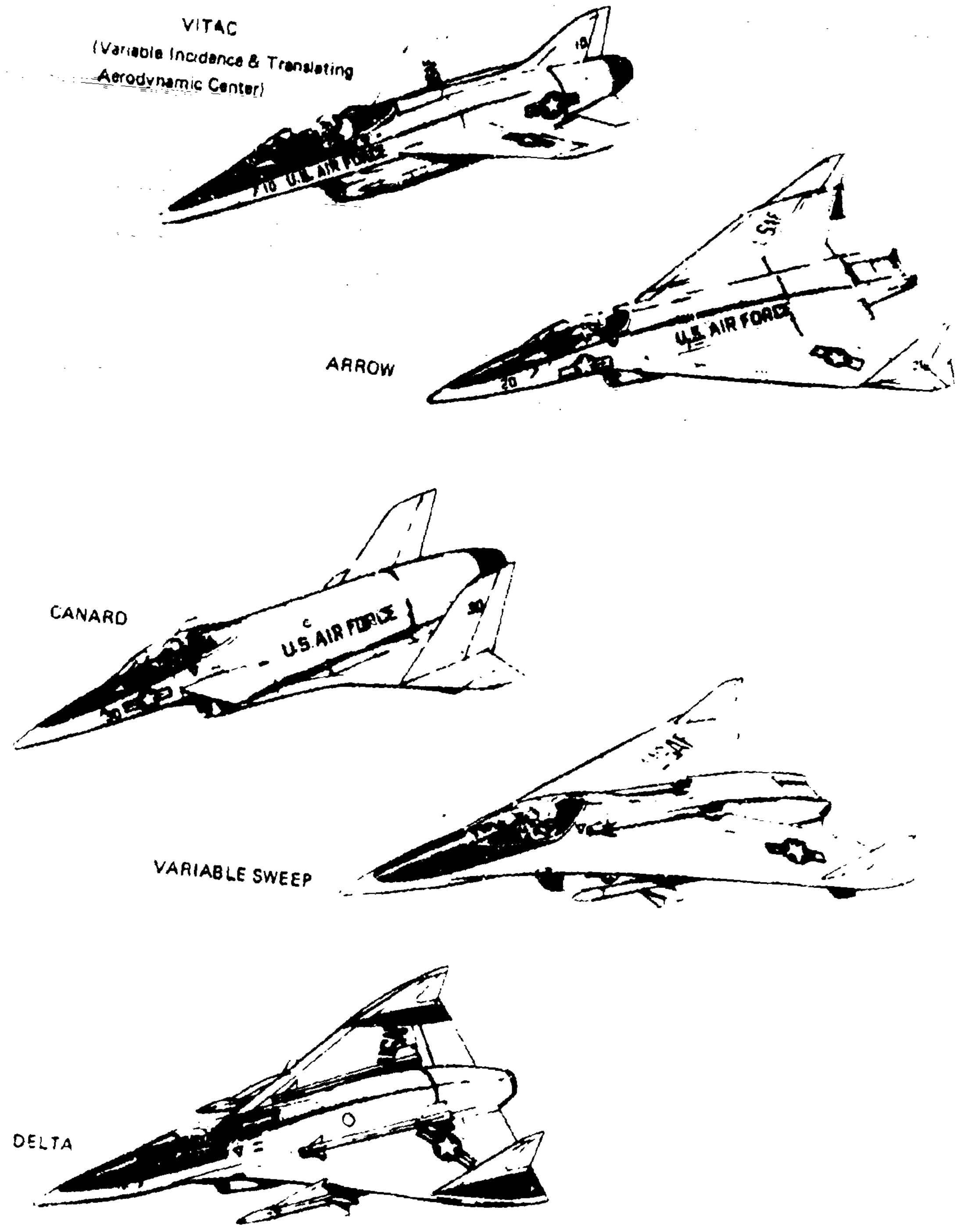


Figure 9: Fighter Baseline – 1975 Technology (U)

3.0 FIGHTER DESIGN SELECTION

(U) Five fighter designs were created for this study and are illustrated in Figure 9. These designs were compared with each other and to operational analysis requirements which were generated in parallel with fighter configuration development. Concurrent Wind Tunnel tests were conducted by AFFDL/FXS on the MF-5 configuration shown in Figure 10. This data assisted the selection of the point design configuration.

(U) This section describes characteristics of the five fighters and the comparisons, leading to selection of two designs and the trade studies leading to selection of characteristics for the 1980 Point Design.

(U) This study was directed toward searching for potential applications for a Micro-fighter. Because no specific mission rules existed at the outset the fighters were sized to the carrier aircraft dimensional limitations. Initially the C-5 aft cargo door opening was believed to be critical for span and fin height. Subsequent study revealed that: 1) C-5A aft cargo doors cannot be fully opened in flight, and 2) cargo loading diagrams for C-5A and 747 revealed critical balance conditions with light cargo loads concentrated in the aft body. Vehicles in the 7-10,000 lb. class must be on-loaded and off-loaded close to the carrier center of gravity. The carrier cargo bay's dimensions constrained the maximum fighter size. Improved technology would serve to minimize fighter size for resulting operational requirements.

(U) To better understand the feasibility of the concept, 1975 level technology was selected for all evaluation and trade studies. The technology in 1980 was assessed to provide a reduced weight fighter with equal or greater performance.

(U) A basic weight of 10,000 lbs. was selected from previous studies, which covered a weight range from 4,000 lbs. to 20,000 lbs.

Design Criteria and Characteristics

(U) Design development of the baseline Micro-fighters included the following criteria:

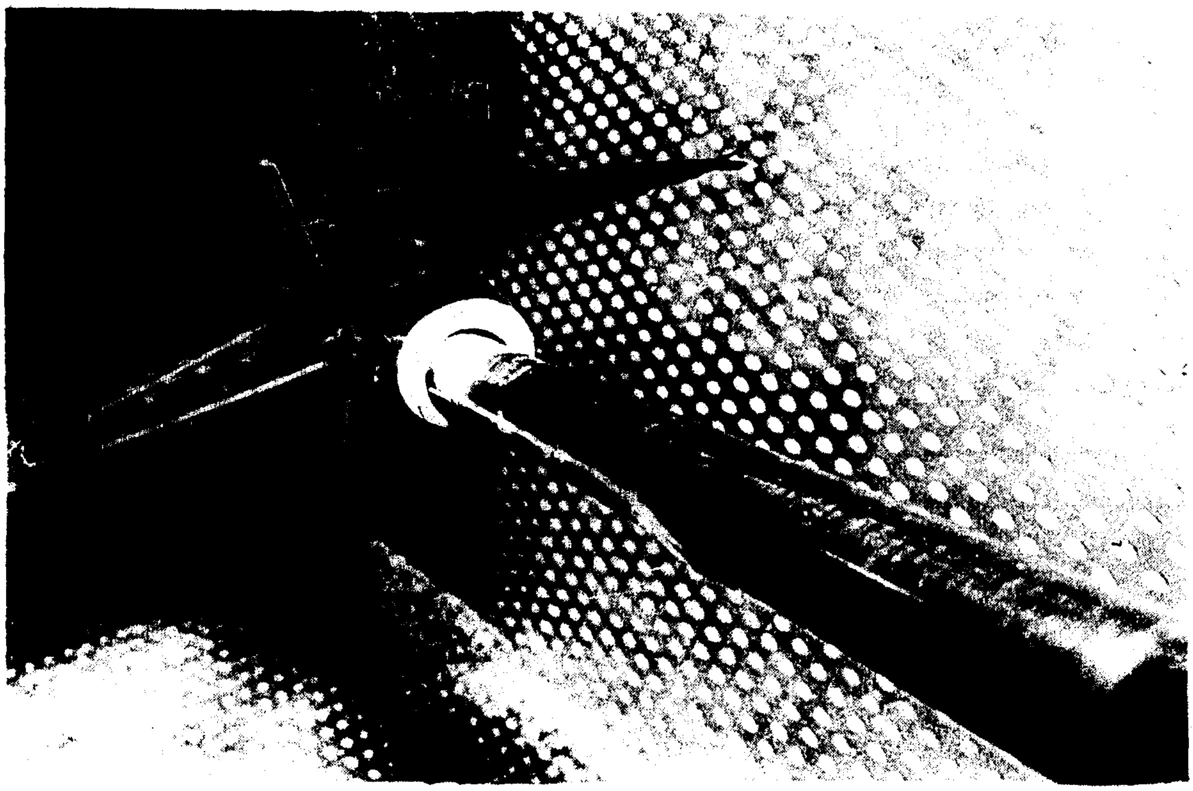
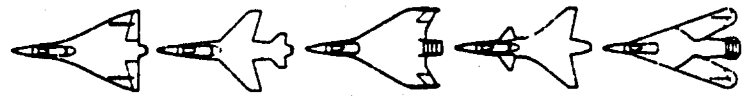


Figure 10: AFFDL/MF-5 Mounted in AEDC Tunnel 4T (U)

- o 1975 Technology
- o Wing Span = 17.5 ft. because of 747 launch by restraints.
- o Variable Geometry - Vehicle designs that employ folding or sweeping surfaces must be flyable at launch and recovery speeds in folded configuration.
- o High-g cockpit design with IIPACS displays and controllers.
- o Inlet design - fixed geometry, 1/2 round with fixed spike.
- o Emergency earth landing gear-shock absorbing skid system and drag chute.
- o Flight control-zero static margin in pitch and neutral directional stability.
- o Basic armament - (2) M-39 cannons and 400 rounds of 20 mm ammo.
- o Fuel volume for 2,5000 lbs. internal.
- o IFR receptacle located to focus boom loads for stable towing.
- o A single YJ101-GE-100 engine will be used.

These ground rules were intended to provide minimum size vehicles with fighter performance. The resulting characteristics are summarized in Figure 11.



TYPE	"DELTA"	"VITAC"	"ARROW"	"CANARD"	"VSW"
Model 985	–1	–10	–20	–30	–40
Launch Wt (Lbs) [1] (1975 Technology)	10,180	10,280	10,350	10,340	10,730
Overall Length (Ft)	30.0	30.0	30.0	30.0	30.0
Minimum Span (Ft					
Stowed	17.5	17.5	17.5	17.5	17.5
Flight	17.5	17.5	17.5	17.5	17.5
Maximum Span (Ft) (In Flight or Docked)	17.5	17.5	17.5	17.5	27.5
Wing Area (Ft^2)	200	100	200	110	206
Flight Aspect Ratio Max/Min	1.53	3.06	1.53	2.784	5.05 / 1.44
Leading Edge Sweep (Deg)	64	45	60	50	40/70
Body Fineness Ratio	8.05	7.86	8.62	8.16	8.20
Internal Fuel (Lbs)	2500	2500	2500	2500	2500
Powerplant	YJ101 GE100	YJ101 GE100	YJ101 GE100	YJ101 GE100	YJ101 GE 100
Overall Height (Ft)	6.4	6.86	6.0	6.5	5.85
Visibility Factor [2]	245	211	263.7	215.9	266/255.8

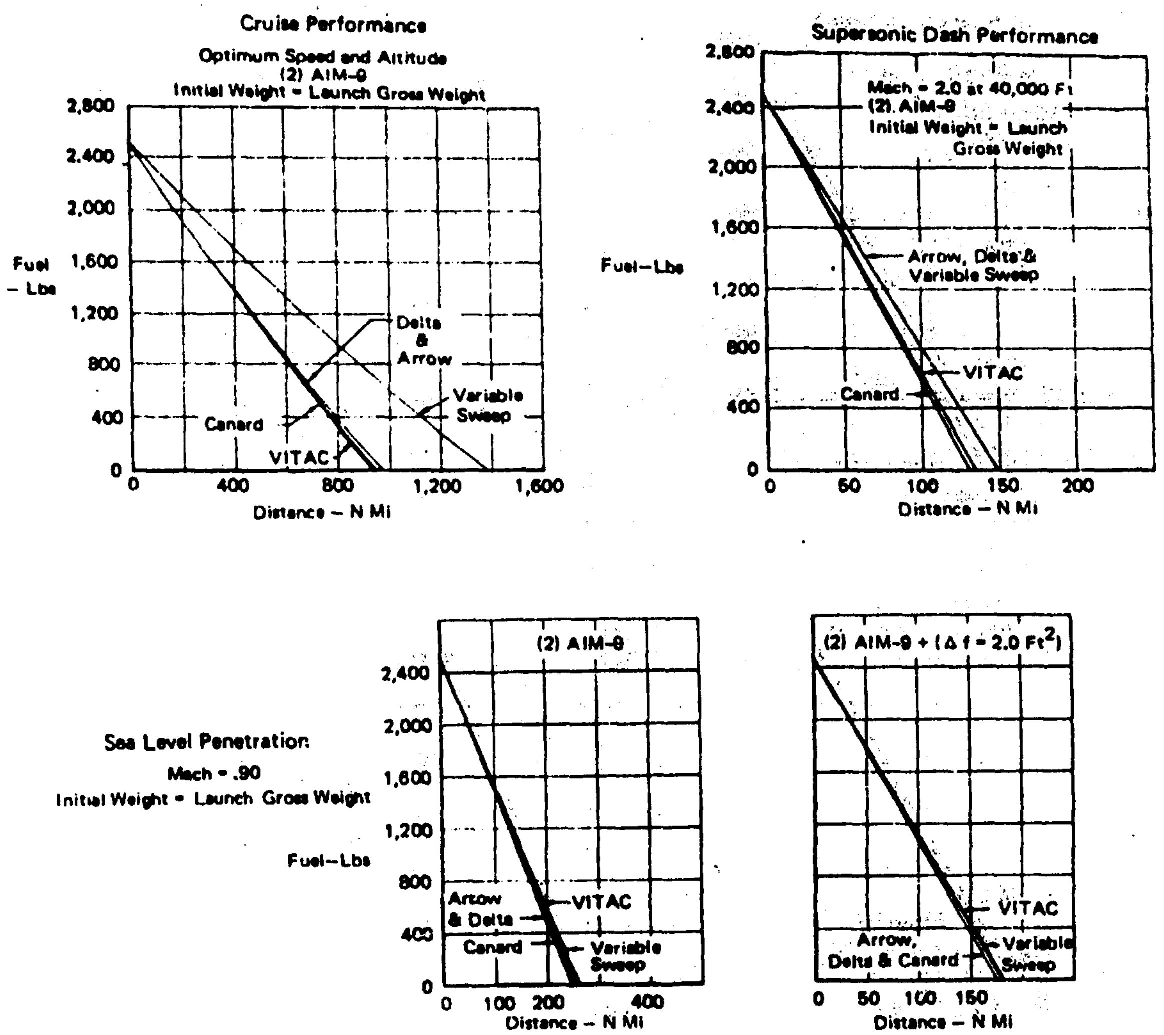
[1] As drawn with full internal fuel + (2) M-39 20mm Cannons + 400 rds ammo + (2) AIM-9E missiles. Avionics package = 100 Lbs

[2] $F_v = \sqrt{A^2_{front} + A^2_{side} + A^2_{plan}}$ (F-4 has F_v = 1200)

Figure 11: Baseline Configurations – Characteristics (U)

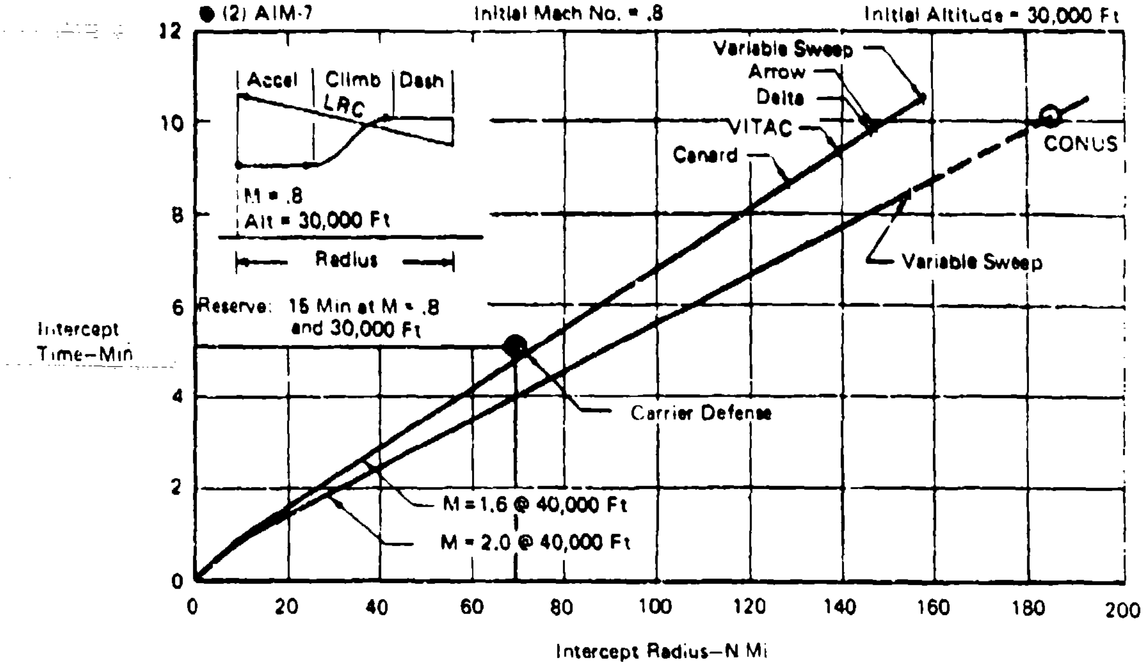
FIGHTER COMPARISON

(U) Studies were conducted with five baseline fighters to establish their capability to meet the requirements identified in the operational analysis. Basic comparisons were made for intercept and strike performance. Subsonic cruise performance was sensitive to vehicle configuration. Cruise specific range for variable sweep is approximately 50% better than other designs but supersonic and low altitude performances are essentially equal. The clipped "arrow" benefits from endplate fins to increase span loading. The Delta provided simplicity and light weight. The high aspect ratio wing selected for "Canard" and VITAC concepts were penalized with high wing loading due to the span limitation. Mission performance is compared on Figures 12, 13 and 14.

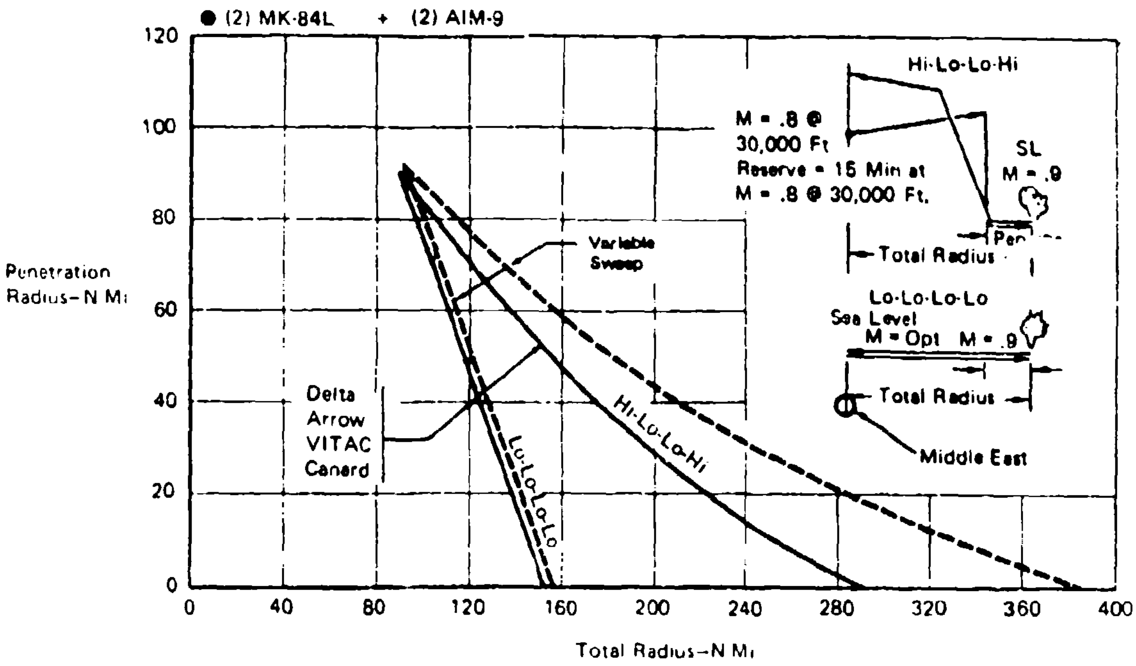


(C) Figure 12: Fighter Performance (U)

(U) Mission performance evaluation shown in Figures 12, 13 and 14 resulted in the initial selection of two configurations, a Delta and a Tailess Variable Sweep design. The Delta possessed design simplicity to favor its selection and the Tailess Variable Sweep configuration overall performance.

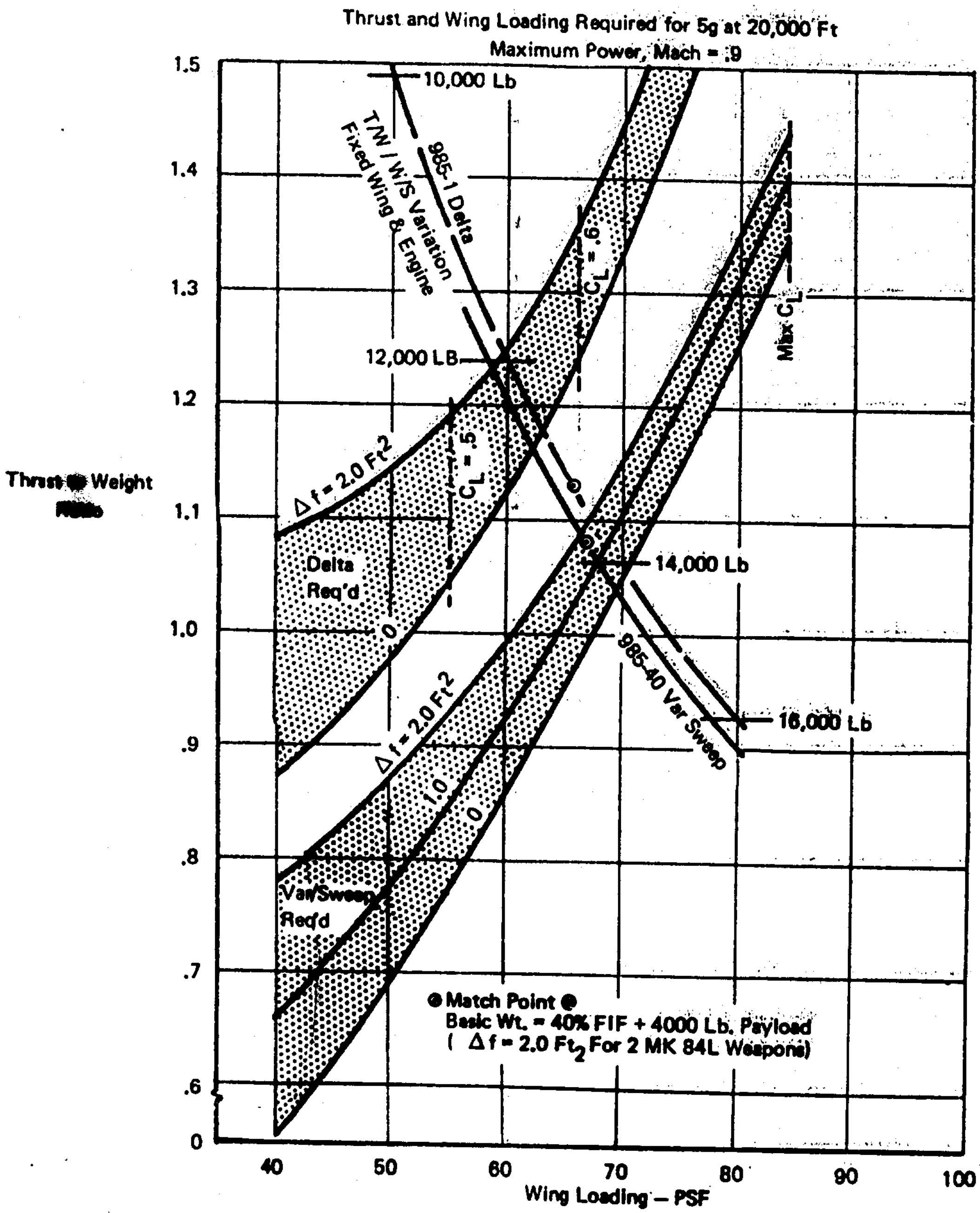


(C) Figure 13: Intercept Mission (U)



(C) Figure 14: Strike Mission Performance (U)

(C) A factor in design selection was the ability of the Micro-fighter to defend itself against the many Mig 21's around the world. Baseline configurations were compared for maneuver with and without air-to-ground weapons in Figure 15. Both configurations have more than sufficient capability for self-protection without external stores.



(C) *Figure 15: Self Defense (U)*

(U) Fighter selection benefited throughout by concurrent wind tunnel testing conducted by the Aerospace Vehicle Branch of the Air Force Flight Dynamics Laboratory. Tests with outboard fins similar to those of the Delta indicated flow interference between the leading edge vortex and the wing mounted fins. To minimize the interference, the fins were moved to the wing tips, essentially resulting in the Delta becoming the Arrow, which was selected for the final point design. The variable sweep configuration with the wing in the maximum swept position for launch and recovery has aerodynamic and geometric characteristics similar to the Arrow. Figure 16 shows the selected configurations.

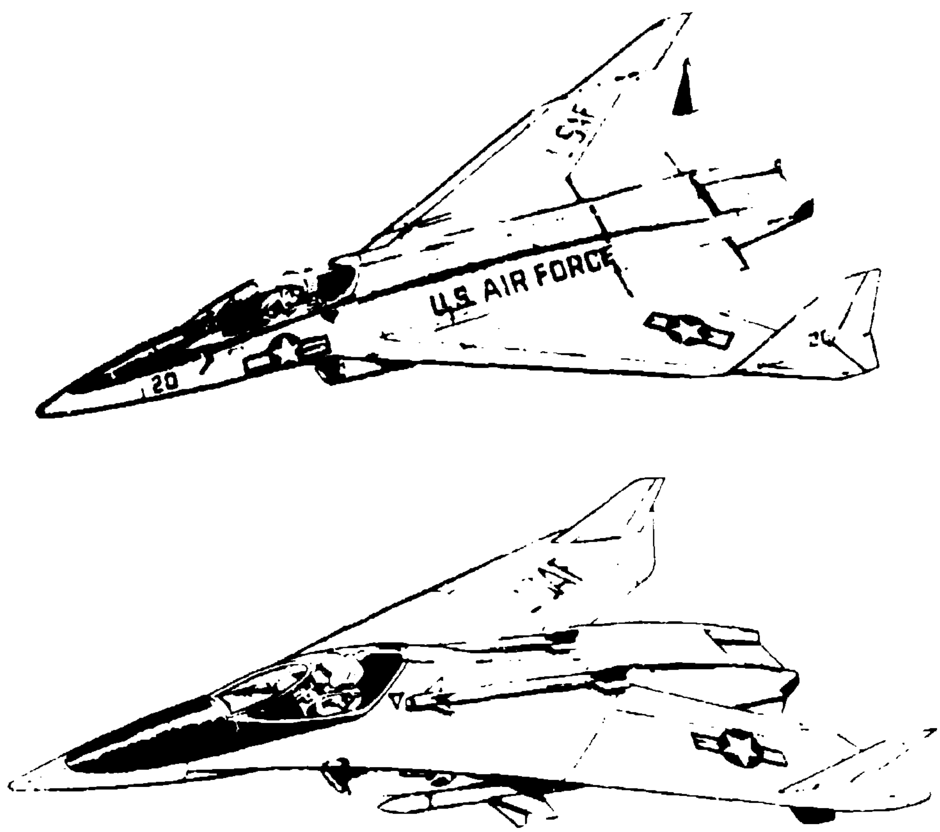


Figure 16: Selected Fighters (U)

4.0 CARRIER SELECTION

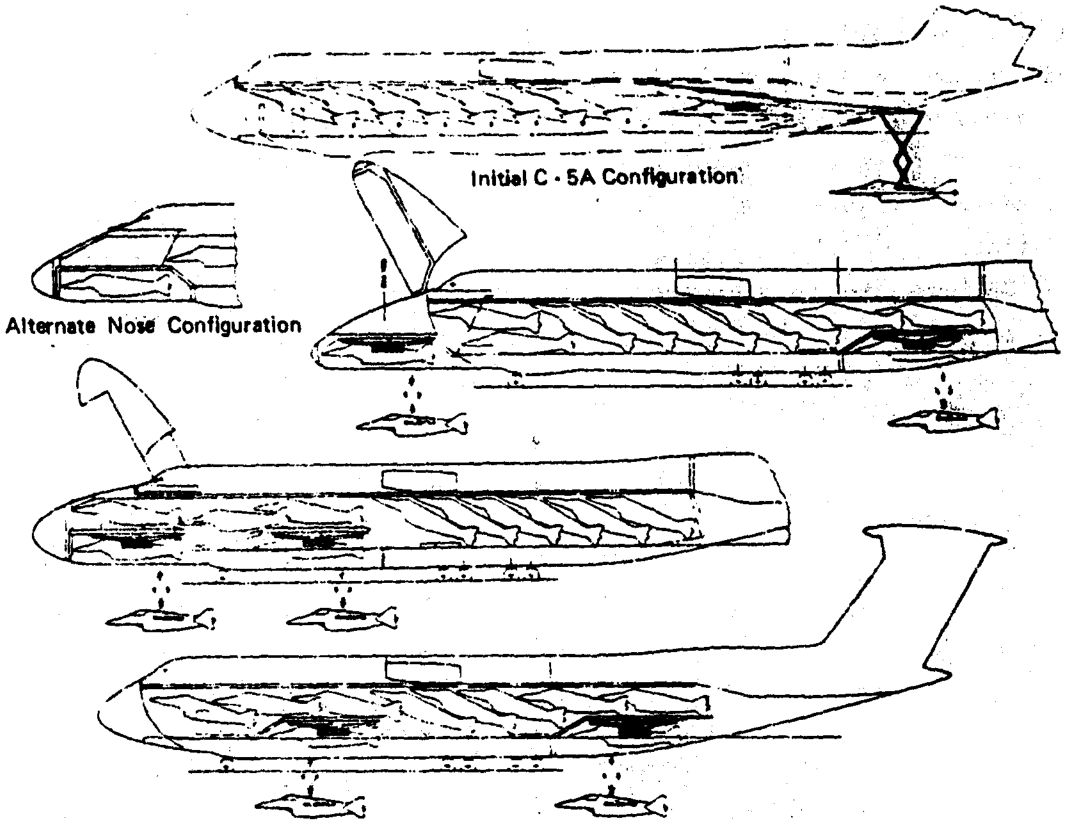


Figure 17: C-5A AAC Concepts (U)

CARRIER SELECTION

(U). 747 and C-5A transports were compared for use as airborne aircraft carriers. Primary considerations were ease of modification, airframe growth, alternate applications and performance. The C-5A body structural arrangement appears easiest to modify; however, when modified it loses much of its cargo capability, as shown in Figure 17.

(U) Carrier design criteria included:

- Dual launch and recovery bays
- In-Flight refueling booms for initial contact and refuel
- High speed - clear air launch and recovery
- Carrier versatility to operate in alternate roles, such as cargo carrier, troop carrier, or tanker.

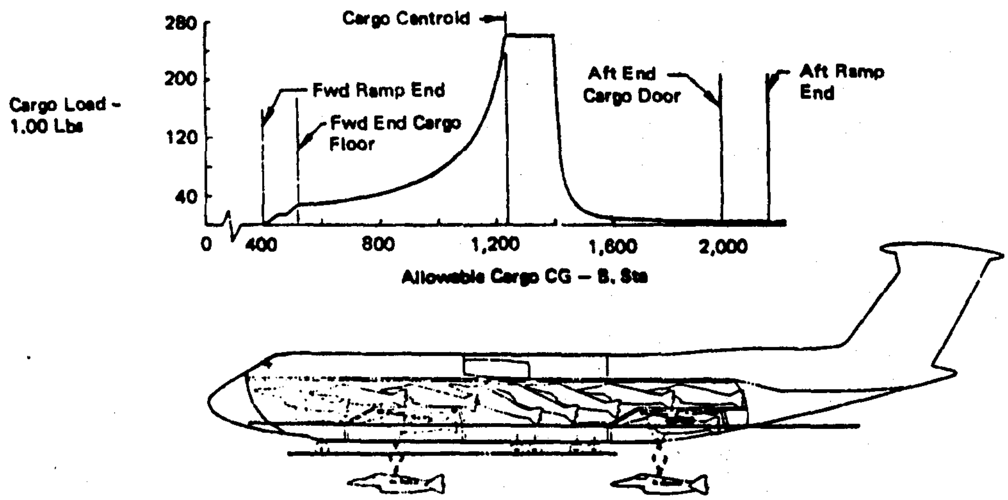


Figure 18: Launch and Recovery Weight and Balancs-C5A (U)

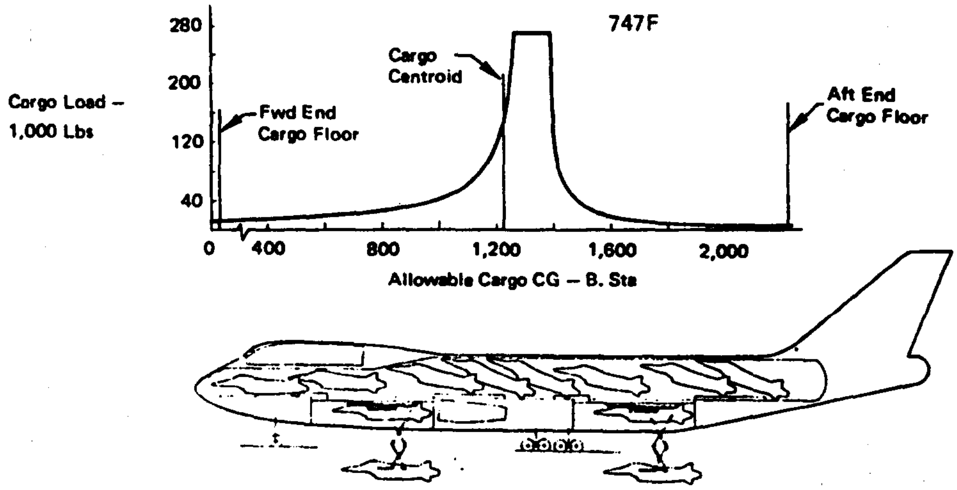


Figure 19: Launch & Recovery Weight & Balance -747F (U)

CARGO LOADING

(U) On-board fighter handling is heavily influenced by carrier balance during launch and recovery as shown in Figures 18 and 19. The C-5A aft location for cargo off-loading is not usable with fighter size vehicles (without extensive modification to airframe and flight control system). Bomb bay type arrangements close to carrier center of gravity allow launch and recovery operations for vehicles up to 15,000 lbs. Forward balance on-loading permits a fighter in the nose position clear of normal movement during launch and recovery. Degraded mode operations can be accomplished with only one launch and recovery bay operable.

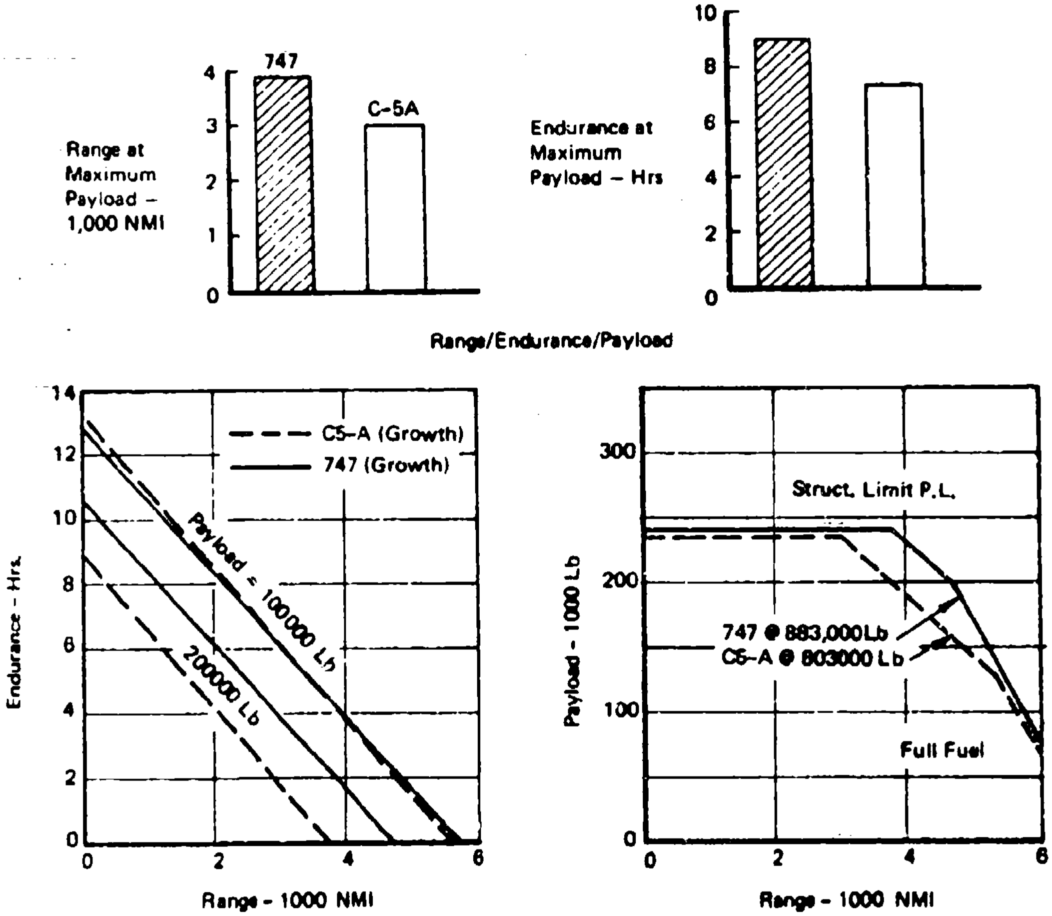


Figure 20: Growth Carrier Performance (U)

CARRIER SELECTION

(U) As shown in Figure 20, the 747 has a growth potential to 883,000 pounds. Growth of the C-5A was projected to 803,000 pounds based on Lockheed data. With this capability range, endurance and speed of the 747 exceed the C-5A. Installation of in-flight fueling boom on the C-5A also presents difficult problems. A single aft location is feasible, however it would not provide assistance to the recovery operation.

Growth Carrier Comparison	C-5A AAC	747F AAC
PERFORMANCE		
Cruise Mach No.	.76 – .77	.84 – .86
Cruise Altitude	27,000	32,000
Max Range – 200,000 Lb Payload	3,700	4,700
Endurance at 3000 Mi Range, 200,000 Lb Payload	1.6 Hrs (1)	3.8 Hrs
LAUNCH & RECOVERY OF MICROFIGHTERS (DUAL LAUNCH & RECOVERY SYSTEM)		
Modification Weight Penalty (ΔOW Lbs)	34,154	44,763
Use of Aerial Refueling Boom for Recovery of Microfighter	See (2)	Inherent in Design
SPOTTING & EQUIPMENT CAPABILITY		
Maximum No. of Microfighters	10	10
Total Pressurized Volume – Cu Ft	66,632	59,000
Volume Usable for Fighter Carriage	41,260	40,266
Usable Volume for Crew & Supt Equipment	3,786+	4,600+
FLEXIBILITY		
Microfighter Transport Only	10	10
Outsize Cargo Capability	Limited by Mod	Limited by Design
8 Ft x 8 Ft Cargo	Requires Special Prov	Inherent in Design
Troop Transport	Good	Good
Tanker	(2)	Inherent in Design

(1) Not Adequate for Applications Requiring Recycle of Microfighters
(2) Aerial Refueling Boom and Operator's Station Possible on ℄ on Aft Body. Single Aft Body Station Does Not Provide Assistance to Recovery Operation.

Figure 21: Carrier Selection Summary (U)

(U) Figure 21 summarizes the primary characteristics of the C-5A and 747F when modified to the AAC configuration. The C-5A lacks endurance for multiple sorties from each fighter. Modification to the 747 requires more weight for the desired arrangement for fighter handling. Both designs can be made to carry 10 fighters with space for on-board rearming but the C-5A loses some of its capability to carry outsize cargo. In-flight refueling at both launch and recovery stations, a requirement for rapid recovery, would require extensive modification to the C-5A. These considerations led to selection of the 747F as the baseline for further studies.

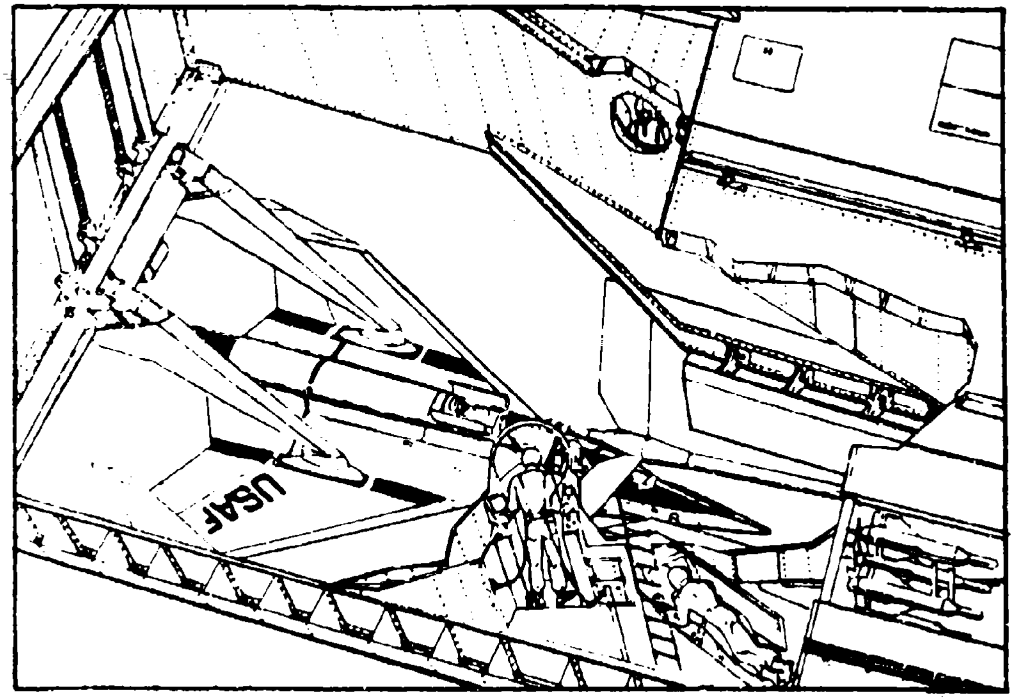
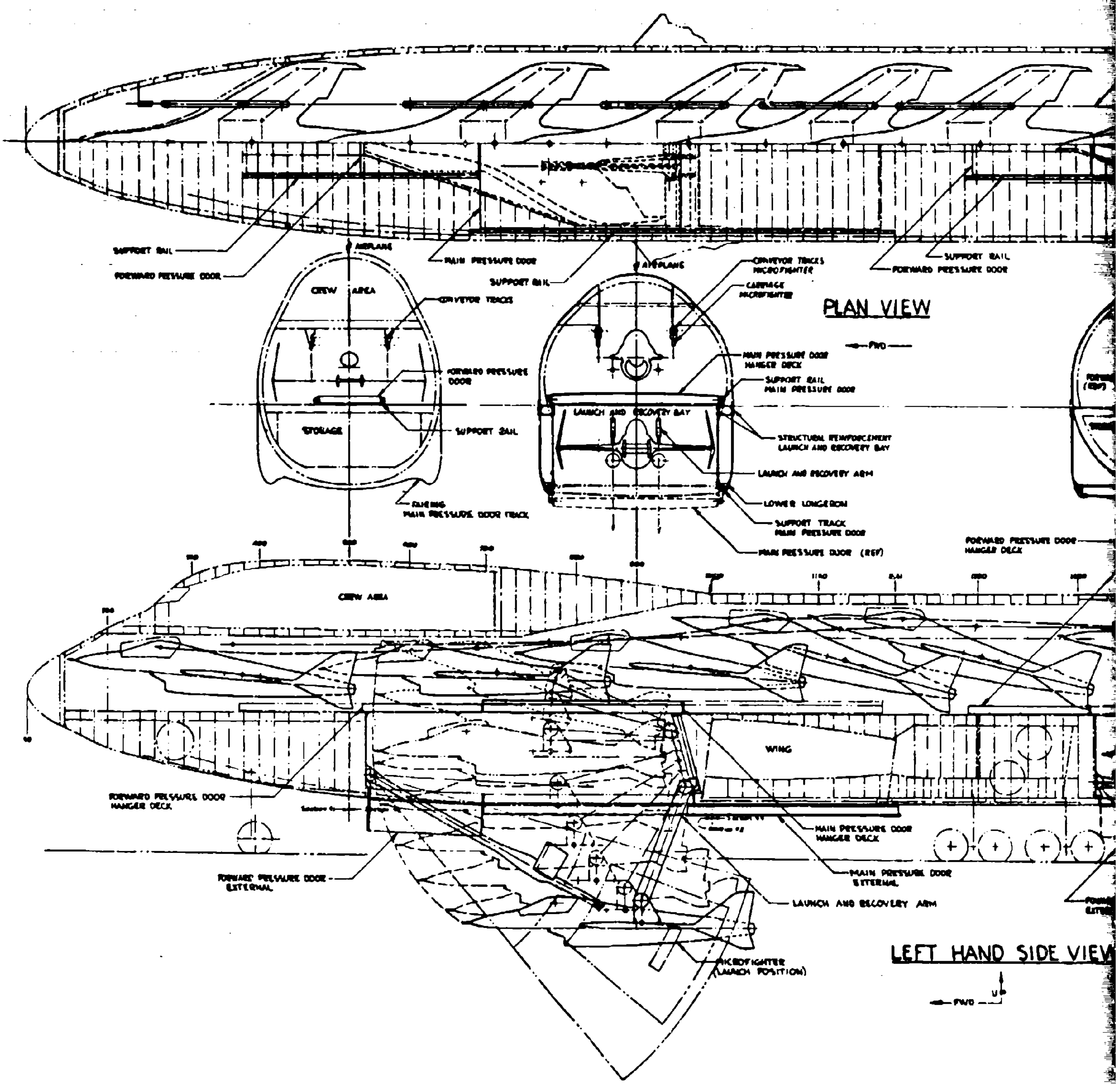


Figure 22: Micro-Fighter Recovery (U)

(U) Fighters are recovered by initial contact with the active in-flight refueling boom. Refueling is accomplished in approximately 30 seconds while the boom is moved to its index position. Retracting action of the telescoping boom then pulls the fighter into the trapeze index and lock fittings. Verification of lock-on brings umbilical power to the fighter while the IFR boom is completely retracted and moved aside to its park position. Engine shut down follows and initiates the hoisting cycle by the trapeze.

(U) To bring the fighter on board, the trapeze is powered and programmed to move the fighter into the launch and recovery bay. Following pressurization, when hangar deck hatch is open and clear, the trapeze moves the fighter to the overhead traveler support for hangar stowage. Operation is controlled by a boom operator, trapeze operator and launch and recovery supervisor as indicated on Figure 22.

(U) The selected arrangement for stowage, launch and recovery is shown on Figure 23.


SUPPORT RAIL
FORWARD PRESSURE DOOR
AIRPLANE
MAIN PRESSURE DOOR
SUPPORT RAIL
AIRPLANE
CONVEYOR TRACKS MICROFIGHTER
CARRIAGE MICROFIGHTER
SUPPORT RAIL
FORWARD PRESSURE DOOR
PLAN VIEW
FWD
CREW AREA
CONVEYOR TRACKS
FORWARD PRESSURE DOOR
STORAGE
SUPPORT RAIL
MAIN PRESSURE DOOR TRACK
MAIN PRESSURE DOOR HANGER DECK
SUPPORT RAIL MAIN PRESSURE DOOR
LAUNCH AND RECOVERY BAY
STRUCTURAL REINFORCEMENT LAUNCH AND RECOVERY BAY
LAUNCH AND RECOVERY ARM
LOWER LONGERON
SUPPORT TRACK MAIN PRESSURE DOOR
MAIN PRESSURE DOOR (REF)
FORWARD PRESSURE DOOR HANGER DECK
CREW AREA
WING
FORWARD PRESSURE DOOR HANGER DECK
MAIN PRESSURE DOOR HANGER DECK
FORWARD PRESSURE DOOR EXTERNAL
MAIN PRESSURE DOOR EXTERNAL
LAUNCH AND RECOVERY ARM
MICROFIGHTER (LAUNCH POSITION)
LEFT HAND SIDE VIEW
UP
FWD

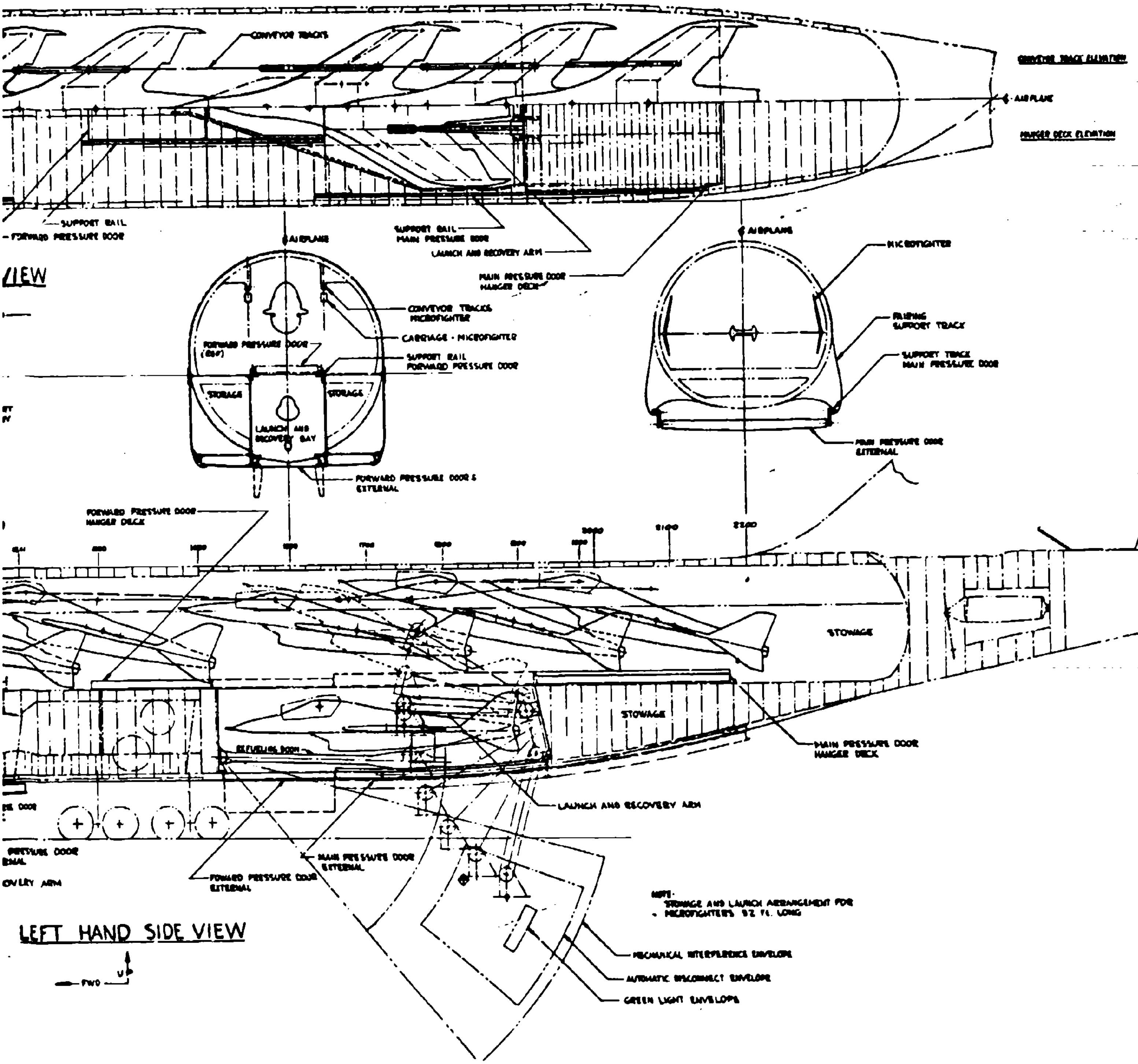

CONVEYOR TRACKS
CONVEYOR TRACK ELEVATION
AIRPLANE
HANGER DECK ELEVATION
SUPPORT RAIL
FORWARD PRESSURE DOOR
SUPPORT RAIL
MAIN PRESSURE DOOR
LAUNCH AND RECOVERY ARM
MAIN PRESSURE DOOR
HANGER DECK
AIRPLANE
MICROFIGHTER
CONVEYOR TRACKS
MICROFIGHTER
CARRIAGE - MICROFIGHTER
FORWARD PRESSURE DOOR
SUPPORT RAIL
FORWARD PRESSURE DOOR
STORAGE
STORAGE
LAUNCH AND RECOVERY BAY
SUPPORT TRACK
SUPPORT TRACK
MAIN PRESSURE DOOR
MAIN PRESSURE DOOR
EXTERNAL
FORWARD PRESSURE DOORS EXTERNAL
FORWARD PRESSURE DOOR
HANGER DECK
STOWAGE
STOWAGE
REFUELING BOOM
MAIN PRESSURE DOOR
HANGER DECK
LAUNCH AND RECOVERY ARM
MAIN PRESSURE DOOR
EXTERNAL
FORWARD PRESSURE DOOR
EXTERNAL
NOTE:
STOWAGE AND LAUNCH ARRANGEMENT FOR
MICROFIGHTERS 12 FT. LONG
MECHANICAL INTERFERENCE ENVELOPE
AUTOMATIC DISCONNECT ENVELOPE
GREEN LIGHT ENVELOPE
LEFT HAND SIDE VIEW
FWD
UP

Figure 23 :

UN

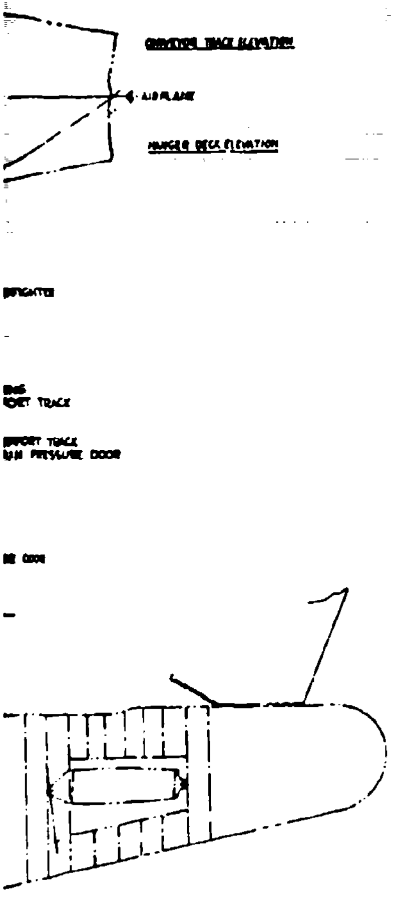


Figure 23 : Stowage and Launch Arrangement Microfighter Carrier 747 F (Modification)

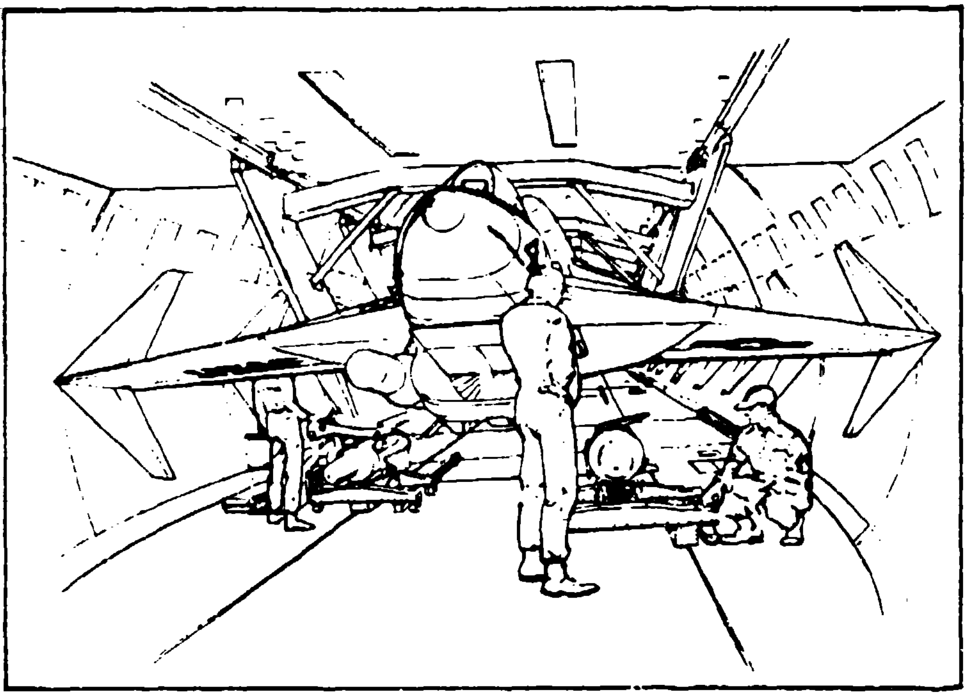


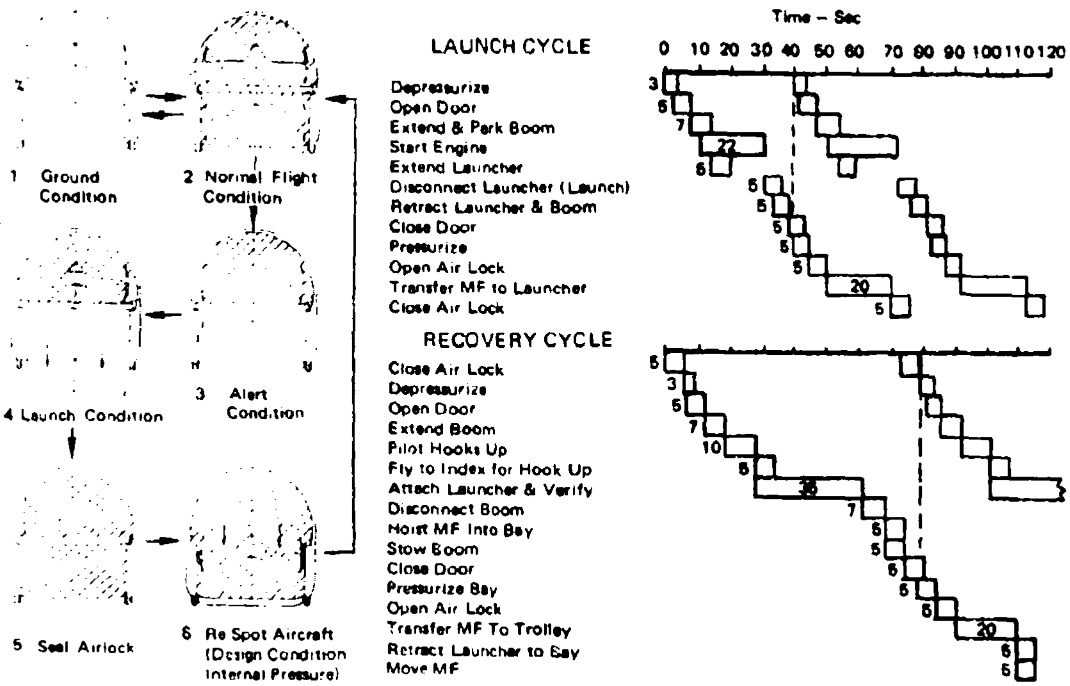
Figure 24: In-Flight Rearming (U)

ON-BOARD HANDLING

(U) On board the carrier, fighters can be serviced, rearmed and turned around. The bomb loading, illustrated on Figure 24, shows 1,750 lb. modular munitions being raised from the ordnance locker to transfer position on the weapon trolley. In the foreground, the weapon is translated on its carriage for alignment to the fighter store station. Trolleys are held to the deck by a zero-g rail and move to any airplane station. With this concept, turnaround including rearming, is estimated to require 10 minutes per airplane.

(U) Personnel requirements are 44 per airplane: an AAC crew of 12, MF squadron of 14 and 18 supporting specialists.

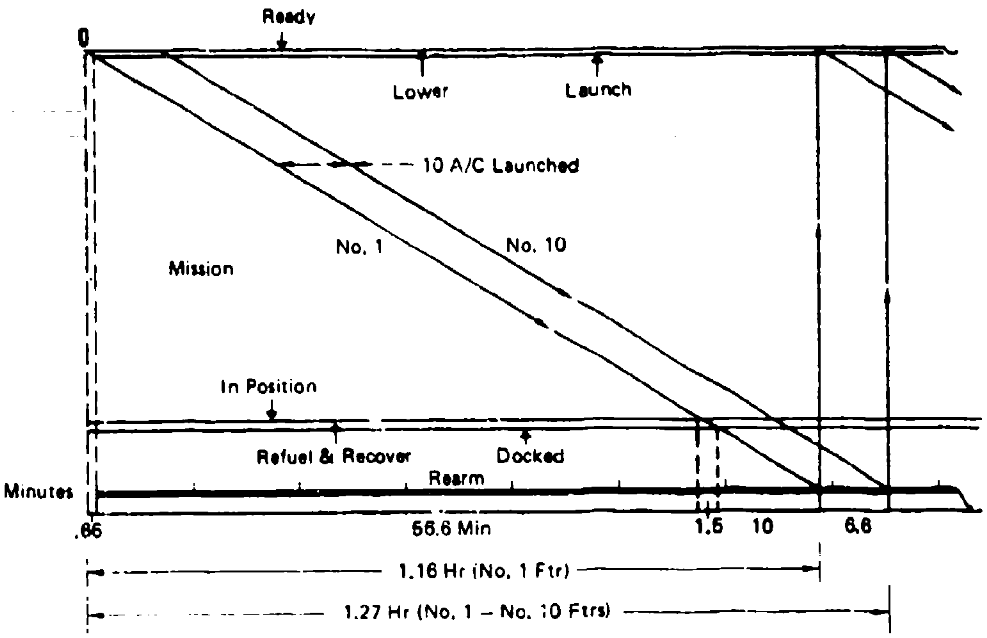
(U) Operation of ten fighters in combat situations from a high altitude base requires pressurized crew compartments and hangar decks. The launch and recovery bays become air-locks to transfer the fighters between environmental extremes.



(C) Figure 25: Launch & Recovery – Timeline (U)

(U) Launch and recovery is expedited by dual systems and ample power available on-board the 747. (Launch and recovery requires power about equal to landing gear retraction.)

(C) The launch cycle shown on Figure 25 is paced by air defense reaction. The first fighter must be launched 1.5 minutes after radar detection of a Mach 3.0 enemy. From an alert status (pilot in cockpit) two MF interceptors could be launched in approximately 80 seconds. Following elements are launched at 80-second intervals. The interval for this concept includes an air-lock pressure manifold to cycle pressurized air between bays. Concepts not using manifold bays would reduce the launch cycle.



(C) Figure 26: Mission Cycle Time (U)

CARRIER TIME ON STATION

(U) The fighter sortie time plus launch and recovery rate establish station time required of the carrier. Carrier payloads near 200,000 lbs. allow multiple sorties by the Micro-fighters. The time line shown in Figure 26 adds a nominal strike mission time to the launch and recovery times.

(C) With this capability recovery operations for mission aborts could be initiated as early as 7 minutes after initial launch. A wide range of mission times are probable. Intercept missions range from 10 to 24 minutes. Lo-level strike missions range from 17 to 88 minutes and combat air patrol could be up to 2.4 hours. The carrier has payload capability for at least three sorties per fighter. Resulting time on station could range to 8 hours for all combat air patrol.

(C) A more likely mission plan would designate part of the force to fly Combat Air Patrol (CAP) for strike missions. One CAP sortie may support two or more strike sorties in 2-3 hours.

5.0 TRADE STUDIES

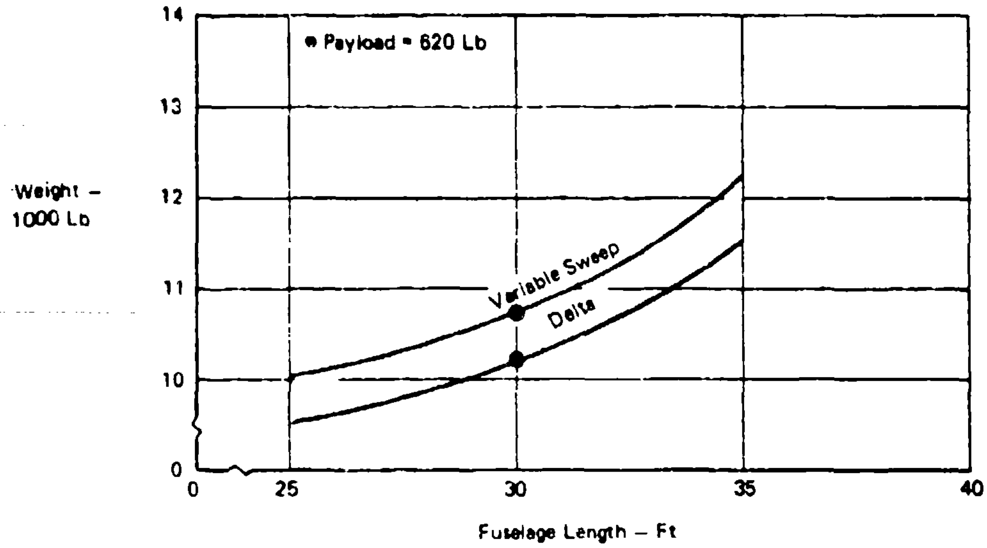
	Mission Performance	Carrier Compatibility	ALAR vs Earth Recovery	Technology Applications (1980 Tech)
FIGHTER				
Fighter Size	• Weight Variation	• Geometry	• Landing Systems	• Reduce Weight
Engine Size	• Survival/agility			• APSI/ATEGG Engine
Fixed vs Var. Geom.	• Performance & Maneuver	• Geometry	• Geometry	• Adv. Tech Airfoil
Armament	• Weapon Carriage	• In-Fit Rearm		• Adv. Gun & Missile
Attack Subsystem	• Mission Modules	• On-Board Handling		• DAIS Modules
Undercarriage	• Δ Wt		• Skid, ACLS, Airbag Pod Gear Conv. Gear	
CARRIER				
C-5A vs 747	• Range/payload	• Required Mods • On-board Handling	• Air Launch vs Air Transport	• Growth Potential
Launch Station Location	• Redundancy • Launch Cycle	• Weight & Balance	• Weight/Payload	
Carrier Size	• Ftr/Carrier Matching	• On-board Handling • Ftr Geometry	• Weight Variation	• Reduced Ftr Wt • Wt Growth

Figure 27: Trade Studies Summary (U)

(U) Trade studies identified on Figure 27 were conducted for variations in the fighter and carrier to determine major impact on system performance, carrier compatibility, airborne launch and recovery and technology applications for the 1985 IOC fighter design. Fighter trades employed the Delta & Variable Sweep designs.

(U) The resulting 1985 point design fighter characteristics included the following; Basic Launch Weight = 8,400 lbs., thrust to weight ratio = 1.35, advanced technology wing design, armament with 25 mm cannon and low cost defense missile, modular munitions-air to ground, digital avionics and flight controls, modular mission subsystems and high-g cockpit.

(U) Advance Airborne Aircraft Carrier characteristics included, take off weight = 1.2 million pounds and a fighter capacity of 14 for airborne launch and recovery.



(C) Figure 28: Basic Weight Air to Air Configuration (U)

FIGHTER SIZE

(U) Size of the Micro-fighter is severely limited by carrier geometry and structural constraints. Within these constraints the primary variation permitted is body length. The variations shown on Figure 28 are the result of body length.

(U) Carrier trades for fighter size variation are shown on Figures 29 and 30. It was believed that significant weight savings could be realized in body torsion material requirements by decreasing the width of the body cutouts, therefore providing a larger torsion box on the out-board sides of the cutouts. Stress sizing was accomplished to determine the theoretical material requirements in the cutout areas for the size variations. Weights were computed using the results of the stress sizing combined with predetermined theoretical-to-actual factors based on past Boeing experience. Figure 29 presents the results of the cutout size study.

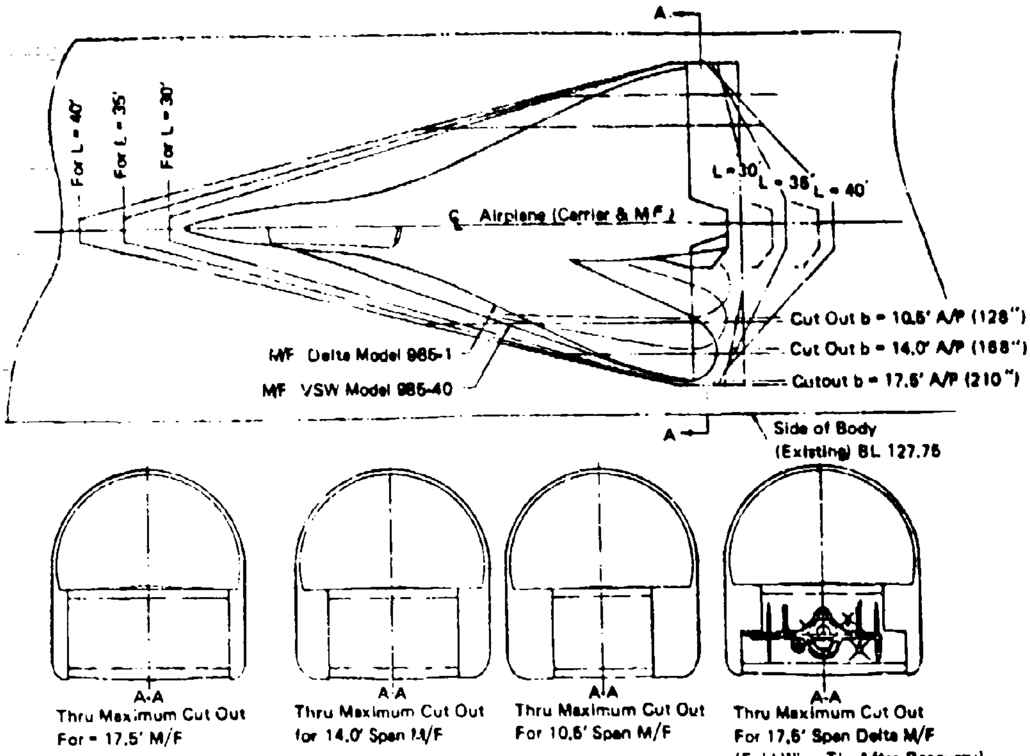


Figure 29: Launch & Recovery Bay Cutouts (U)

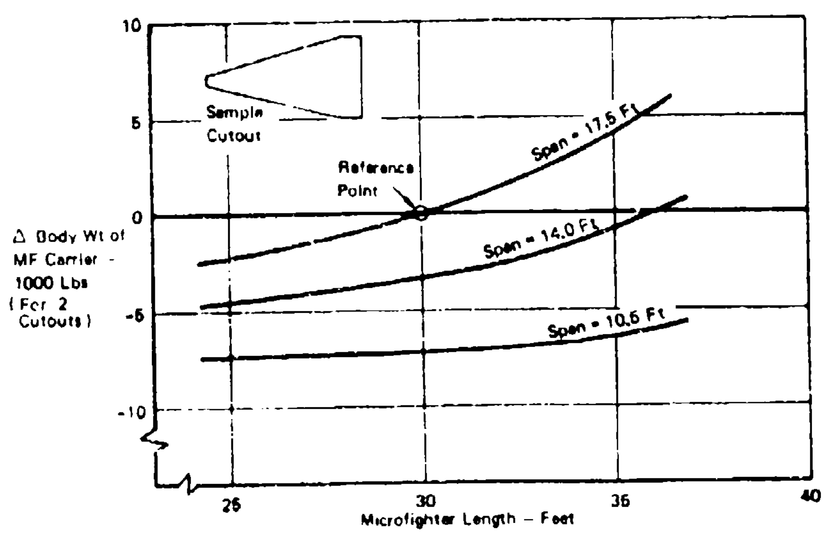
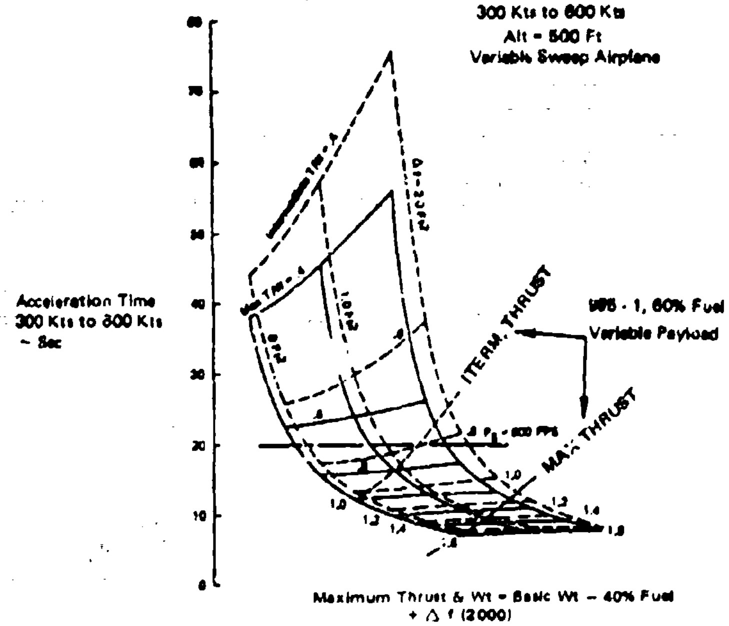


Figure 30: Effect of Cutout Size on Microfighter Carrier Body Weight (U)



(C) Figure 31: Effect of Thrust and Store Drag on Subsonic Acceleration (U)

ENGINE SIZE

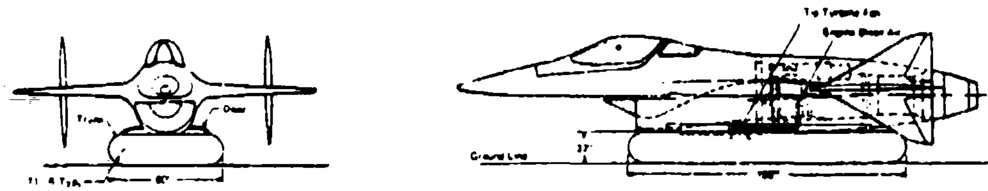
(C) Holding the airplane fixed and increasing engine size increases the penetration Mach number at sea level. Desired speed from a survivability standpoint is $M \geq .9$. Engine size and external drag effects on low altitude acceleration are shown on Figure 31. A typical Mig-21 threat possesses a specific excess thrust level of 600 fps which corresponds to approximately 20 seconds for acceleration from 300 to 600 kts. The 60% fuel line at intermediate thrust provides adequate acceleration up to a Δf of 1.35 square feet. With maximum augmentation the baseline thrust to weight ratio of 1.4 could out accelerate the Mig-21 without salvo of weapons.

	Metal Skid Baseline	Inflated Skid	ACLS	Wheels	
				Pod	Internal
Operation	EM-Ldg	EM-Ldg	TO & Ldg	TO & Ldg	TO & Ldg
Braking Method	Hi- µAft	Hi- µAft	Brake Pods	Disk Brakes	Disk Brakes
Drag Chute (45 Lb)	✔	✔	✔	✔	✔
Extension System	Precharge	Air Bottle	Tip Fan + Engine Bleed	Hyd System	Hyd System
Retract System	Hyd	Bungee	Tip Fan + Lanyard	Hyd	Hyd
Installed Volume Ft^3	1/2	5	25	30	4
Installed Weight	230	330	590	740	660

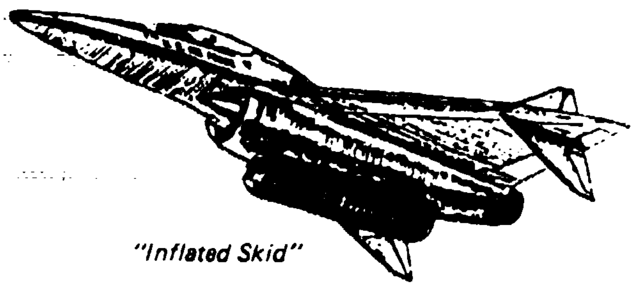
Figure 32: Landing Gear Characteristics (U)

EMERGENCY LANDING SYSTEM TRADES

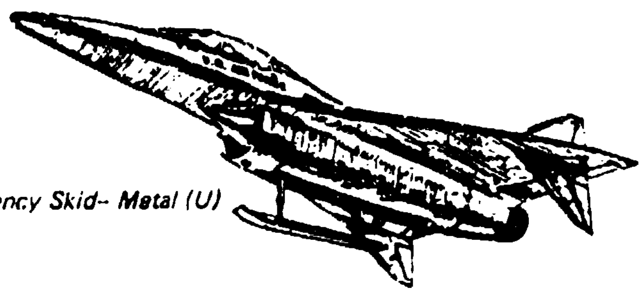
(U) Four alternate landing gear designs were examined in addition to the baseline skid concept. The characteristics and influence on fighters are summari in Figure 32 and illustrated in Figure 33. Two air cushion landing systems were studied. The inflated skid employs technology now being developed for air cushion landing systems. For emergency landing the metal skid was retained for its minimum cost, weight, and volume.



Air Cushion Landing System (U)

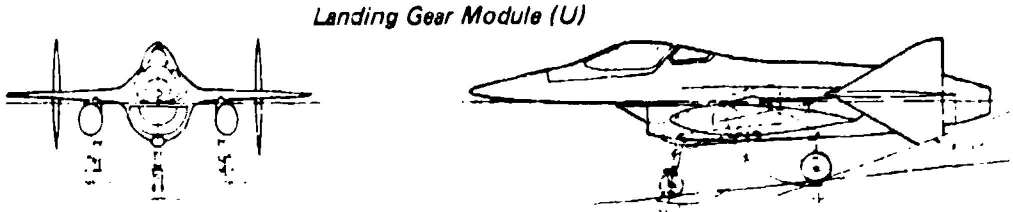


"Inflated Skid"



Emergency Skid-- Metal (U)

Landing Gear Module (U)



Integral Landing Gear (U)

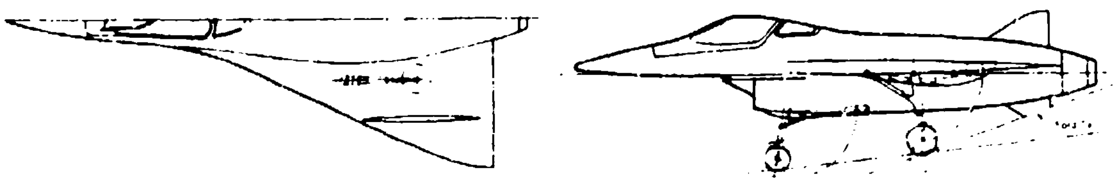


Figure 33: Landing Gear (U)

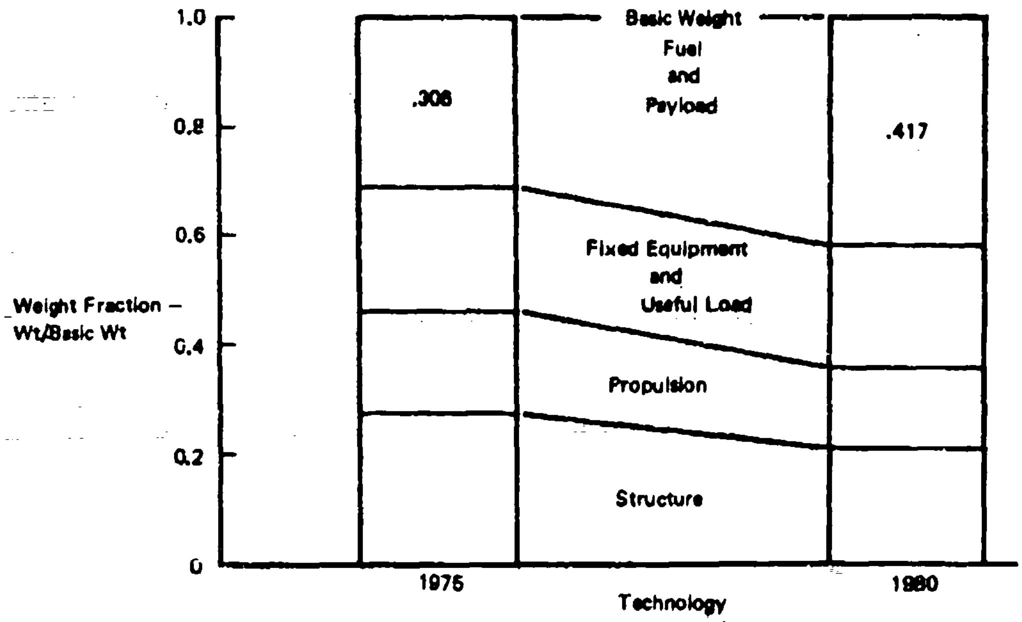


Figure 34: Technology Application (U)

TECHNOLOGY APPLICATIONS

(U) Technology projections for 1980 were examined to determine those high leverage applications that would reduce fighter size and basic launch weight. Weight reduction was identified as a primary goal because the carrier weight limits are reached before volume limits. Figure 34 summarizes the results which include those high leverage technologies illustrated on Figures 35 through 40. Discussion of these technologies can be found in Volume II.

(U) Development programs in progress toward these projections can be identified for all areas except certain armament elements. Armament development is required for a low cost defense missile, a light weight 25 mm gun, and airframe weapons integration of modular munitions to provide the maximum benefits in a minimum fighter.

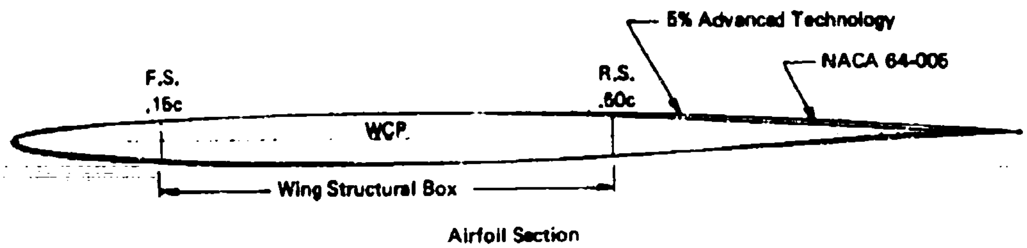


Figure 35: Advanced Technology Wing Design (U)

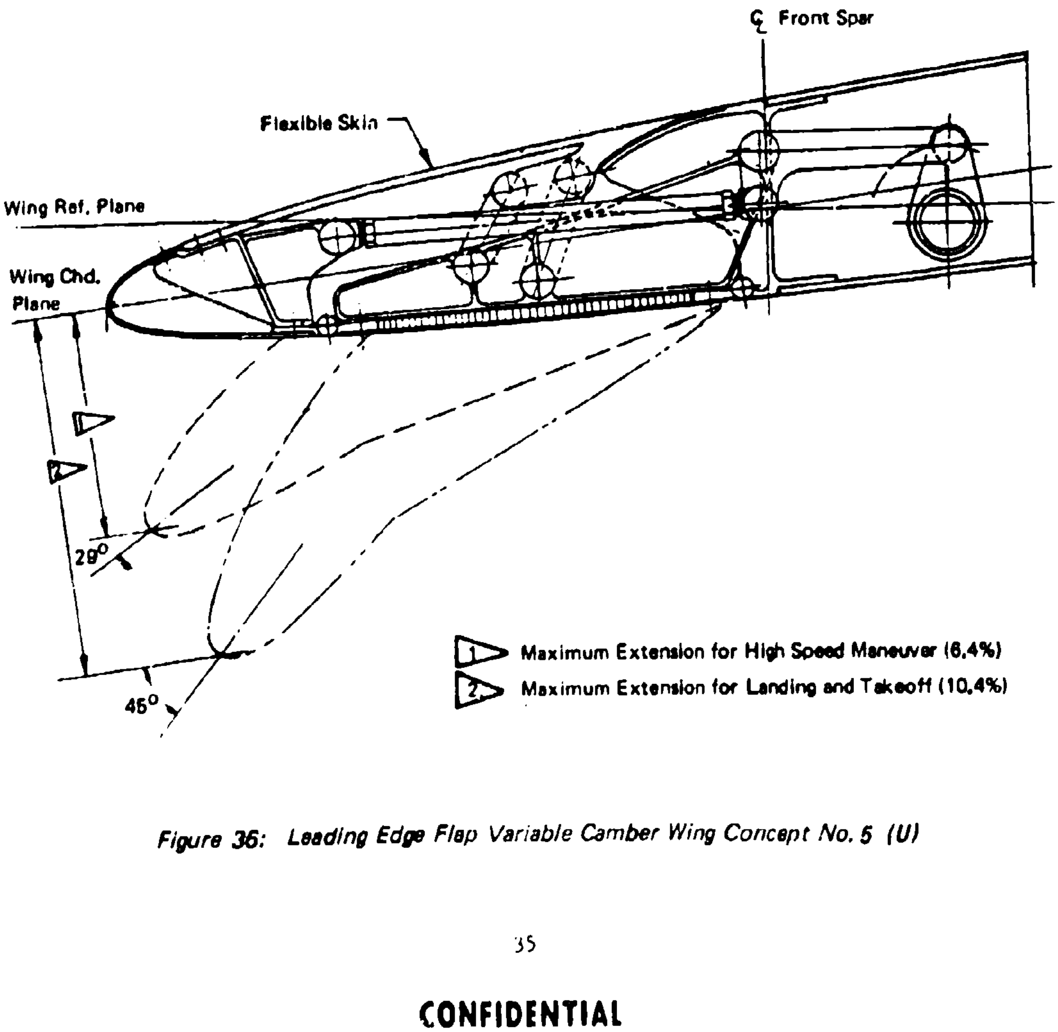
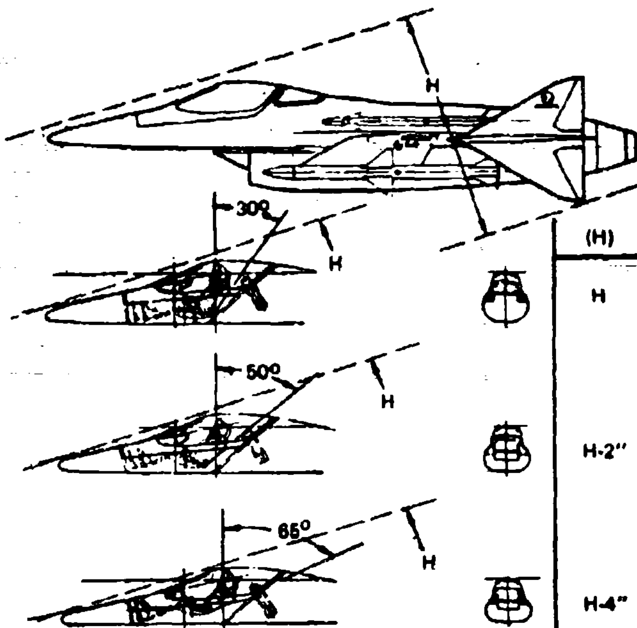


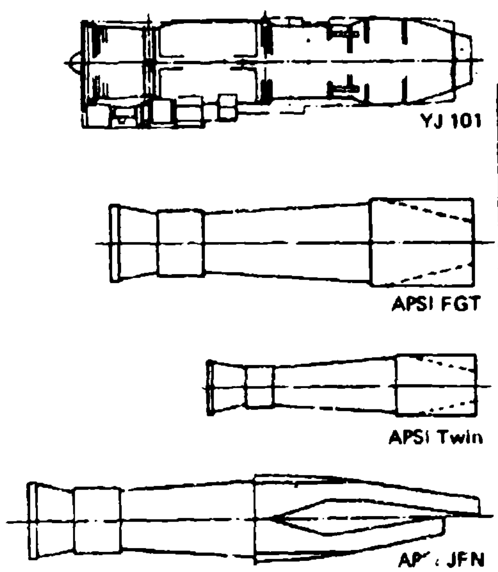
Figure 36: Leading Edge Flap Variable Camber Wing Concept No. 5 (U)



(H)	A_{Panel}	Gs Sustained
H	3.1 Ft^2	8.6
H-2"	2.0 Ft^2	9.1
H-4"	.28/Side	10.1

(U) Figure 37: Technology: Advanced Cockpit Design (U)

CONFIDENTIAL



Characteristics
15,000 Lb Thrust Engines

	YJ-101	APSI "A"	APSI "B"	APSI "C"
F_n/W_o	117.60	100.81	129.42	125.53
F_n/A Front (Inlet)	28.0	20.36	20.80	23.60
F_n/Wt	8.82	9.56	12.71	10.78
Length (In.)	144.00	94.41	150.60	133.22
Weight (Lbs)	1690	1510	1180	1391
R_p Fan	3.4	3.8	3.6	4.2
R_p Overall	21.7	21.3	21.6	21.0
BPR	0.2	1.7	.9	.5
Augmentation	Mixed Flow	Core Aug Duct Heater	Mixed Flow	Mixed Flow
sfc M = .9; 36k'	1.067	.93	.999	1.026

(C) Figure 38: Technology: Advanced Engine Cycles (U) CONFIDENTIAL

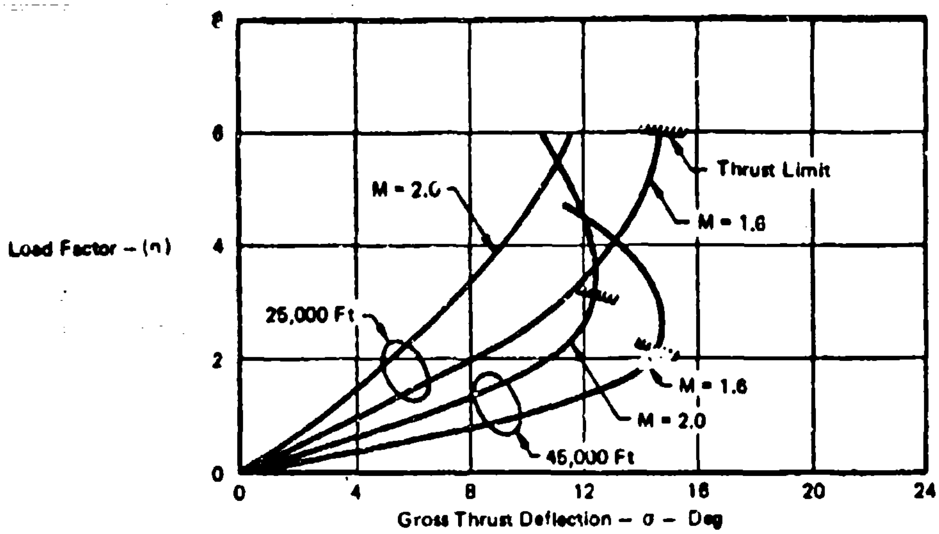


Figure 39: Maneuver Control with Vectored Thrust (U)

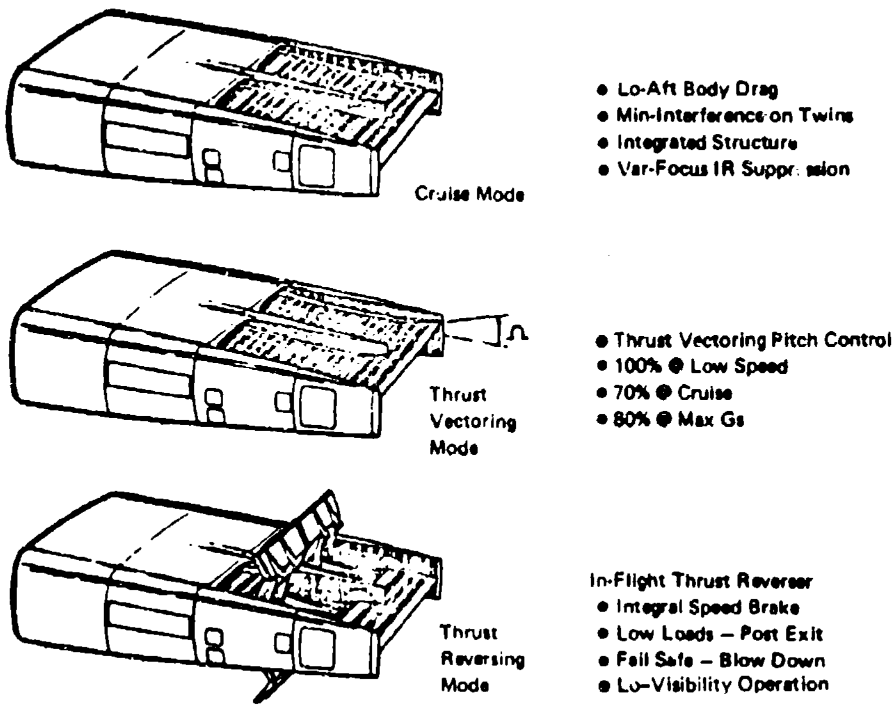


Figure 40: Integrated Dual Nozzle (U)

6.0 POINT DESIGN MICRO-FIGHTER – 1980 TECHNOLOGY

(U) Requirements for the Advanced Technology Micro-fighter evolved from the operational analysis and the trade studies.

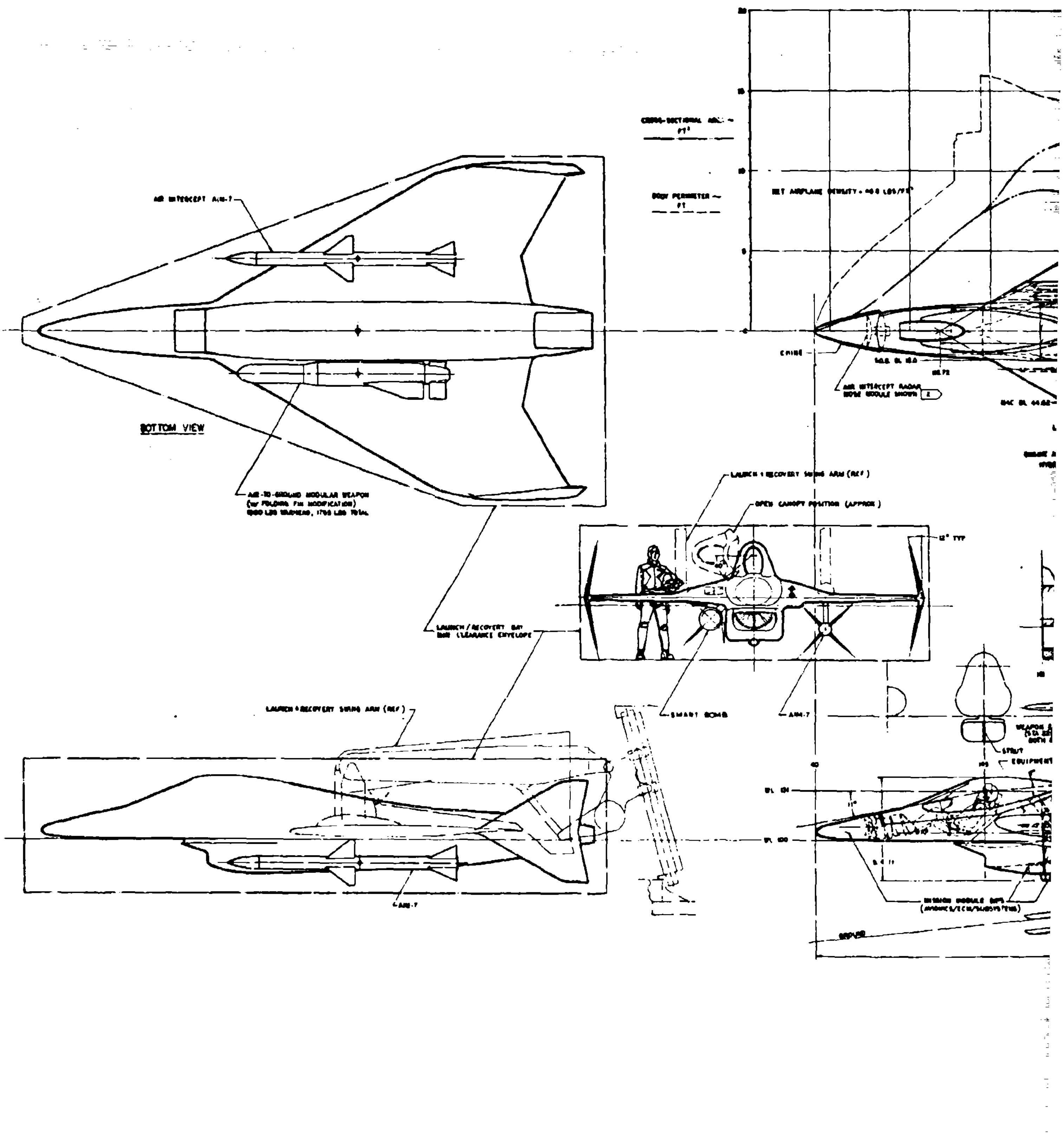
(C) For most engagements in remote areas normally denied to U.S. Forces, the enemy airborne threat will be comprised of many MIG-21's (even in 1985) and advanced fighters with capabilities similar to the F-16. The presence of MIG-21's should not degrade the MF strike force in any operation, air-to-air or air-to-ground. Therefore, trade studies have examined the MF agility in a heavy strike configuration to maneuver and accelerate with the MIG-21 in a GCI intercept configuration. This matching performance, plus inflight thrust reversing, will provide rapid positioning for conversion - particularly during scissors and yo-yo maneuvers. The point design can outrun the clean MIG-21 at low level, loaded with 3,500 lbs. of bombs, using partial afterburner. Acceleration w/afterburner is possible from best sea level cruise to V_L (M = 1.0) in less than 15 seconds. This throttle response will require an increase in V_L for safety. For the Point Design, M = 1.2 is believed to be adequate.

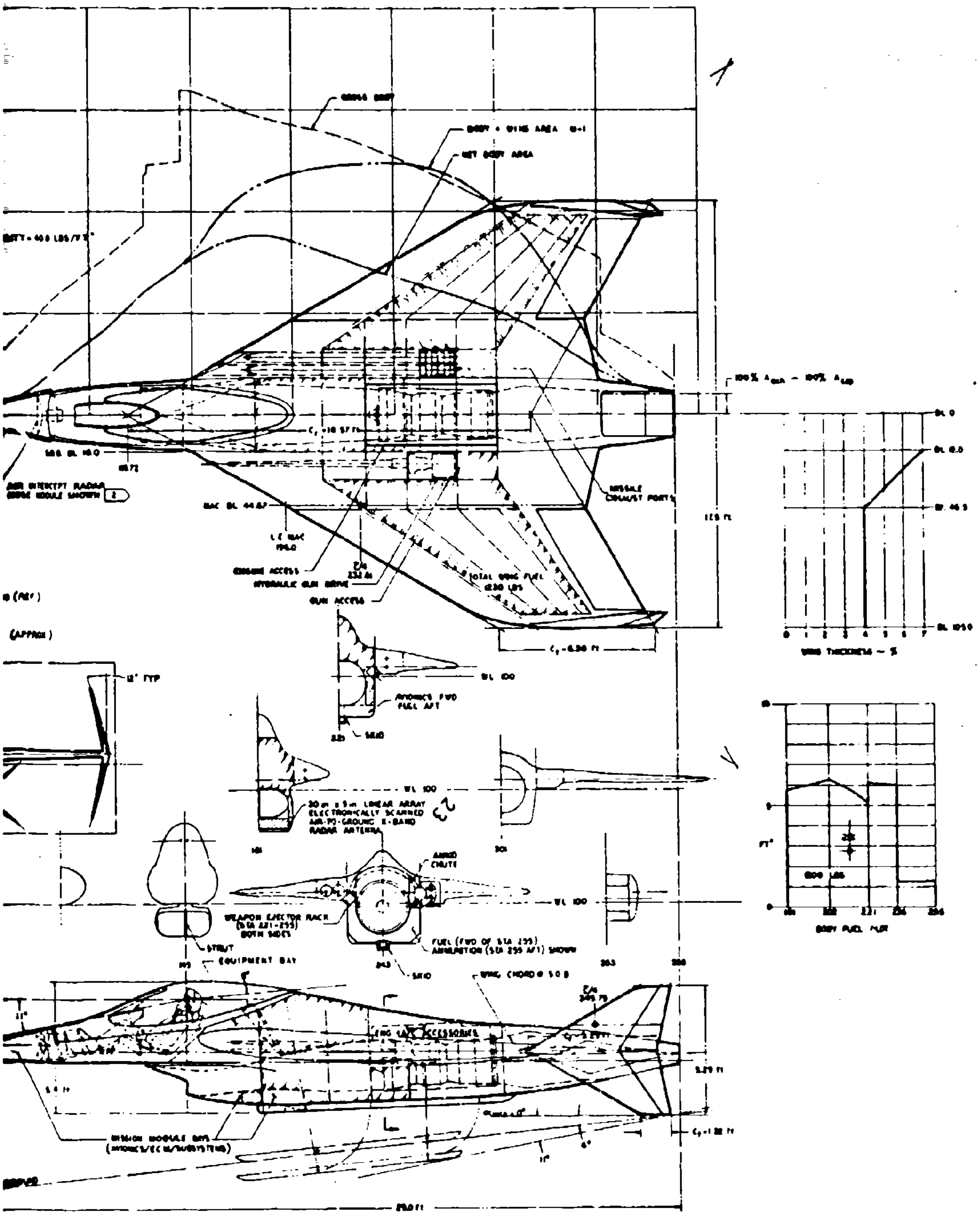
6.1 AIR VEHICLE DESCRIPTION

(U) The advanced Micro-fighter, Model 985-121, Figures 41 and 42, was developed by incorporating selected emerging technology items into the current technology arrow wing Micro-fighter, Model 985-20. The major configuration advancements are described below with subsystem descriptions following.

Model 985-121 Features

(U)
- Advanced technology "Arrow" wing planform with tip mounted vertical surfaces for improved flow field over fins.
- Smooth variable camber leading edge (VCW) for improved maneuverability.
- Direct side force control (DSFC) device for precision maneuvers.
- Body-wing blending for internal carriage of the gun and dogfight missiles with simpler structure.
- Advanced linear array radar module for installation in two dimensional horizontal ramp inlet.
- Hi-acceleration cockpit design with 50° inclined seat for tolerance of higher sustained g levels.


AIR INTERCEPT AIM-7
BOTTOM VIEW
LAUNCH + RECOVERY SWING ARM (REF)
OPEN CANOPY POSITION (APPROX)
12° TYP
SMART BOMB
AIM-7
CHINE
AIM-7
GROUND



DESIGN CHARACTERISTICS

REFERENCE GEOMETRY

			WING	H. TAIL	V. TAIL	
L.E. SWEEP		deg	60		60	
AREA	S	ft²	200		17.5 EA	
DIHEDRAL	Γ	deg	0		–	
ASPECT RATIO	A		1.33		1.60	
TAPER RATIO	λ		.38		.25	
M.A.C.	c̄	ft	12.2		3.7	
INCIDENCE	i	deg	0		0	
THICKNESS RATIO	t/c		SEE PLOT		.05	
TAIL VOLUME COEF	V̄		–		.06	
AIRFOIL SECTION			TR 38 MOD		BI-CONVEX	
L.E. FLAP AREA	S	ft²	20.3		–	
T.E. FLAP AREA	S	ft²	–		–	
L.E. FLAP DEFL.	δ	deg	30		–	
T.E. FLAP DEFL.	δ	deg	–		–	
CONTROL AREA	S	ft²	16.6		5.3/PN	
CONTROL DEFL.	δ	deg	±20		±20	
TWIST					–	
EXPOSED AREA		ft²				

WEIGHT SUMMARY

LBS

STRUCTURE	2100	
PROPULSION	1480	
FIXED EQUIP	1620	
WEIGHT EMPTY	5200	
NON-EXP USEFUL LOAD	320	
OPERATING WEIGHT	5520	
FUEL	2400	
PAYLOAD	380	
GROSS WT (LBS)	8300	

WETTED

WING GROSS
BODY STRAKE
WING WETTED
EXP WETTED
AERO BODY
EXPOSED WING
EXP HORIZ
EXP VERTICAL
TOTAL AERO

DESIGN NOTES

POWER PLANT 1 AFSI TECHNOLOGY ENGINE (FWE 9005), 49 SCALE,

INLET 1 2 DIMENSIONAL HORIZONTAL RAMP, A_{cap} = 1.34 ft²

SKID LANDING GEAR 1 MAIN – ( ) ___ x ___ : ___ PLY, ___ PSI ;
NOSE – ( ) ___ x ___ : ___ PLY; ___ PSI ;

ARMAMENT (INTERNAL) 1 (1) ADVANCED 21 mm TWIN BARREL, DOUBLE ENDED, (HYDRAULIC) GUN w/ 300 rds CASELESS AMMO
(2) ADVANCED LOW COST DOGFIGHT MISSILES (LC

[1] NOSE VOLUME OF 4 ft³ ADEQUATE FOR PROJECTED AIR-TO-A ELECTRO-OPTICAL SENSOR MODULE (e.g. LASER SEEKER, ANGLE SYSTEM, OPTICAL CORRELATOR)

INCHES

FI

DESIGN CHARACTERISTICS

[illegible] GEOMETRY

			WING		H. TAIL	V. TAIL	
[illegible]		deg	60			60	
[illegible]	S	ft²	200			125 EA	
[illegible]	Γ	deg	0			—	
[illegible]	AR		133			160	
[illegible]	λ		38			25	
[illegible]	b	ft	122			3.7	
[illegible]	i	deg	0			0	
[illegible]	t/c		SEE PLOT			.05	
[illegible]	V̄		—			.86	
[illegible]			TP 38 MOD			BI-CONVEX	
FLAP AREA	S	ft²	20.3			—	
FLAP AREA	S	ft²	—			—	
FLAP DEFL.	δ	deg	30			—	
FLAP DEFL.	δ	deg	—			—	
[illegible] AREA	S	ft²	16.6			5.3/FIN	
[illegible] DEFL.	δ	deg	±20			±20	
[illegible]						—	
[illegible] AREA		ft²					

WEIGHT SUMMARY (LBS)

STRUCTURE	2100	
PROPULSION	1480	
[illegible] EQUIP	1620	
WEIGHT EMPTY	5200	
[illegible] USEFUL LOAD	320	
OPERATING WEIGHT	5520	
[illegible]	2400	
[illegible] LOAD	380	
[illegible] WT (LBS)	8300	

WETTED AREA (FT²) / AERO REF.

			[illegible]
WING [illegible]	60°		
BODY [illegible]	280		
WING [illegible]	-26		
EMP [illegible]	0		
AERO BODY	254		
EXPOSED WING	316		
EXP HORZ	0		
EXP VERTICAL	70		
TOTAL AERO	640		

DESIGN NOTES

[illegible] PLANT : 1 [illegible] TECHNOLOGY ENGINE ([illegible]), [illegible] SCALE, [illegible] LB A/B SLST

[illegible] : 2 DIMENSIONAL HORIZONTAL RAMP, A_{cap} = [illegible] ft²

[illegible] : [illegible] – ( ) ___ x ___ ; ___ PLY ; ______ PSI ; ______ MPH
NOSE – ( ) ___ x ___ ; ___ PLY ; ______ PSI ; ______ MPH

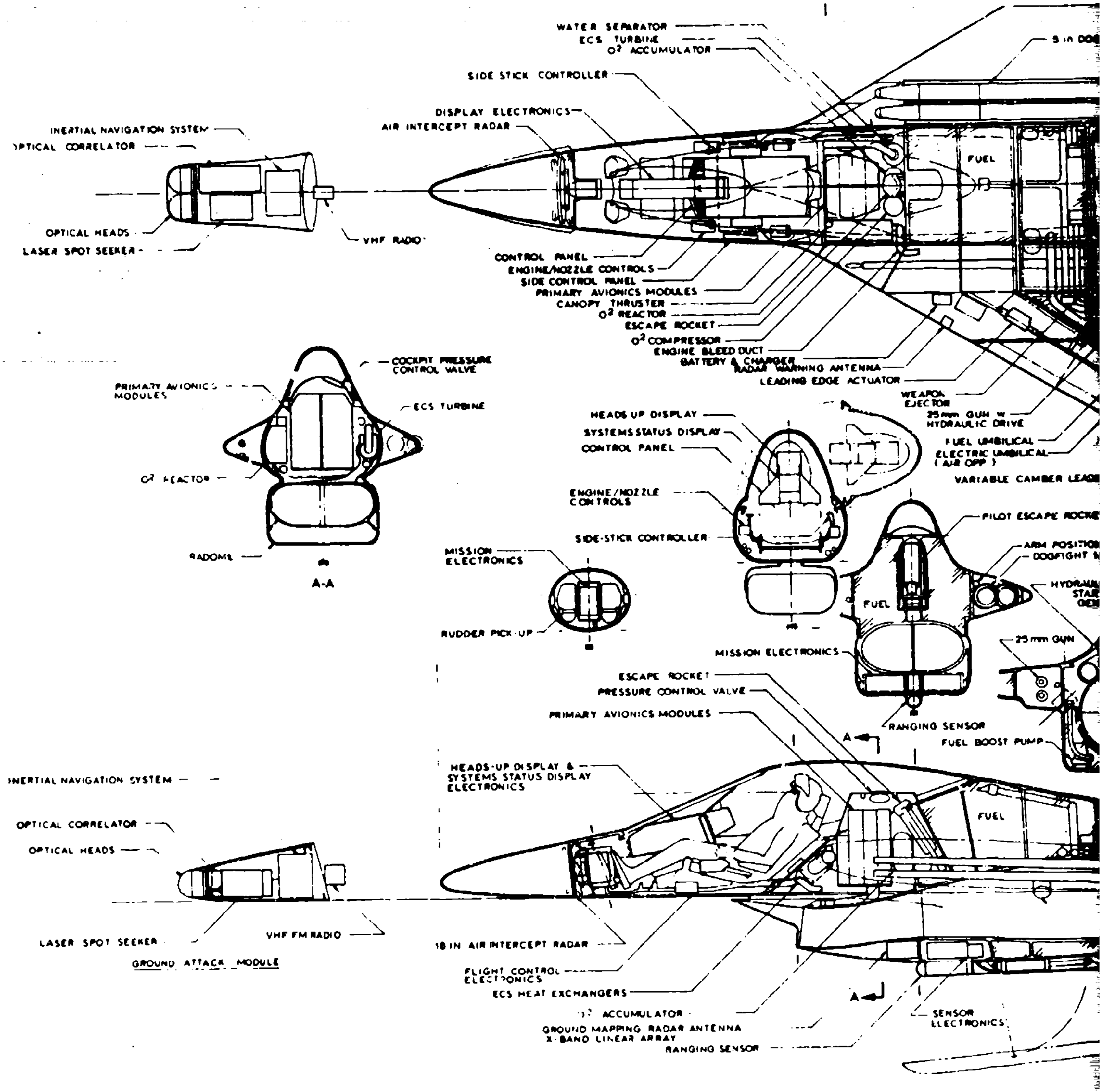
[illegible] : (1) ADVANCED 25mm TWIN BARREL, DOUBLE ENDED, EXTERNALLY POWERED (HYDRAULIC) GUN w/ 300 rds CASELESS AMMUNITION
(2) ADVANCED LOW COST DOGFIGHT MISSILES (LCDM), TUBE LAUNCHED

[illegible] VOLUME OF 4 ft³ ADEQUATE FOR PROJECTED AIR-TO-GROUND MISSION ELECTRO-OPTICAL SENSOR MODULE (e.g. LASER SEEKER, ANGLE RATE BOMBING SYSTEM, OPTICAL CORRELATOR)

0 — 30
INCHES

Figure 41 : Gen. Arrangement 1985 Point Design (U)

1


WATER SEPARATOR
ECS TURBINE
O^2 ACCUMULATOR
SIDE STICK CONTROLLER
DISPLAY ELECTRONICS
AIR INTERCEPT RADAR
INERTIAL NAVIGATION SYSTEM
OPTICAL CORRELATOR
OPTICAL HEADS
LASER SPOT SEEKER
VHF RADIO
FUEL
CONTROL PANEL
ENGINE/NOZZLE CONTROLS
SIDE CONTROL PANEL
PRIMARY AVIONICS MODULES
CANOPY THRUSTER
O^2 REACTOR
ESCAPE ROCKET
O^2 COMPRESSOR
ENGINE BLEED DUCT
BATTERY & CHARGER
RADAR WARNING ANTENNA
LEADING EDGE ACTUATOR
WEAPON EJECTOR
25mm GUN w HYDRAULIC DRIVE
FUEL UMBILICAL
ELECTRIC UMBILICAL (AIR OPP)
COCKPIT PRESSURE CONTROL VALVE
PRIMARY AVIONICS MODULES
ECS TURBINE
O^2 REACTOR
RADOME
A-A
HEADS UP DISPLAY
SYSTEMS STATUS DISPLAY
CONTROL PANEL
ENGINE/NOZZLE CONTROLS
SIDE-STICK CONTROLLER
MISSION ELECTRONICS
RUDDER PICK-UP
PILOT ESCAPE ROCKET
FUEL
MISSION ELECTRONICS
25mm GUN
RANGING SENSOR
FUEL BOOST PUMP
ESCAPE ROCKET
PRESSURE CONTROL VALVE
PRIMARY AVIONICS MODULES
HEADS-UP DISPLAY & SYSTEMS STATUS DISPLAY ELECTRONICS
INERTIAL NAVIGATION SYSTEM
OPTICAL CORRELATOR
OPTICAL HEADS
LASER SPOT SEEKER
VHF FM RADIO
GROUND ATTACK MODULE
18 IN AIR INTERCEPT RADAR
FLIGHT CONTROL ELECTRONICS
ECS HEAT EXCHANGERS
O^2 ACCUMULATOR
GROUND MAPPING RADAR ANTENNA X-BAND LINEAR ARRAY
RANGING SENSOR
SENSOR ELECTRONICS
A
A

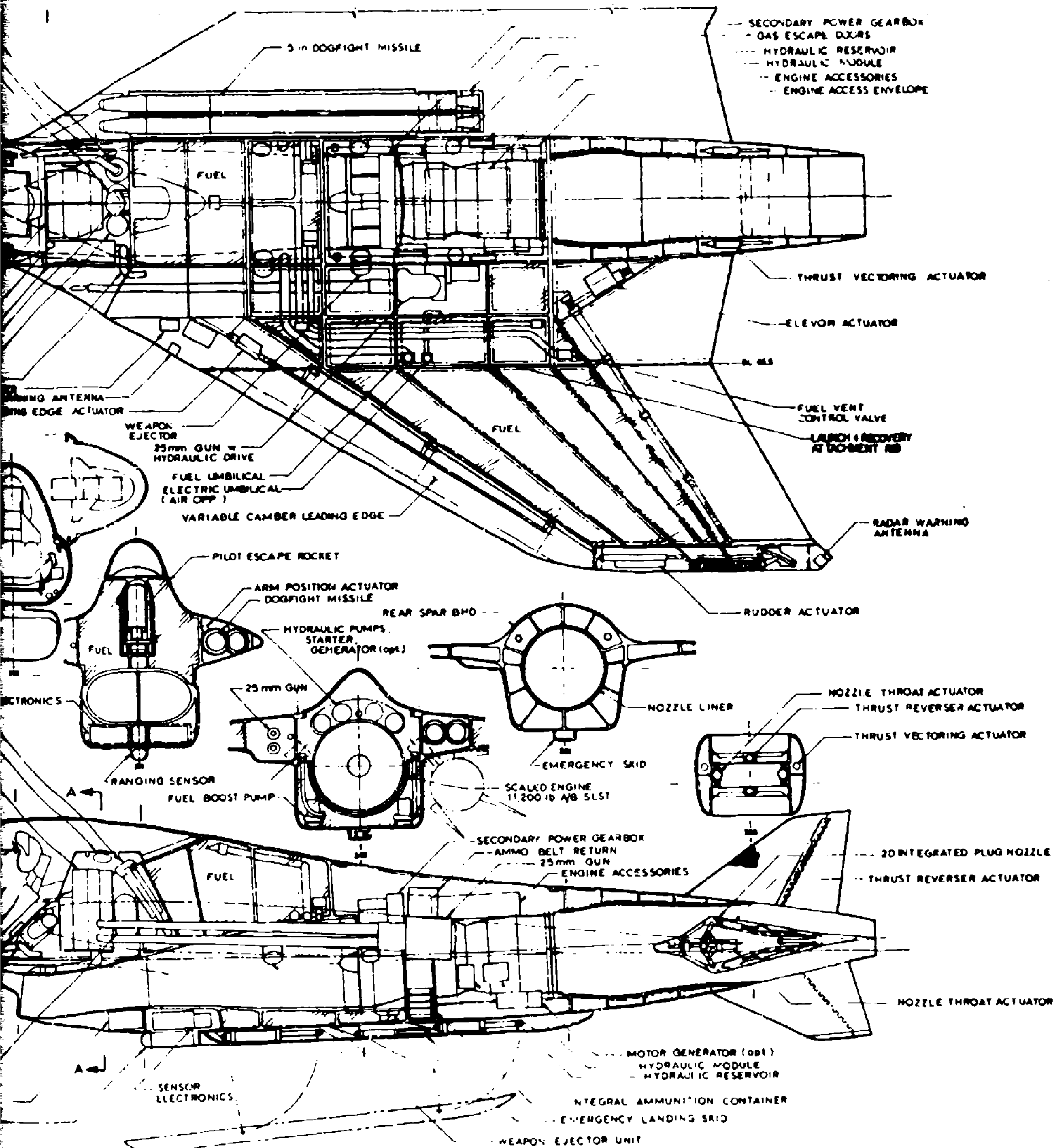


Figure 42 : Inboard Profile 1985 Point Design (U)

(U) o Extensive use of advanced composite and metallic structure.

o A smaller, advanced cycle engine resulting from past aircraft propulsion subsystem integration (APSI) studies.

Gun

(U) A gun system using 25 mm caseless, GAU-7 type ammunition was chosen for the 1980 Micro-fighter. Due to weight and volume constraints, a two barrel external drive gun concept by Hughes Tool Co., Aircraft Division was selected.

Advanced Short Range Missile

(U) Two internally carried, tube launched, dog-fight missiles are postulated for the 1980 Micro-fighter. A wingless configuration with vectored rocket thrust for high maneuverability and a body diameter similar to AIM-9 or Zuni is considered feasible. Missile exhaust gases are ducted overboard (open tube launch). Look-before-launch capability is provided by projecting the missiles guidance section through the wing leading edge frangible ports.

External Stores

a. Strike Mission

(U) Two 1765 lb. "Smart bombs"have been chosen for the primary air-to-ground mission. A folding fin derivative of this modular weapon is shown carried tangent at the wing-body intersection. Additional weapon carriage hard points are provided under each wing just inboard of B.L.46.5 to accommodate a variety of weapons. Potential performance gains resulting from wing-body intersection stores carriage should be evaluated during external store development and/or selection for the advanced technology Micro-fighter.

(U) Because of mothership launch bay and storage bay clearance restrictions, lower body, corner mounted, finned weapons and lower body tangent stores have been excluded.

b. Air Intercept Mission

(U) Two AIM-7F Sparrow Missiles, carried on wing pylons were selected. the performance characteristics of this developmental missile are compatible with those assumed in the operational analysis of the intercept mission.

c. ECM & Reconnaissance Missions

(C) Although detailed analyses of the equipment requirements for these missions were not completed during this study, coordination with suppliers in both fields indicates that their advanced ECM & RECON Equipment will be pod mounted. The wing pylons will be used to carry these pods. The selection of deception ECM is an exception to pod carriage. Track breaking ECM electronics is packaged in the lower body avionics bay of Model 985-121.

Mission Modules

(U) The 1980 technology Micro-fighter configuration allows two volumes to be dedicated to modularized mission avionics:

1) Aircraft nose. Volume = 4 ft^3.

2) Lower lip of engine inlet. Volume = 3.5 ft^3.

With few exceptions, all avionic components of the mission system modules are accommodated in these volumes. In addition to necessary cockpit volume for controls & displays, limited volume is available in the wing leading edge between flap actuators and gun/missile bays for component installation (e.g. antennas).

(U) Figure 42, Model 985-121 inboard profile, shows the installation concept for major system components.

6.2 WEIGHT AND BALANCE

(U) Mass properties are estimated on Table I, for the Point Design Micro-fighter (Model 985-121). Weight and balance are predicted for the design as drawn, Figure 41.

6.3 PERFORMANCE

(U) The 1980 version of the Arrow MF is similar to the 1975 version but includes some configuration and structural changes that result in slightly different aerodynamic characteristics and considerably less weight. The changes which influence the aerodynamics were principly the thicker wing root sections, the reduced volume and shortened fuselage and the internal carriage of the two air defense missiles replacing the external AIM-9's of the 1975 version. At most operating regimes these changes tended to favor the -121.

(C) The advanced engine chosen for this future application was a turbofan investigated during earlier APSI/ATEGG studies. The engine was sized to provide a 1.4 thrust to weight at 8,000 lbs MF weight.

Table I: Group Weight Statement

FLT. DES. WT. = 7920 LBS n = 6.5 @ FLT. DES. WT.	WEIGHT (LBS)	HORIZONTAL ARM (BSTA)	
WING	630	263	
HORIZONTAL TAIL	-	-	
VERTICAL TAIL	180	354	
BODY & STRAKE	940	222	
SINGLE SKID	190	247	
NACELLE OR ENG SECTION	40	283	
AIR INDUCTION	120	193	
STRUCTURE	(2100)	(247.4)	
ENGINE + A/B + NOZZLE	1240	297	
ENGINE ACCESSORIES	40	267	
FUEL SYSTEM	120	239	
ENGINE CONTROLS	50	178	
STARTING SYSTEM	30	244	
PROPULSION	(1480)	(286.4)	
AUXILIARY POWER UNIT	-	-	
INSTRUMENTS & NAV EQUIP	70	120	
SURFACE CONTROLS	240	315	
HYDRAULIC/PNEUMATIC	80	310	
ELECTRICAL	240	210	
AVIONICS	280	100	
ARMAMENT	30	175	
FURNISHINGS & EQUIP	180	143	
AIR COND & ANTI-ICING	130	185	
AUXILIARY GEAR	20	230	
RADAR REFLECTIVITY RED.	-	-	
GUN AND PROVISIONS	350	253	
FIXED EQUIPMENT	(1620)	(207.0)	
WEIGHT EMPTY	5200	245.9	
CREW	200	138	
CREW PROVISIONS	10	138	
OIL & TRAPPED OIL	20	253	
UNAVAILABLE FUEL	30	237	
PAYLOAD PROVISIONS	60	235	
WEAPON BAY FUEL PROV	-	-	
NON-EXP USEFUL LOAD	(320)	(172.7)	
OPERATING WEIGHT	5520	241.7	31.2% MAC
AMMO (300 RNDS, 25mm)	280	258	
MISSILE (LCDM)(2)	200	232	
PAYLOAD (INCL EXP PEN AIDS)	-	-	
FUEL-WING	1200	262	
FUEL-BODY	1200	212	
GROSS WEIGHT	8400	240.7	30.5% MAC

NOSE AT BS 40
LEMAC AT BS 196.0
MAC LENGTH = 146.4 IN.
WLM 7/1973

"ARROW"
MICRO-FIGHTER
985-121

(C) Figure 43 shows the T/W and W/S required for maneuver at .9M and 20,000 ft. The T/W is adequate to meet the requirements of the 5 G maneuver condition, with the two 1,750 lb. strike weapons included. In the clean configuration sustained maneuver is superior to advanced fighter threats capable of 7g's at the condition shown.

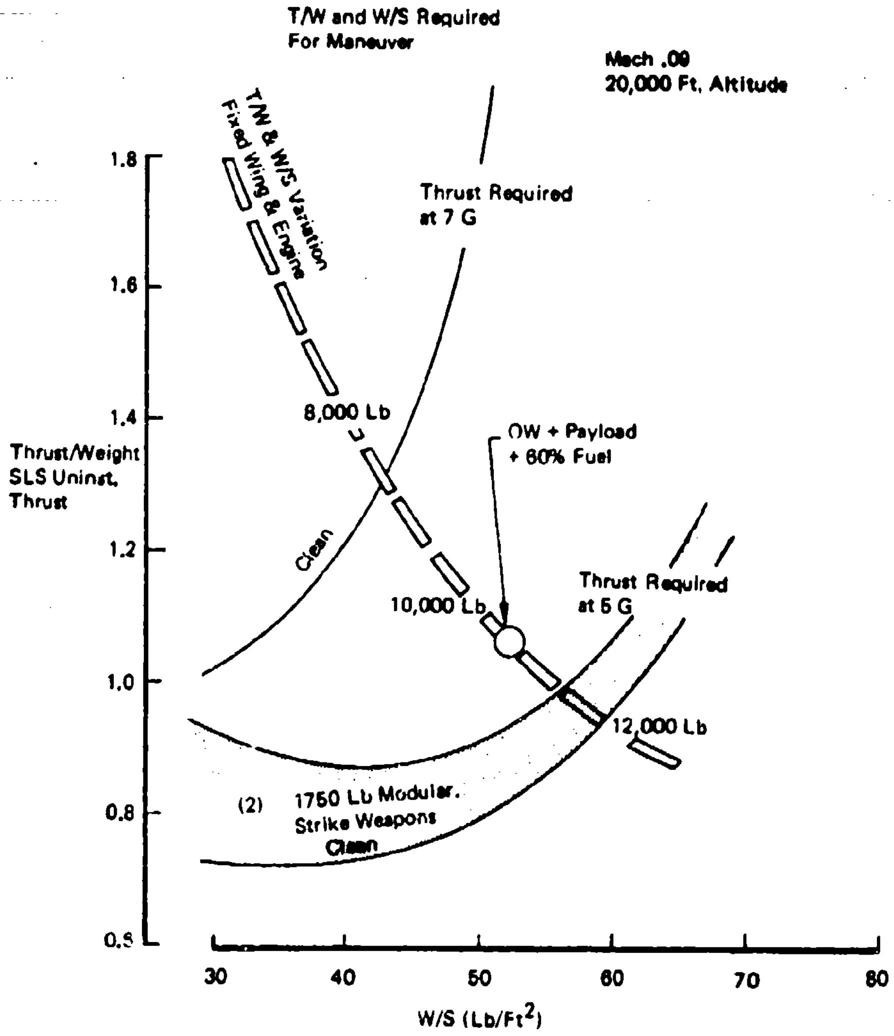
(C) The flight envelope for the 985-121 with maximum thrust is shown on Figure 44 and indicates that the aircraft can engage in air-to-air combat up to an altitude of 50,000 feet and speeds up to Mach 2.0.

(C) The intercept mission seen on Figure 45 starts with the launch at 30,000 ft. and .8 Mach. The intercept radius of 150 nautical miles is performed in approximately 10 minutes from launch.

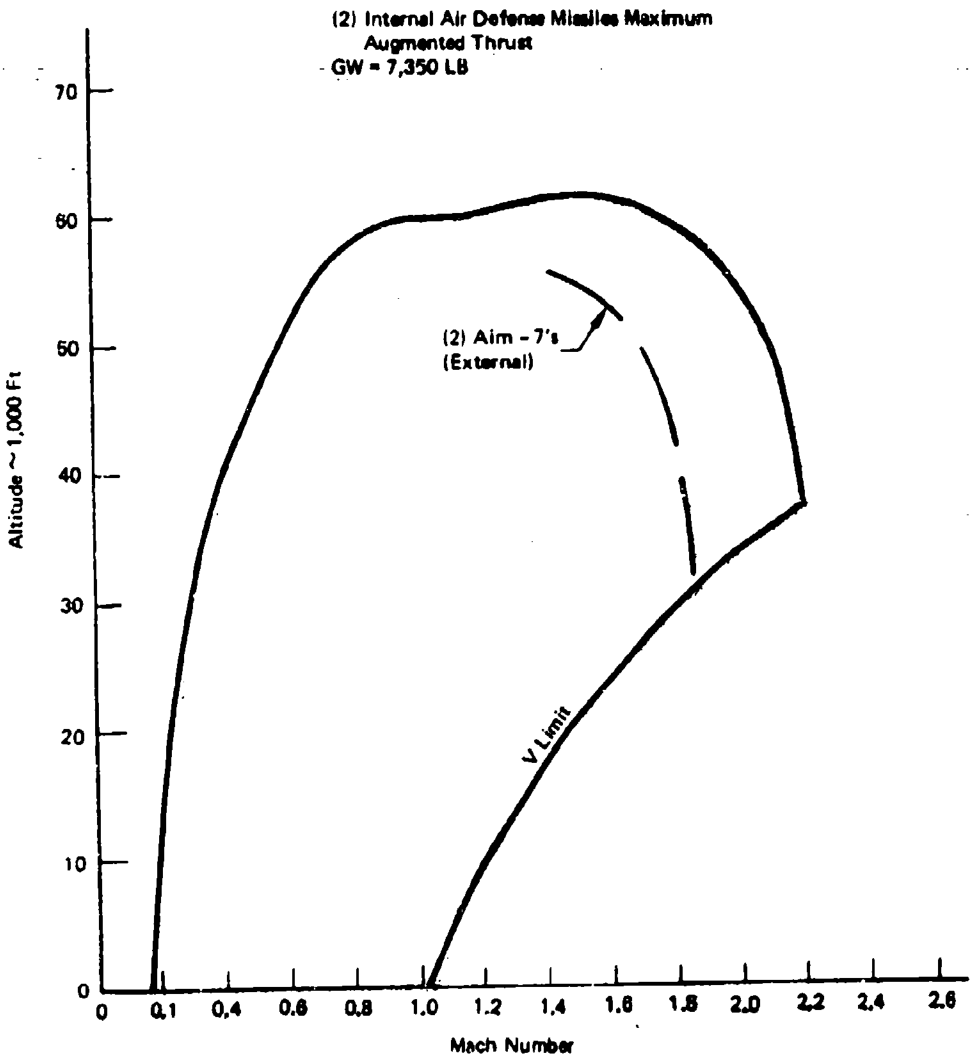
(C) Strike mission performance carrying 2 advanced modularized weapons is shown on Figure 46. The drag of this weapon installation is about 75% of that for 2 MK84L's because they are well integrated into the airplane configuration.

(C) The air-to-air mission has a subsonic outbound and inbound cruise with a combat segment in the middle. Figure 47 shows the combat turns available at several Mach-altitude combinations vs. missions radius. The combat turns available consider the fuel penalty of accelerating from cruise to the combat speed. At a mission radius of 350 miles approximately 10 full 360° turns at maximum thrust at the transonic speeds typical of the air-to-air encounters are achieved.

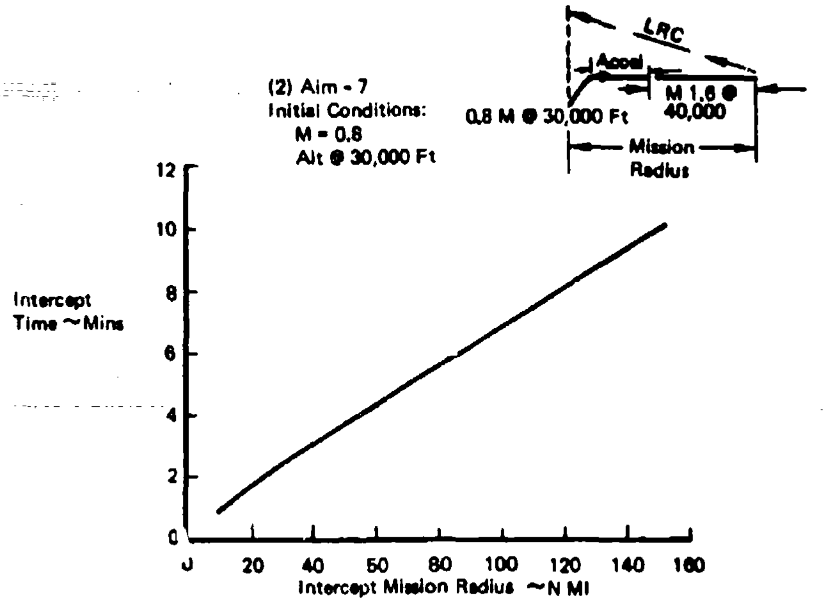
(C) Some of the changes incorporated in the -121, relative to the baseline model -20, have a negative influence on the high speed performance. The shorter fuselage and the thicker wing root both result in additional wave drag. However, the airplane can still achieve Mach 2.2 in the air-to-air configuration, since the air defense missiles are carried internally. The dashed lines on Figure 44 show the speed penalty for carrying two AIM-7's on underwing pylons to be approximately .3 to .4 Mach. This penalty results because the MF is a very small airplane and even though the AIM-7 is relatively clean aerodynamicaly, it is large and difficult to attach to the airplane in a low drag configuration. Much of this penalty could be avoided if the weapon were designed with folding or retracting fins allowing the missiles to be carried tangentially.



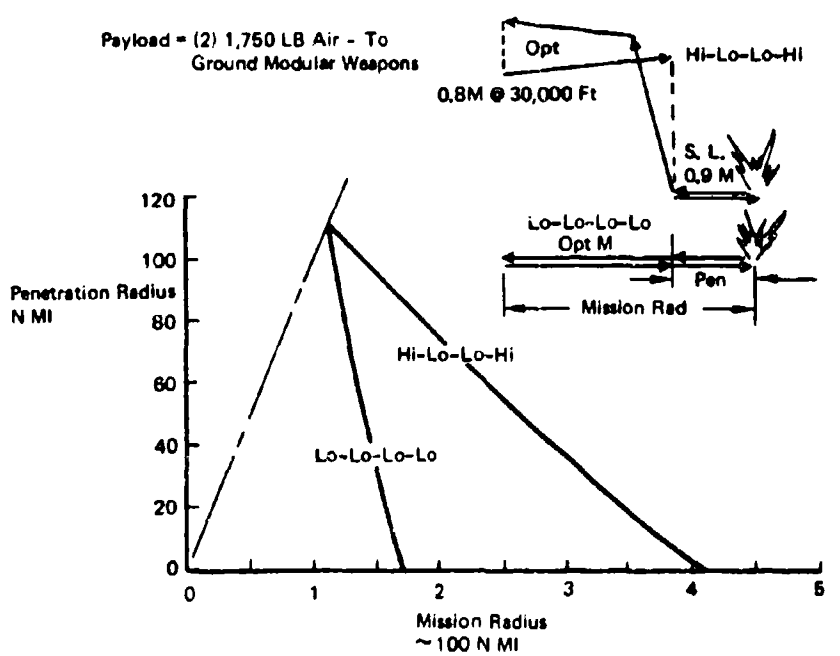
(C) Figure 43: Maneuver Performance Point Design (U)



(C) Figure 44: Flight envelope (U)

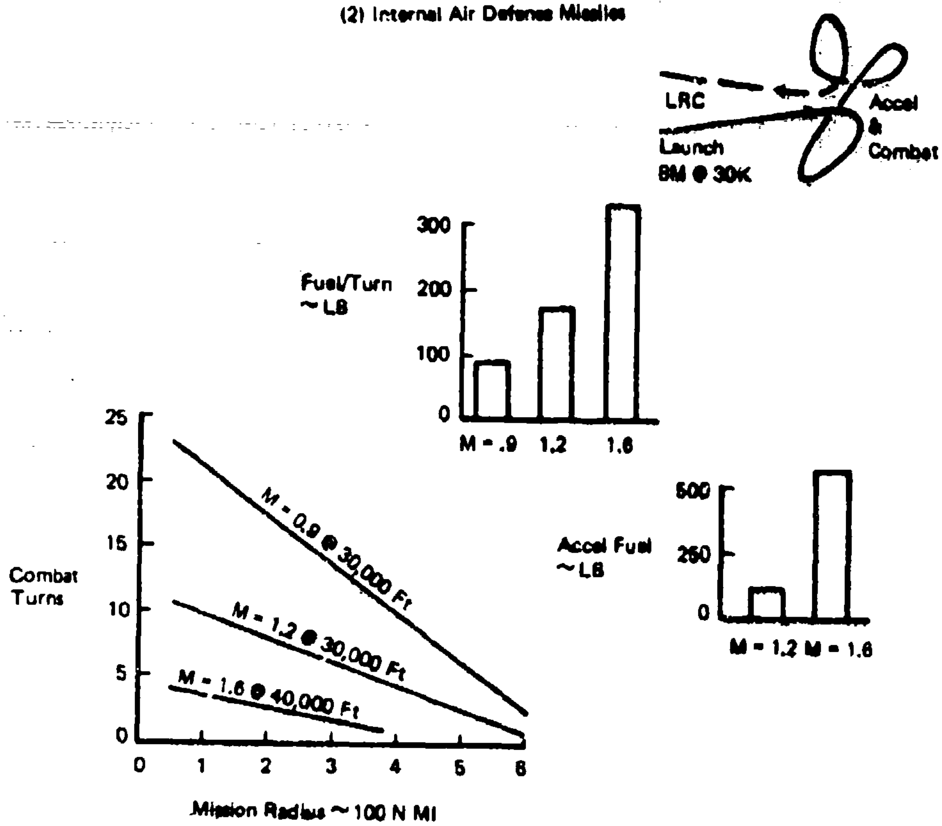


(C) Figure 45: Intercept Mission (U)



(C) Figure 46: Strike Mission, Point Design (U)

(2) Internal Air Defense Missiles



(C) Figure 47: Air to Air Mission (U)

6.4 STABILITY AND CONTROL

(U) Predicted lift curve slope and aerodynamic center are shown on Figure 48. DATCOM methods were used, for the basic wing-body characteristics, in conjunction with NACA TN 2229 for tip plate effects. The most forward aerodynamic center is at 42% MAC. Therefore, for zero static margins the aft c.g. limit is at 42% MAC. At present the actual aft c.g. is almost 11% ahead of this point. The c.g. envelope requirements will be firmed up after wind tunnel testing.

(U) Directional stability is shown in Figure 49. The airplane will be stable throughout the Mach-angle of attack range. At supersonic speeds, loss of stability due to angle of attack is minimized because the vertical tails are mounted on the wing tips and do not experience the dynamic pressure loss typical of center mounted tails.

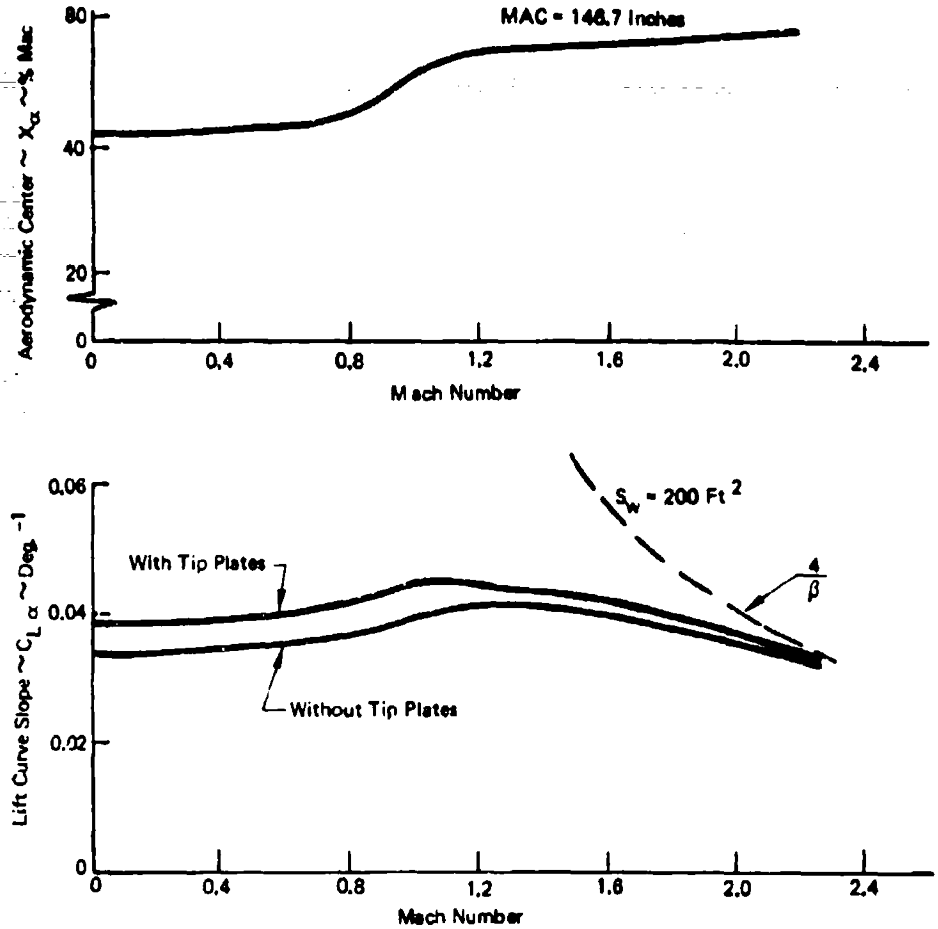


Figure 48: Longitudinal Aerodynamic Characteristics (U)

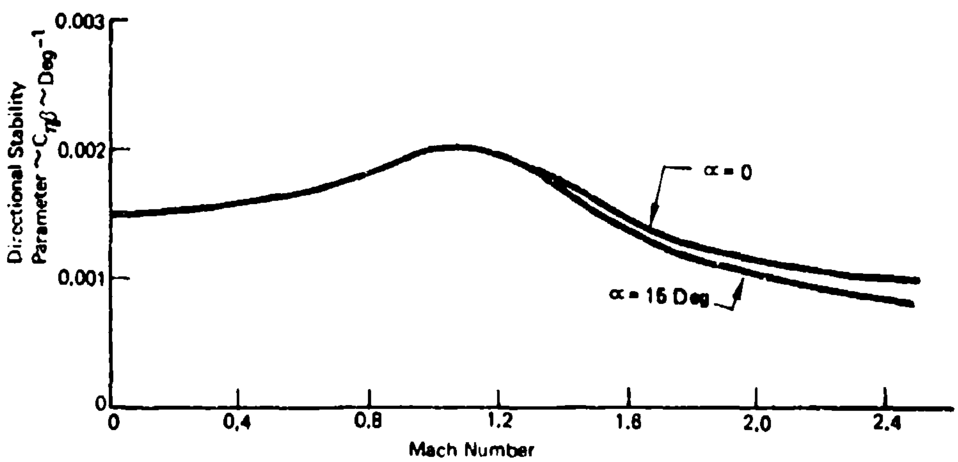


Figure 49: Directional Stability

7.0 MF/AAC SYSTEM CONCEPTS – 1975 AND 1980 TECHNOLOGY

7.1 MULTI-PURPOSE STRIKE SYSTEM CONCEPT (MPSS)

(U) To project applications of the MF/AAC concept to operational employment additional system elements must be recognized. The AAC shows best capability if assigned to carry, recover and turnaround its fighter elements. Command and control is best handled by AWACS. Global deployment will benefit from in-flight refueling of the AAC and AWACS.

<u>1975 Technology - System Concept</u>

(C) A 1980 IOC Multi-Purpose Strike System (MPSS) would best employ 10 747 AAC + 1 747 AWACS. This complement provides 100 fighters (approximately 4 squadrons) for deployment to Europe in 8 hrs. from alert - on station and ready for combat with fighter crews rested and briefed. Twenty percent of the fighters would be configured for fleet air defense against all threats up to Mach 3.0. The remaining 80 percent could be configured for CAP, Recci, Recci Strike or CAS from stores and provisions on each AAC.

(C) With 200,000 lbs. expendable load the 1980 IOC AAC could remain on station 4-1/2 hrs. at 2,600 n.mi. radius while each of the fighters operate for 3 or 4 sorties over combat radii from 100 to 250 n.mi. Global deployment could be accomplished with 747 tankers for each AAC and AWAC. Global coverage from U.S. Bases requires one refueling and 17 hrs. to reach the farthest air launch station near conflicts.

(C) The 747 AWAC/Command Ship (AWAC/C) is envisioned as best for the MPSS because it has the range, endurance and payload capability to best match the 747 AAC while performing the Recci task in addition to the AWACS task now performed by the E-3A.

(C) The 747 AWAC/C would incorporate some of the modifications common to the AAC. Two launch and recovery bays would carry two Micro-fighters configured for reconnaissance. Other Recci-fighters from the AAC fleet could be brought aboard for transfer of intelligence data. On-board processing of photo recon data would be included in the 747 AWAC/C. This would allow rapid decision making and early briefing of all Micro-fighter crews by video.

(C) This Multi-Purpose Strike System would include a complement of 525 men. Expendable weapons would amount to approximately 1,200.000 lbs. for each deployment. Table II shows the nominal breakout for the force if 20% of all fighters are dedicated to fleet air defense. Currently programmed systems do not have this self contained force capability.

(C) Table II: Expendables - Multipurpose Strike System

WEAPONS	WEAPONS/FTR. *	WPNS/AAC	WPNS/MPSS FORCE
20 MM Ammo (Rounds)	1200	12,000	120,000
2,000 lb. Mod Munition	6	48	480
Air Intercept Missiles (Aim-7F Type)	6	18	180
Air to Air Missile (AIM-9E Type)	6	60	600

* 3 Sorties per MF
80% Configured for Air/Ground
20% Configured for Air Intercept.

1980 Technology System Concept

(C) The projected 1985 IOC system employs a growth 747 AAC with take off weight equal to 1,200,000 lbs. Each carrier is capable of carrying 14 Advanced Micro-fighters and weapon loads for three sorties each. Modular munition development is projected to provide guided bombs in the 1,500 lb. class with lehtality equal to the 2,000 lb. bombs of today.

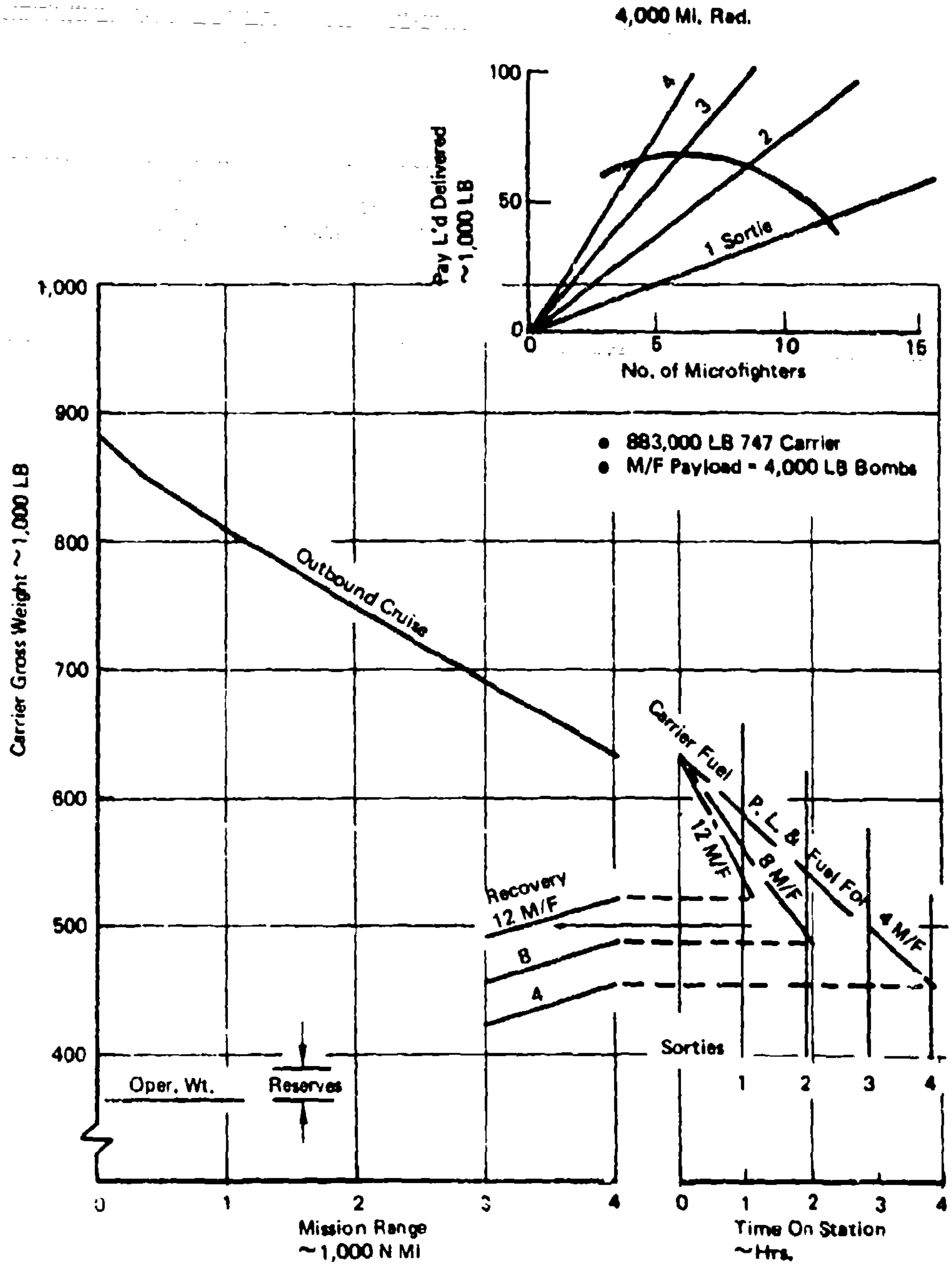
7.2 FIGHTER/CARRIER MATCHING

7.2.2.1 Fighter/Carrier Performance

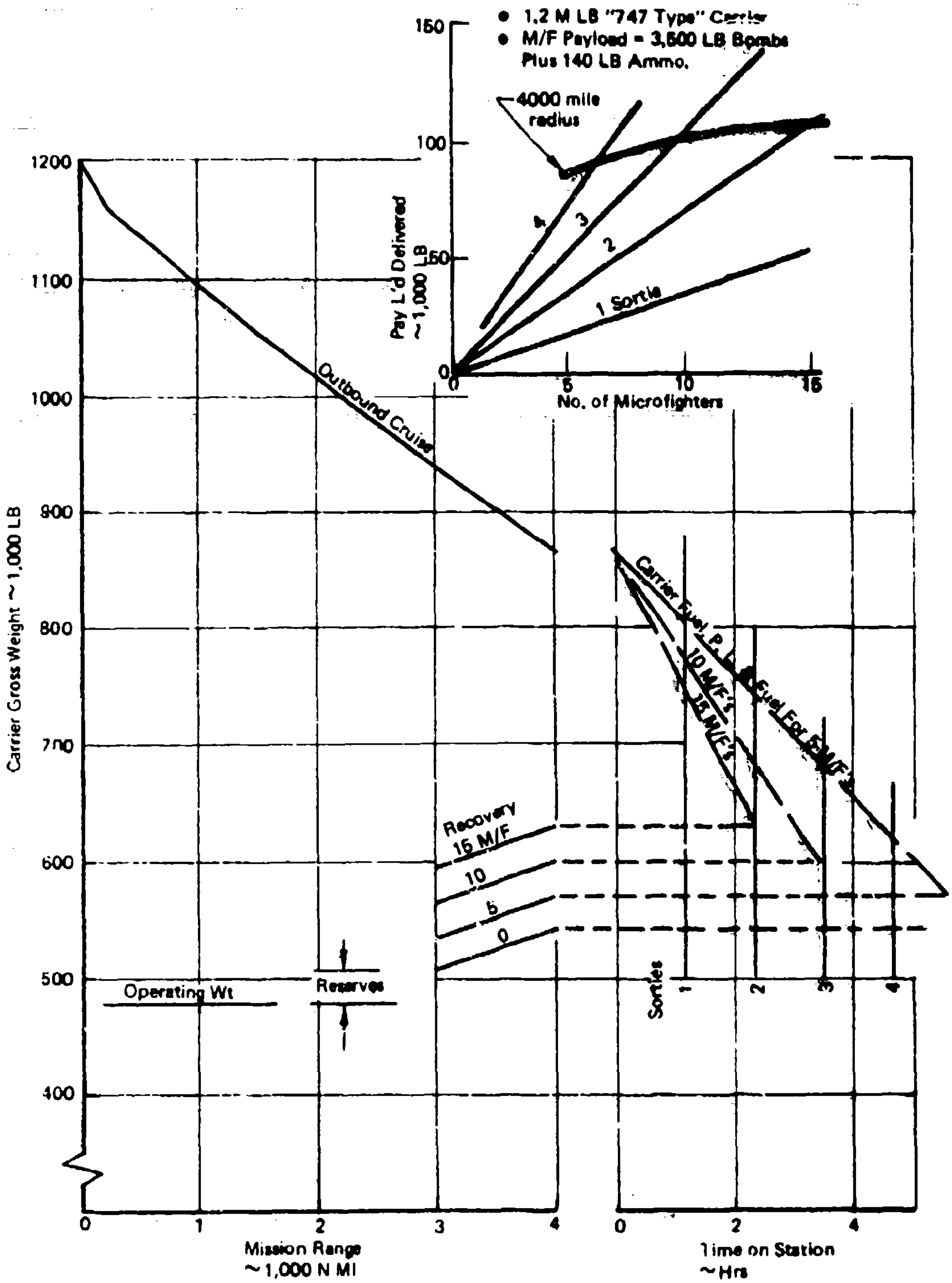
(C) The impact of the fighter on the carrier and the carrier on the fighter is shown on Figure 50. With an expendable load of 200,000 lbs., the 747 carrier can cruise outbound 4,000 n.mi., remain on combat station from 1 to 3.6 hours, depending on Micro-fighter complement, and return 1,000 n.mi. The effect of Micro-fighter complement size on payload delivered to the target is included on Figure 50. An optimum number of fighters for a given mission can be selected by trading the carrier on-station fuel against the rate that payload is delivered, the rate Micro-fighters use fuel, and the empty weight of the Micro-fighter complement. This Micro-fighter complement trade indicates that the optimum number of fighters for the ground attack mission is between 6 and 8. With a hangar capacity of 10, at least two Micro-fighters are available for carrier defense.

7.2.2 Fighter Carrier Matching - 1980 Technology

(c) When the 1985 IOC Micro-fighter is teamed with an advanced carrier of increased capabilities, system performance like that shown on Figure 51 can be projected. In this case, a 1.2 million lb. growth version of the 747 is shown deploying a variable number of MF's at a distance of 4,000 n.mi. The payload to the target provided by varying numbers of MF's flying multiple sorties is shown: At 4,000 n.mi. radius, over 100,000 lbs. of payload can be delivered with 10 MF's flying 3 sorties each. The expended load at 4,000 n.mi. is approximately 300,000 lbs. A typical strike mission of 40 n.mi. sea level dash and 210 n.mi. cruise (see Figure 46) carrying (2) 1,750 lb. weapons was the basis for the plots.



(C) Figure 50: Fighter Carrier Matching 1975 Technology (U)



(C) Figure 51: Fighter/Carrier Matching 1980 Technology (U)

8.0 CONCLUSIONS & RECOMMENDATIONS

(U) This study has uncovered many questions, which require answers beyond the scope of this effort. Most of the conclusions are qualitative because of the limited depth of the study. The real payoff relative to current concepts needs to be explored. Any comparison study rapidly involves other parts of the system and supporting systems - because the MF/AAC is part of a totally new concept of operations. The system (referred to here as the Multi-Purpose Strike System) is an airborne version of the U.S. Navy's seaborne strike force. Self contained completely for the duration of operations away from its home base.

8.1 CONCLUSIONS

(U) The concept of a Micro-fighter/Airborne Aircraft Carrier is technically feasible and could be operational by 1980 with emerging technology. Operational feasibility requires technology demonstrations of air launch and recovery and on-board handling of the fighters.

(C) The system concept offers the potential of great national benefit in a political world that leans toward a low profile American exposure overseas while being responsive to diverse needs of our allies.

System Potential

(C) Qualitative evaluation of the system indicates the following potential.

1. Same day response to any part of the world, ready for combat.
2. Smaller lower cost combat vehicles.
3. Deployment as an Airborne Strike Force or a CONUS Air Defense System.
4. Reduced manpower requirements through available technology and reduction of overseas bases. Less than 1/2 the manpower now required for a CASF Squadron.
5. A concept of operation that provides an alternative to V/STOL fighters in the combat theatre.
6. A rapid deployment strike force that supports itself and protects itself in combat, without large stockpiles of prepositioned equipment and manpower.
7. 1980 Initial Operating Capability from emerging technology (1975) and current technology demonstrator programs.

(C)

8. Deployment of a strike force by Airborne Aircraft Carrier is more effective than deployment by air transport only.

9. In-flight rearming and fighter turnaround to minimize time enroute to combat.

Airborne Aircraft Carrier (AAC)

(U) Airborne Aircraft Carriers can be developed from current large aircraft, either the C-5A or the 747F. The present feasibility study has identified the following characteristics as desireable for airborne aircraft carriers.

1. Payload capability should allow a maximum number of Micro-fighters to be carried, consistent with spotting density and critical weight and balance.

2. Dual launch and recovery capability for redundancy and minimum launch cycle time.

3. Inflight refueling available at both launch and recovery stations to refuel fighters at recovery and to provide refueling for other aircraft.

4. Speed and altitude capability for recovery of overloaded fighter, M = .8 and 30,000 ft.

5. Performance versatility for launch and recovery in clear air without contrails.

6. Carrier versatility to operate, in other roles. Alternate applications include: cargo carrier, tanker, troop transport, Micro-fighter transporter.

7. On-board rearming and turnaround servicing to allow multiple sortie ility from each fighter!

8. Pressurized hanger and work areas with air-lock compartments for launch and recovery.

(U) No unique technology development has been identified for Airborne Aircraft Carrier. Demonstration of capability is possible within the current state-of-the-art. The 747F best meets these requirements.

8.2 RECOMMENDATIONS

(U) Further research is recommended to develop a basis for developmental decisions regarding this concept of operation.

1. Wind tunnel test of the Point Design model to better determine the aerodynamic characteristics over the full flight envelope and in the aerodynamic influence of the airborne aircraft carrier. Initial testing should measure interference effects at each event during the recovery.
2. Research launch and recovery dynamics with pilot in the loop simulation employing characteristics of the Point Design Micro-fighter and 747.
3. Design studies to identify more detailed requirements for on-board handling of fighters for rearming, servicing, and aircraft transfer within the carrier.
4. Preliminary design studies of modifications to 747 carrier airframe for demonstration of airborne launch and recovery.

9.0 REFERENCES

1. D180-17538-4, "Micro-Fighter Operational Analysis," Sept. 1973, The Boeing Company (Secret-NF).*

2. D180-15147-1, Vol. I - Final Report, "Air Vehicle Mission Evaluation for Advanced Engine Development Program," Oct. 1972, The Boeing Company (Confidential). *

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13. ABSTRACT

(U) The report presents the results of an exploratory investigation to determine the size, performance and feasibility of a Micro-fighter design such that a number of vehicles could be transported or air launched and recovered by a C-5 class carrier aircraft. Emphasis was placed on; identification of potential applications and requirements for a Micro-fighter airborne aircraft carrier system, determination of technology requirements for airborne launch and recovery and the technology requirements for airborne launch and recovery and the technology requirements for the Micro-fighter. The scope of investigation included evaluation of five fighter concepts and two carrier aircraft. Trade studies were performed to assess launch and recovery schemes and technology applications. Evaluation led to the definition of 1980 IOC and 1985 IOC concepts for Micro-fighter Airborne Aircraft Carrier Systems.

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(... to unclassified)

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Security Classification

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	ROLE	WT	ROLE	WT	ROLE	WT
PARASITE FIGHTER						
MICRO-FIGHTER						
AIRBORNE AIRCRAFT CARRIER						
1980 AIRPLANE TECHNOLOGY						
AIRBORNE LAUNCH & RECOVERY						

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S/N 0102-1050 ORIG. 8/71 PART 2 OF 3

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HEADQUARTERS 88TH AIR BASE WING (AFMC)
WRIGHT-PATTERSON AIR FORCE BASE OHIO

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8725 John J. Kingman Rd.
Ft. Belvoir VA 22060

25 July 2005

FROM: 88 CG/SCCM (FOIA Office)
Bldg 1455
3810 Communications Blvd
WPAFB OH 45433

SUBJECT: Freedom of Information Act (FOIA) Case, WPAFB FOIA Control # 05-422LC

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2. I am the point of contact and can be reached at (937) 522-3091 or DSN 672-3091.

Lynn Kane
Freedom of Information Act Analyst
Management Services Branch
Base Information Management Division

Attachment
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AFMC Form 556
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