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Contents

Nomenclature

ACSYNT	AirCraft SYNThesis aircraft design program
APU	Auxiliary Power Unit
ASTOVL	Advanced Short TakeOff and Vertical Landing
ATF	Advanced Tactical Fighter
BCAM	Best Cruise Altitude and Mach number
BPR	Bypass Ratio
CAP	Combat Air Patrol
CAS	Close Air Support
C_{Do}	Minimum drag coefficient at zero lift based on wing area
C_{Dwet}	Drag coefficient based on wetted area
CNA	Center for Naval Analyses
DLI	Deck Launched Intercept
DOC	Desired Operational Characteristics
FPR	Fan Pressure Ratio
HARM	High-speed Anti-Radiation Missile
LGB	Laser Guided Bomb
LRM	Long Range Missile
M	Mach number
Medium AW	Medium All-Weather attack aircraft
Medium FW	Medium Flying Wing attack aircraft
Medium IW	Medium Internal Weapons attack aircraft
MFVT	Mixed Flow/Vectored Thrust propulsion system
NASA	National Aeronautics and Space Administration
NFA	Naval Fighter/Attack aircraft
q	Dynamic Pressure, lb/ft^2
RAM	Radar Absorbing Material
RCS	Radar Cross Section
SEAD	Suppression of Enemy Air Defenses
SEP	Specific Excess Power (ft/sec)
SFC	Specific Fuel Consumption (lbf/(lbt*hr))
SRM	Short Range Missile
SSF	STOVL Strike Fighter
STOVL	Short TakeOff and Vertical Landing
TAD	Technology Availability Date
TOGW	TakeOff Gross Weight
T/W	Thrust to Weight ratio
US/UK ASTOVL	United States/United Kingdom ASTOVL Program

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Summary

This report describes a study of technology trends for several classes of tactical aircraft. Subsonic attack, supersonic fighter, and supersonic multimission classes were designed and then compared in terms of mission capability and fallout range performance. This approach used in this study emphasized consistency so that all aircraft classes can be directly compared in operational utility or cost analysis trends.

Land-based, sea-based, and Short Takeoff and Vertical Landing (STOVL) multimission aircraft were compared to evaluate the influence of technology and mission requirements and to address the impact of aircraft navalization. This study highlights the effect of changing requirements on the penalties associated with STOVL capability and addresses the penalties associated with carrier compatibility. Of course, STOVL and navalization (along with supersonic flight) weight penalties buy additional capability. In a low technology timeframe with no requirement to perform dry supersonic cruise, the STOVL aircraft without hover thrust augmentation was very heavy compared to a mission-equivalent land-based aircraft. However, with advanced technology and a dry supercruise requirement, the STOVL aircraft with little or no thrust augmentation in hover was much lighter, thus reducing the cost, risk, and/or weight penalties associated with STOVL. With advanced technology, the STOVL aircraft was lighter than the conventional Naval aircraft because the STOVL weight penalties were less than the penalties associated with carrier compatibility.

The subsonic attack aircraft evaluation compared flying wing to conventional designs, single- versus two-place crew, two versus four bombs, and internal versus external weapon carriage. Technology improvements had less effect on the attack aircraft than on the multi-mission aircraft, due primarily to the lower growth factor of subsonic aircraft. The addition of two more bombs had more impact on the takeoff gross weight than the addition of a second crewmember. Attack aircraft designs with internal weapons are lighter than those with external weapons, given the assumptions and estimates used in this study. This study also identifies the flying wing as the favored concept for attack aircraft and examines the impact of internal weapons carriage for attack aircraft. The flying wing aircraft was lighter than the other four-bomb aircraft mainly because of its reduced drag.

Section I – Introduction

The Center for Naval Analyses (CNA) evaluated the future of the carrier task force, including cost and flexibility of operations using different carrier types, tactical aircraft combinations, and operational philosophies. Their study also included different combinations of electronic warfare, anti-submarine warfare, and tactical aircraft, as well as nontraditional air vehicle concepts such as airships, unmanned aerial vehicles, and tilt-rotor tankers. The details of their study involved issues such as deck spotting factor, sortie rates, aircraft availability, mission effectiveness, and affordability. Their findings are reported in reference 1.

In support of the CNA future carrier study, NASA Ames Research Center conducted a conceptual aircraft design study to provide the CNA with a tactical aircraft database. The key to this study is that all of the aircraft were sized with consistent analysis methods, requirements, propulsion modelling, and technology/weight estimates. The study produced an aircraft database which supports evaluations of technology trends, requirement trends, cost, and operational utility. It includes the following data:

- Takeoff gross weight
- Maneuver performance
- Impact of cruise Mach number on Deck Launched Intercept (DLI) mission radius
- Impact of number of bombs carried on the Strike mission radius
- Impact of loiter time on the Combat Air Patrol (CAP) mission radius
- Fallout range on all SSF Desired Operational Characteristics (DOC) missions

Since the CNA was evaluating future carrier force trends, Ames provided them with aircraft developed in two technology timeframes. Mission requirements and aircraft technologies changed between these two timeframes. The first timeframe represents demonstrated technology levels and is referred to in this report as the 1990-TAD (Technology Availability Date) timeframe.[1] The second technology level, referred to as the 1995-TAD timeframe, uses higher thrust to weight ratio (T/W) engines and advanced materials technologies. Structural weight savings used in this study are conservative compared to those that were agreed upon during the United States/United Kingdom Advanced Short Takeoff and Vertical Landing (US/UK ASTOVL) program (ref. 2). The assumptions in that study (1986) were the consensus of what technology levels would be demonstrated by 1995. Additional requirements on the aircraft in the 1995-TAD timeframe are low observability (approximately ATF (Advanced Tactical Fighter)-level), nonafterburning supersonic cruise (dry supercruise), and increased maneuver capability. Aircraft using 1990-TAD assumptions have performance that could be expected if aircraft development were started today, while the 1995-TAD designs show what could be expected in the near future. The primary differences between these timeframes are:

- Engine technology
- Weight of structural material
- Supercruise and maneuver requirements
- Survivability (Radar Absorbing Material (RAM), internal weapons, stealth planform)

Several aircraft classes were developed so that size and mission effectiveness could be compared between Fighter, Attack, and Multimission aircraft. This study highlights the effect of changing requirements on the Multimission class including the so-called “STOVL penalty” and the impact of the carrier-basing (or navalization) penalty. Several Attack aircraft types were developed to evaluate the impact of crew size, weapons load, internal versus external weapons carriage, and low observables. The study includes the following classes and types of aircraft:

- Supersonic Fighter class:
  - Variable-sweep-wing Fighter (F-14 type)
- Subsonic Attack class:
  - Light (A-4 type)
  - Medium (A-7 type)
  - Medium All-Weather (A-6 type) called Medium AW
  - Medium Internal Weapons (A-3 type) called Medium IW
  - Medium Flying Wing (A-12 type) called Medium FW

[1]The technology availability date is the date at which technologies have been demonstrated and are available for incorporation into full-scale development projects. Currently, first operational capability follows TAD by approximately 10 years.

Supersonic Multimission class:

- Land-based MultiRole Fighter (MRF)
- Sea-based Naval Fighter/Attack (NFA)
- STOVL Strike Fighter (SSF)

Many of the estimates required to size aircraft in this study were difficult to determine accurately. Since the goal of this study was to produce time-based trends for aircraft Takeoff Gross Weight (TOGW), enabling consistent comparisons between aircraft concepts was of more importance than attempting to predict the actual weight of the aircraft in a specific timeframe. Therefore, reasonable estimates were made and applied consistently to all the aircraft for such things as materials technology level, weapon advancement, engine technology, and avionics capabilities/requirements.

In this paper, a distinction is made between aircraft similarities and differentiators. Similarities are estimated technology levels or requirements that are the same for all of the aircraft in a particular class such as Multimission. Differentiators are unique features applied to each aircraft type, such as land-based versus naval Multimission. Aircraft trends found in this study are driven by these differentiators. The similarities and differentiators used in this study are discussed separately in major sections of this paper.

This study was conducted over a four month period by an eight member team in early 1991. The team members were:

Samuel B. Wilson III: technical director

Jeffrey J. Samuels: team leader and aircraft designer

Andrew S. Hahn: chief aircraft designer

David R. Schleicher: aircraft designer

Kevin B. Carbajal: propulsion

J. R. Gloudemans: graphics

Paul A. Gelhausen and Mark D. Moore: ACSYNT aircraft synthesis code

This aircraft design study was conducted using the NASA Ames aircraft design and synthesis code, ACSYNT (refs. 3–6). ACSYNT was developed in the early 1970s as a flexible conceptual aircraft design and analysis tool. The code has been used at NASA Ames Research Center for a variety of projects and it undergoes continual development through a joint effort by NASA, industry, and academia. ACSYNT is particularly useful for TOGW trends such as those desired by the CNA. ACSYNT was also used to evaluate aircraft TOGW sensitivity to some of the more important aircraft differentiators in this study.

ACSYNT is comprised of several independent analysis codes which have been combined in order to evaluate complete aircraft. These analysis codes are geometry, weights, structures, aerodynamics, propulsion, takeoff performance, and mission performance. ACSYNT includes methodology for determining a design’s TOGW for a given mission. An optimization module is coupled to ACSYNT to provide an automatic closed-loop optimization of the vehicle. Designs are optimized for a particular objective function, typically minimum TOGW, while being subject to user-defined constraints. Numerous correlation studies with existing aircraft have been performed and they have shown ACSYNT to be extremely accurate (ref. 7). ACSYNT is useful for determining critical technology items and showing aircraft trends (refs. 8 and 9).

Section II – Aircraft Similarities

This section describes the consistent practices and estimates that were applied to all of the aircraft classes during the design process. Design rules or requirements that are unique to a specific aircraft class or aircraft type are discussed later.

A. Geometry

The aircraft in this study were based on existing aircraft and limited to only a few geometries. This was done to eliminate differences in ACSYNT's weight and aerodynamic predictions for aircraft components that were not important drivers in the study (different locations for the horizontal stabilizer, for example). The information presented below is summarized in table 1.

Aircraft length and folded wing span were limited to 64 ft and 34 ft, respectively, to ensure that the aircraft could fit onto a carrier. These constraints only affected the largest SSF aircraft. The minimum allowed fuselage diameter[2] was 4.5 ft for packaging the cockpit and engines. Several of the smaller Attack aircraft were constrained by this limit. Conventional wing planforms have a minimum tip chord of 24 inches for carrying the Short Range Missile (SRM) on the wing tip.

For the Fighter class, the fuselage was based on the F-18 with nose, afterbody, and overall fineness ratios of 5.0, 3.0, and 10.0, respectively. The wing and tail planforms and the tail area ratios were based on an F-14. The vertical and horizontal tails were sized as a fixed percentage of the wing area.

Subsonic Attack aircraft fuselages were optimized by allowing both length and maximum diameter to vary, but they all have the same nose and afterbody fineness ratios based on the A-6 (1.5 and 5.13, respectively). Attack aircraft wing planforms were optimized, while the tail planforms and volume coefficients were based on the A-6.

The Multimission class used the same fuselage shape as the Fighter class. Wings in the 1990-TAD timeframe used a supersonic trapezoidal planform similar to the F-15 because of the emphasis on supersonic flight in the design mission, and the tail configuration was based on the F-18. In the 1995-TAD timeframe, the Multimission wings and tails have low-observable diamond planforms. The vertical and horizontal tails were sized as a fixed percentage of the wing area.

[2]Diameter used here is the equivalent diameter for the fuselage cross section with inlet and nozzle flow-through area removed.

B. Aerodynamics

ACYSNT's aerodynamic predictions were applied to each conceptual aircraft configuration. Thus lift and drag consistently reflect modifications made to the aircraft geometry during sizing and optimization. ACSYNT's calculation procedures employ both theoretical methods and empirical information. Friction drag estimates are based on the method of Bertram (ref. 10), with an empirical correction for thickness-induced pressure fields. Base drag was computed using base pressure coefficient as a function of Mach number. Lift and induced drag are derived from a combination of potential theory and momentum integration procedures.

C. Structural Weight

Airframe weights are based on the geometry definition and are calculated from empirical equations based on correlations of existing aircraft data. The wing weight, for example, is a function of load factor, aspect ratio, leading-edge sweep, taper ratio, thickness-to-chord ratio, design dynamic pressure, and vehicle gross weight. Load factor, surface area, maximum Mach number, and vehicle gross weight are the parameters used to determine the fuselage weight. Weights of the tail surfaces are determined by similar empirical methods.

Between the two study timeframes, technological advances in both materials and construction techniques result in lower structural weight. Structural weight savings in ACSYNT are expressed in terms of savings relative to conventional, all aluminum construction. A 10% and 15% weight reduction over aluminum was used for the 1990-TAD and 1995-TAD structures, respectively. The assumption for 1990-TAD is reasonable since technology at the time of this study was better than the baseline (all aluminum) technology level assumed by ACSYNT's weight equations. The 15% reduction used in the 1995-TAD timeframe is conservative compared to the 1995-TAD assumptions agreed upon in the US/UK ASTOVL program.[3] Although claims for advanced structures and materials exceed the values used in this study, recent industry experience with composites has tempered expectations. Again, the emphasis was on applying the same assumptions to all the aircraft to establish trends.

[3]Weight savings in the US/UK ASTOVL program ranged from 25% for the wing to 18% for the fuselage.

Table 1. Summary of aerodynamic surface planforms

Aircraft	Wing AR	Λ c/4	λ	H-tail AR	Λ c/4	λ	Area	V-tail AR	Λ c/4	λ	Area
							Area ratio				Area ratio
Fighter	6.79	15.8	0.29	2.81	44.6	0.18	0.3751	1.17	48	0.32	0.1042
							Volume coefficient				Volume coefficient
Attack	4.4–5.2	12.8–18.2	0.312	3.574	30	0.386	0.5	1.02	30	0.302	0.07
Flying wing	3.5	39.1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
							Area ratio				Area ratio
90 NFA and MRF	2.5	36.6	0.2	3	43	0.36	0.3818	1.25	34	0.38	0.1517
90 SSF	2.5	42.8	0.2	3	43	0.36	0.3813	1.25	34	0.38	0.1517
							Area ratio				Area ratio
95 NFA and MRF	2	24.3	0.05	2	24.3	0.05	0.381	1	24.3	0.05	0.151
95 SSF	2	24.3	0.05	2	24.3	0.05	0.3052	1	24.3	0.05	0.121

D. Fixed Equipment

The fixed equipment weights for each aircraft class were based on current inventory aircraft as shown in table 2. However, the Auxiliary Power Unit (APU) was assumed to be 200 lb for each aircraft class. The technology improvements used for structures (10% and 15%) were applied to fixed equipment weights as well.

E. Propulsion Database

To ensure the consistency desired by the design team, only one engine model, Pratt & Whitney’s CCD-1178 engine deck, was used to generate families of engines in both timeframes. Several standardized estimates were also used, as follows. High-pressure bleed was 0.5% of compressor mass flow, and power extraction for subsystems was 100 hp. A propulsion installation factor of 16% of engine weight was used for all aircraft. Since cruise nozzle weight generally scales with engine mass flow,

Table 2. Equipment weight and reference aircraft for each aircraft class

System	Fighter (F-14A)	Multimission (F-18A)	Attack (A-6E)
APU	200	200	200
Instruments	169	94	219
Electrical	784	544	817
Avionics	3006	1652	2790
Crew accommodations	534	375	613
Air conditioning	995	610	398
Total	5688	3475	5037

the afterburning convergent/divergent nozzle weight was empirically derived (nozzle weight equals 1.15 times design mass flow). Also derived empirically, subsonic nonafterburning nozzle weight was 63% of the convergent/divergent nozzle weight. Nozzle weight equations were not modified for technology level. Fuel system weight was 14% of engine weight (STOVL-unique equipment weight was excluded from this calculation). All aircraft use the military specification 5008A inlet recovery schedule. The aircraft are all single engine designs to keep the number of engines from being an aircraft discriminator; however, a sensitivity study was conducted to determine the impact this decision had on aircraft takeoff weight.

Engines in each technology timeframe have the same basic cycle characteristics in terms of overall pressure ratio, combustor exit temperature, and nozzle cooling as shown in table 3. Several engines were produced in each timeframe for selection in each aircraft class, as shown in tables 4a and 4b. The selected engines for each aircraft class are shown in table 5.

Table 3. Engine technology trends

Time frame	OPR	Combustor exit temperature	Nozzle cooling (% core flow)
1990-TAD	28	3000°F	6.0
1995-TAD	32	3400°F	2.5

Table 4a. 1990-TAD study engines

Engine model	FPR	BPR	T/W[a] dry	T/W[a] A/B	SFC SLS	Throttle setting	Nozzle type
A	1.8	5.00	6.04	_	0.418	Navy waveoff	Fixed-area axisymmetric convergent
B	2.0	4.00	6.55	–	0.455	Navy waveoff	Fixed-area axisymmetric convergent
C	2.2	3.00	6.23	–	0.505	Navy waveoff	Fixed-area axisymmetric convergent
D	3.0	1.45	7.50	–	0.627	Navy waveoff	Fixed-area axisymmetric convergent
E	4.1	0.70	7.96	12.72	0.742	Navy waveoff	Variable-area axisymmetric convergent-divergent
F	4.6	0.44	8.53	12.95	0.796	Navy waveoff	Variable-area axisymmetric convergent-divergent
F STOVL	4.6	0.44	5.80	8.81	0.796		
G	5.2	0.25	9.06	13.10	0.847	Navy waveoff	Variable-area axisymmetric convergent-divergent

[a]Uninstalled, unscaled, nozzle weight included.

Table 4b. 1995-TAD study engines

Engine model	FPR	BPR	T/W[a] dry	T/W[a] A/B	SFC SLS	Throttle setting	Nozzle type
A	2.1	5.00	9.12	–	0.449	Navy waveoff	Fixed-area axisymmetric convergent
B	2.3	4.00	9.38	–	0.488	Navy waveoff	Fixed-area axisymmetric convergent
C	2.6	3.00	9.83	–	0.540	Navy waveoff	Fixed-area axisymmetric convergent
D	3.0	2.30	10.36	–	0.587	Navy waveoff	Fixed-area axisymmetric convergent
E	4.1	0.94	9.76	16.21	0.703	Dry supercruise	Variable-area axisymmetric convergent-divergent
F	4.6	0.66	10.51	16.66	0.754	Dry supercruise	Variable-area axisymmetric convergent-divergent
	4.6	0.94	10.69	17.13	0.745	Navy waveoff	
F STOVL	4.6	0.66	7.15	11.33	0.754	Dry supercruise	
	4.6	0.94	7.27	11.65	0.745	Navy waveoff	
G	5.1	0.45	11.21	16.97	0.803	Navy waveoff	Variable-area axisymmetric convergent-divergent

[a]Uninstalled, unscaled, nozzle weight included.

Table 5. Engines selected for each class of aircraft

1990-TAD	Engine model	Throttle ratio
Fighter	G	Waveoff
Attack	A	Waveoff
NFA and MRF	F	Waveoff
SSF	F	Waveoff
1995-TAD	**Engine model**	**Throttle ratio**
Fighter	G	Supercruise
Attack	A	Waveoff
NFA and MRF	F	Supercruise
SSF	F	Supercruise

A comparison of the engines in table 4 shows that the primary impact of the assumed technology advancements was approximately a 25% increase in uninstalled engine T/W. Existing engine development programs have this level of improvement as a goal. Also note that the specific fuel consumption (SFC) of the higher temperature 1995-TAD engines was, in general, no lower than for the 1990-TAD engines. Thus fuel efficiency was not a significant contributor to aircraft weight reduction with technology.

Engine throttle ratio[4] was used to optimize engines for both high- and low-speed missions. In the 1990-TAD timeframe, all aircraft use a throttle ratio which optimizes engine performance at sea level static conditions. This benefits both carrier waveoff and hover performance. In the 1995-TAD timeframe, engines for the supersonic aircraft use a throttle ratio which optimizes performance for supersonic cruise conditions since the engines for all dry supercruising[5] aircraft were sized by the dry supercruise requirement. An additional engine was generated for the 1995-TAD SSF using a waveoff throttle ratio in case hover proved to be the critical engine sizing condition for that aircraft, but the dry-supercruise throttle setting produced the lighter aircraft.

ACSYNT resizes the engine (using engine scale factor, ESF, which sizes thrust, dimensions, and airflow) during the synthesis process to meet thrust requirements. Engine thrust scales directly with ESF while engine weight scales with ESF according to the equation $W_{ENG} = W_{(ESF=1.0)} * (ESF)^{(EXP)}$. Typically, the exponent (EXP) is greater than 1.0 in aircraft studies as a weight penalty to discourage disproportionate engine growth. An exponent of 1.05 was used in this study as shown in figure 1, which also shows the constant engine T/W that would result from an exponent of 1.0. Unfortunately, EXP greater than 1.0 also means that engine T/W becomes optimistic when engine data are scaled down. Attack aircraft in this study have engine scale factors as low as 0.4, with a corresponding 5% increase in engine T/W. Since this is one of the less certain influences in this study, the impact of this increased T/W was examined as an attack aircraft sensitivity (see section on sensitivities).

F. Design Missions

The design missions used in this study were based on missions in the Navy STOVL Strike Fighter Desired Operational Characteristics (SSF DOC) (ref. 11). The design missions used for the different aircraft classes are as follows: a modified Combat Air Patrol (CAP) for the Fighter aircraft, Interdiction for the Attack aircraft, and a new composite mission for the Multimission aircraft. Each of these missions is described in more detail later.

The SSF DOC supersonic missions required dry supercruise, so it was also required in the 1995-TAD timeframe of this study. Dry supercruise was not required in the 1990-TAD timeframe (i.e., afterburner was allowed for supersonic cruise) to reflect the capability of current inventory aircraft.

For consistency, the following mission-related items were applied. All aircraft:

- Loiter at sea level and 0.3 Mach prior to landing to ensure that enough fuel is available to wait for deck/runway availability
- Complete the design mission with internal fuel
- Carry a gun and 150 rounds of ammunition
- Use takeoff fuel composed of 10 minutes at idle for warmup, taxi, and 30 seconds at maximum power for takeoff
- Have 150 lb of trapped fuel
- Have 15° max angle of attack for maneuvers or landing
- Have no high-lift devices modelled for maneuvers or landing
- Use untrimmed aerodynamics
- Use naval aviation jet fuel, JP-5, with a density of 51.1 lb/ft^3
- Retain all weapons on the design missions, since both laser guided bombs and air-to-air missiles are considered to be high value stores
- Have no descent or landing phases, no range credit for climb (this had the effect of making the design fuel weight, and therefore design takeoff weight, conservative)
- Have 5% reserve fuel after landing

G. Weapons

Aircraft weapons loads were normalized to facilitate comparisons between aircraft (table 6). The Long Range Missile (LRM), Short Range Missile (SRM), and Laser Guided Bomb (LGB) used in this study are the AIM-54 Phoenix, tail-steering AIM-9 Sidewinder, and GBU-16/B MK83, respectively.

The weapon carriage depends on aircraft class and timeframe, but all aircraft use consistent weight and drag values for missiles, bombs, pylons, and support gear (ejectors, rails, etc.). Wing tip installation of the SRM was assumed to have zero net drag. Weapons and support weight were assumed to remain unchanged in both timeframes of this study. Table 7 lists data for some of the weapons and support equipment (increments are per item).

Total weapons and support weight was determined through the addition of standardized component weights. Weapon drag was determined using the method of R. R. Snodgrass (ref. 12) with standardized incremental drags including shielding effects. An example is shown in table 8.

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[4]The ratio of maximum combustor exit temperature to sea level static standard day design temperature. By increasing this ratio, the engine can be made to operate at a higher maximum inlet flow or a higher inlet temperature.

[5]Level supersonic cruise without afterburner.

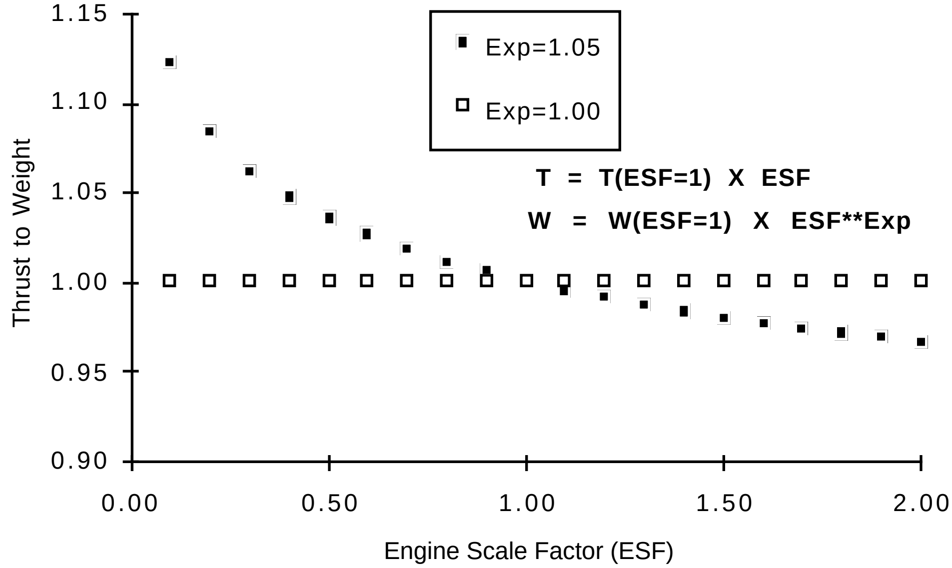

Figure 1. Effect of growth exponent on engine weight.

Table 6. Weapons load for each aircraft class

	LRM	SRM	LGB
Fighter	4	4	0
Attack	0	2	2/4
Multimission	2	2	0

Table 7. Weight and drag for weapons and support equipment

Weapon	Weight, lb	Drag area (0.2M), ft^2
Laser Guided Bomb (LGB)	1091	0.39
LGB support	100	0.35
Long Range Missile (LRM)	985	0.46
LRM support	470	0.11
Short Range Missile (SRM)	199	0.144*
SRM support	100	0.1*
Heavy pylon	300	0.42
Light pylon	150	0.2
Gun (25 mm)	360	
Installation	252	
Ammo(150 rounds)	287	

*No drag penalty for SRMs on wing tips.

Table 8. Example of external stores weights and drags

Description	Weight, lb	D/q, ft^2 @ 0.3M
4 MK83 Laser Guided Bombs (LGB)	4364	1.56
2 ASRAAMs*	398	0.00
2 Long pylons + 2 triple ejector racks	800	1.54
2 LAU 114 missile launchers*	200	0.00
No external fuel tank	0	0.00
Total	5762	3.10

*Wing tip mounted missiles and launchers have no net drag over a mission.

H. Carrier Compatibility

The carrier-based aircraft in this study required several modifications compared to land-based aircraft.

Carrier aircraft fly slower approaches than land-based aircraft and must be able to perform a waveoff at low speed. Therefore, a full power 1.5g turn at 0.2M and sea level with all stores and reserve fuel on board was used as a design requirement to ensure an adequate maneuver margin. This requirement determined the wing loading for many of the sea-based aircraft. The SSF was exempt from this waveoff requirement because it performs vertical landings.

Carrier operations require heavier structures for several reasons: 1) arrested landings require a tail hook and reinforced fuselage, 2) landing gear are designed for 24 ft/s sink rate, and 3) catapult launches require reinforced nose gear and a strengthened fuselage. The SSF was also exempt from these requirements.

These weight increments are difficult to quantify because there are no data for aircraft that were designed for both land-based and sea-based operations with exactly the same mission capability. For example, contrary to the expected navalization penalty, the land-based F-4 actually had a higher empty weight than the carrier-based version. But in this case the land-based version used the increased strength and wing area of the carrier aircraft to carry an increased equipment load, which equates to higher mission capability. Similarly, few aircraft have successfully made the transition from land-based to sea-based operations. The carrier version of the British Hawk did perform catapult launches and arrested landings but required substantial structural reinforcement to do so. Jane’s All the World’s Aircraft shows that the navalized Hawk is approximately 11% heavier empty, but it can no longer fly as far as the land-based version.

Since historical research did not provide values for fuselage and landing gear weight penalties for carrier operations, an estimate had to be made another way. To this end, the F-14 and F-18 were modelled using ACSYNT’s land-based weight equations. The actual aircraft fuselage and landing gear structure weights were approximately 30% greater than those modelled by ACSYNT. Therefore, 30% fuselage and landing gear weight penalties were applied to carrier-based aircraft in this study. Informal comments by U.S. Navy personnel[6] agreed that 30% was a reasonable estimate.

[6]Several active and retired U.S. Navy personnel were involved in a review of this material by the CNA.

I. Maneuver Requirements

Maneuver requirements are important because they can size the wing and/or engine. The maneuver capability desired of the supersonic aircraft with 60% of mission fuel and air-to-air weapons was approximately 4.0g for the 1990-TAD timeframe and 5.0g (approximately ATF-level) for the 1995-TAD timeframe. However, the maneuver constraints used in this study were set somewhat lower than these values because maneuvering flaps were not modelled during the aircraft sizing process. Therefore, in the 1995-TAD timeframe, Fighter and Multimission aircraft were required to perform 3.8g at 0.9M and 30,000 ft. This maneuver requirement was reduced to 3.0g for the 1990-TAD timeframe. Similarly, sea-based aircraft were required to perform a 1.5g turn for approach waveoff.

For completeness, fallout combat maneuver performance was evaluated using maneuver flaps.

J. Structural Limits

In the 1990-TAD timeframe, design load limits were based on existing aircraft, as shown in table 9. In the 1995-TAD timeframe, Fighter and Multimission structural requirements were increased to be comparable to F-16 levels of performance. Dynamic pressure requirements were also increased. A safety factor of 1.5 was used to determine the ultimate load factor which was used by ACSYNT’s weight estimation routines.

Table 9. Structural limits for aircraft classes

1990-TAD	Aircraft	g-limit	Max q	Max sea level Mach
Attack	A-6	6.5	1140	0.88
Fighter	F-15	6.5	2060	1.18
Multimission	F-18	7.5	1790	1.1

1995-TAD	g-limit	Max q	Max sea level Mach
Attack	6.5	1336	0.95
Fighter and Multimission	9.0	2132	1.2

K. Overall Density Constraints

Overall aircraft density is an important constraint used to ensure valid aircraft packaging. As an aircraft becomes more dense it becomes lighter for the same mission, but maintenance access will be difficult. If a sizing study allows an aircraft to become more dense in response to an increase in weight, it will experience less growth than if it had been resized at the same overall density. If, on the other hand, maximum density is constrained, the wing and/or fuselage must increase in size to provide additional volume.

Overall aircraft density provides only a general design constraint and does not address individual component locations or densities. The baseline overall aircraft density for this study was derived by modelling an F/A-18 on ACSYNT. The flow-through volume of the inlet and nozzle was not included in the total volume. The remaining volume was divided into the operational empty weight, which includes fuel and pilot, and yields an estimated overall aircraft density of 31 lb/ft^3. A consistent method of accounting was devised to allow aircraft density to vary from this baseline for specific reasons such as internal weapons bays, STOVL-unique features like ducting, and flying-wing packaging constraints.

L. Low Observables Design

Since low observables were required for some aircraft in the 1995-TAD timeframe, a simple but consistent approach for design was needed. Therefore, Multimission aircraft evolve into the diamond planform for wing and tail shown in figure 2. Low observables aircraft have an additional 5% weight penalty on the wing, tail, and body structure to model the application of radar absorbing material. The flying wing Attack design has an inherently low-observables planform.

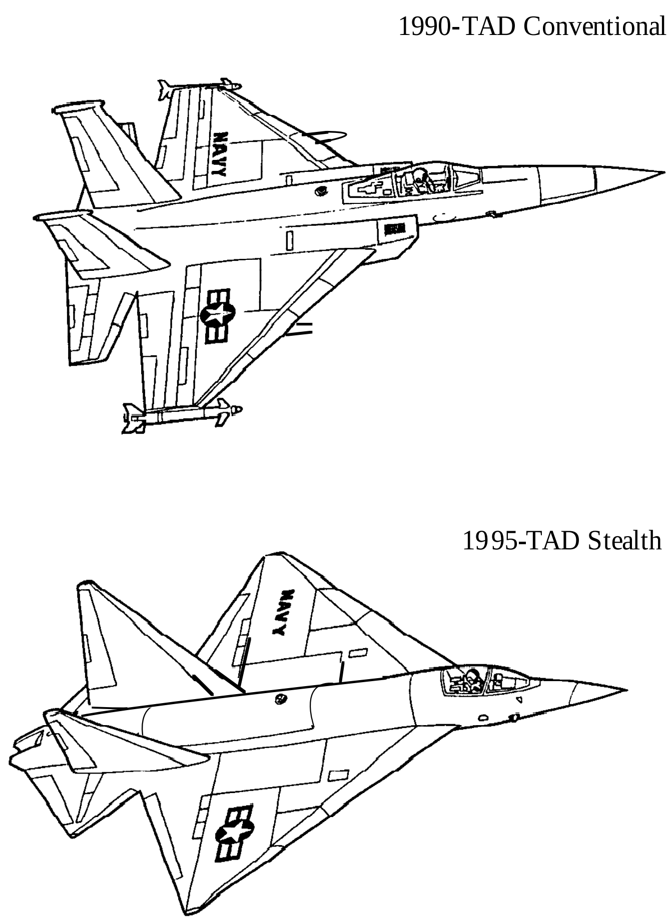

Figure 2. Evolution of Multimission aircraft.

Low-observables aircraft were also required to carry their weapons internally. The increased surface and frontal areas of the fuselage resulting from internal weapon bay volume are accounted for by ACSYNT's aerodynamics module. The volume of the weapon bays was estimated using the length and fin span of the largest munitions the aircraft were required to carry in the SSF DOC missions. The main weapon bay length of 172 inches was determined by the length of an AGM-88A High-speed Anti-Radiation Missile (HARM) with 4 inches clearance on each end. The HARMs require folding fins to fit in the bomb bay. The height and width of 23 inches were determined by the canted span of a GBU-16/B MK83 Laser Guided Bomb with 3 inches of clearance on either side. A similar approach was used for the SRM bays that hold the AIM-9 Sidewinder defensive missiles, yielding dimensions of 128 by 13 by 13 inches. These dimensions yield a volume penalty of 52 ft^3 per bomb bay and 15 ft^3 per missile bay for a total of 234 ft^3.

Unfortunately, the weight penalty of the internal weapon bays was much harder to determine. It seemed reasonable that a weight penalty should be assessed for doors, actuation, and reinforcement of the cutout. However, this penalty depends on the dynamic pressure at the doors and on the size/location of the cutout. Since there was no simple method of predicting this weight penalty, it was decided to use a constant weight penalty of 300 lb per bay. This arbitrary penalty is not coincidentally equal to the weight of one pylon. This means that the weight penalty for the two-bomb configurations is exactly the same regardless of whether the bombs are carried internally or externally (there is also a 50 lb increment for weapon ejectors, for both pylon- and bay-mounted weapons). Also, this leads to a direct comparison of the performance advantages of internal carriage, assuming that the assumed weight penalty is adequate.

An additional detail required attention for Attack aircraft with four bombs carried internally. The external pylons, weighing 300 lb each, can carry two bombs each while each internal bay used in this study can only carry one bomb. Therefore, carrying four bombs internally requires the equivalent weight penalty of four pylons which weigh 600 lb more than when carrying them externally.

Obviously, these weight penalties are arbitrary, given that actual internal weapons bay structural penalties are detailed-design dependent. Consequently, a sensitivity study was performed for Attack aircraft with internal bays. This sensitivity study used double and triple the baseline 300 lb weight penalty per bay. The outcome of this sensitivity study is reported in the results section.

Section III – Aircraft Differentiators

A. Fighter

The Fighter class of aircraft serves in the fleet air defense role by performing supersonic intercept and combat air patrol missions. It features a variable-sweep-wing design for enhanced loiter and supersonic cruise capability. The wing sweeps to maintain 0.75 Mach number perpendicular to the leading edge and also eliminates the need for a wing-fold mechanism. The wing weight was increased 30% to account for the pivot, actuation, and additional wing/fuselage structure. This factor was derived by comparing weights from an ACSYNT model of the F-14 to actual weight data and was supported by reviewing Navy personnel.

The Fighter was not intended to overfly highly defended targets and was assumed to operate its radar in an active search mode. Therefore, this design does not require any compromise for stealth in either timeframe; the missiles are carried externally and the wing, horizontal tail, and twin vertical tails are conventional in design. The LRMs are carried semi-submerged on the fuselage to save weight and drag compared to pylon-mounting them on the moving part of the wing. The SRMs are carried on short pylons on the fixed part of the wing. Finally, in both timeframes, the Fighter has the carrier compatibility weight and waveoff penalties. The differentiators for this aircraft class are summarized in table 10.

Table 10. Fighter class common technologies and requirements

	1990-TAD	1995-TAD
Radar absorbing material	+0%	+0%
Carrier compatable	Yes	Yes
Wing pivot	+30%	+30%
Internal weapons carriage	No	No
Dry supercruise required	No	Yes
Design load factor	6.5	9.0
Maneuver required	3.0g	3.8g
Wing/tail planform	Conventional	Conventional

The Fighter design mission (fig. 3) was a combination of the CAP and DLI missions from the SSF DOC which achieves a balance between supersonic and loiter capability. The original CAP mission had a loiter segment but only had 3 minutes of supersonic flight, whereas the DLI mission emphasized supersonic cruise but did not include loiter. The compromise mission consists of 400 nm cruise at best cruise altitude and Mach (BCAM) to a 60 minute loiter at 35,000 ft. After a lateral 100 nm supersonic dash, the aircraft performs 3 minutes of combat at 1.6 Mach number and 35,000 ft. The mission ends with 400 nm return cruise to the carrier at BCAM, followed by a 20 minute loiter at sea-level and 0.3 Mach to simulate the holding pattern required by carrier operations. The fighter's design weapon load was four AIM-54 Phoenix long-range air-to-air missiles (LRMs), four tail-steering AIM-9 Sidewinder short-range defensive missiles (SRMs), and a gun with 150 rounds of ammunition.

B. Attack

A matrix of subsonic Attack designs was developed so that the following four capabilities could be evaluated by the CNA:

Two vs. four bombs

One vs. two crew

External vs. internal weapon carriage

Conventional vs. flying wing planform

The SSF DOC Interdiction mission was used for the Attack design mission. It consists of a 500 nm cruise at BCAM, followed by a 50 nm dash at sea level and 0.80 Mach (fig. 4). The aircraft then performs 2 minutes of combat at 0.85M at sea level. The return leg is similar to the outbound leg with 20 minutes of loiter at sea level at 0.3 Mach added to simulate the holding pattern required by carrier operations. Attack aircraft were required to perform initial climbout in less than 75 nm to ensure that the minimum aircraft T/W was reasonable compared to existing Attack aircraft (~0.5 for the A-4). The aircraft returns with the design weapon load of GBU-16/B Mk-83R laser-guided bombs (LGBs), two AIM-9 Sidewinder short-range defensive missiles (SRMs), and a gun and with 150 rounds of ammunition.

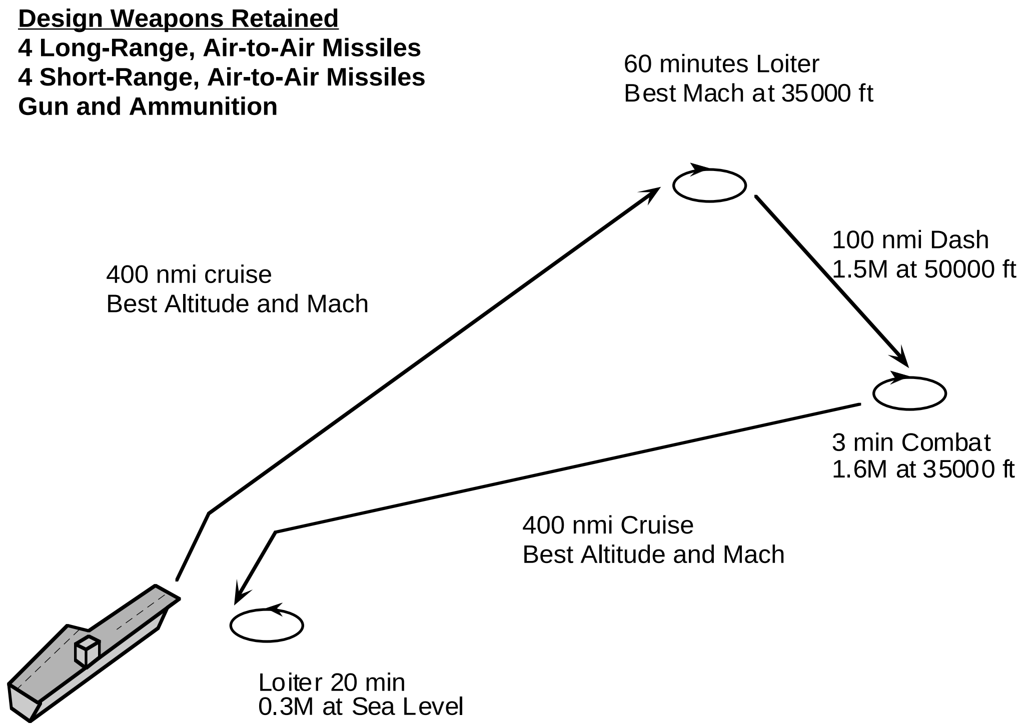

Figure 3. Combat air patrol design mission for Fighter aircraft.

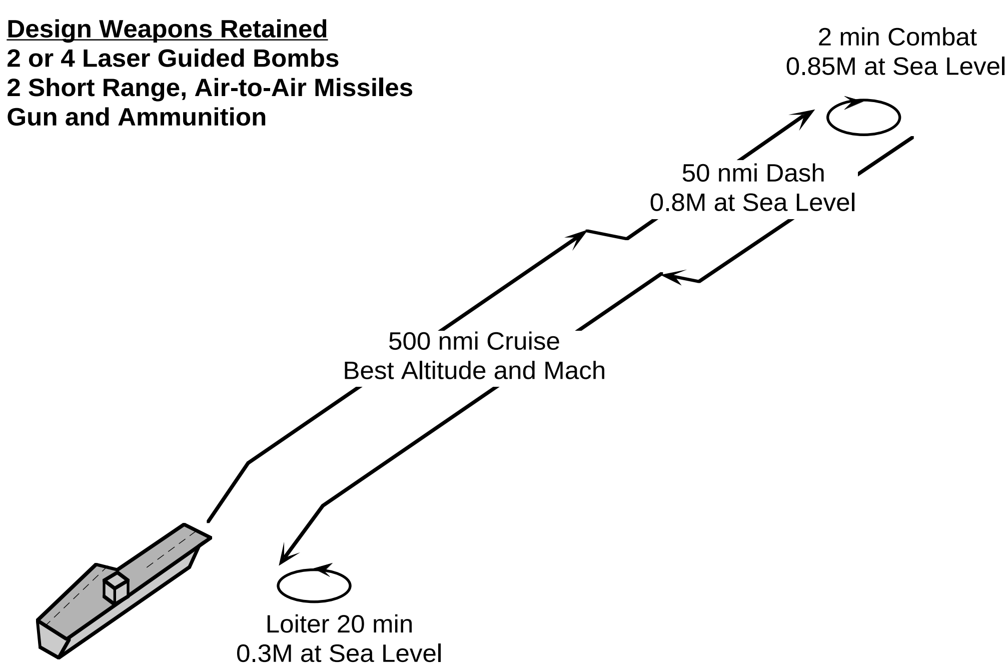

Figure 4. Interdiction design mission for Attack aircraft.

All Attack aircraft were designed to be carrier compatible. Both single and dual place Attack aircraft have 598 lb of fixed weight in the fuselage for cockpit armament, based on A-6 weights. Table 11 lists the items which differentiate the Attack aircraft class from the other classes. The items which differentiate each type of Attack aircraft are described below and in table 12.

1. Conventional Attack

For the four conventional aircraft, aspect ratio and wing sweep were optimized by ACSYNT. To support mission effectiveness studies, the mission capability of the conventional designs was varied as described below.

The Light Attack design is the aircraft from which all Attack types were derived. While not directly based on the A-4 Skyhawk, this aircraft performs in a similar role. It has a single place cockpit, a moderate avionics weight appropriate for daylight missions, and two bombs mounted externally on the fuselage.

Some effort was required to ensure that the fixed equipment weights for this single-place aircraft were consistent with two-place aircraft in this study which used equipment weights from the two-place A-6. When the equipment weights for the F/A-18 and the A-6 were compared, the weight for furnishing, instrumentation, and avionics/electrical support appeared to be proportional to the number of the crew. Therefore single-seat weights from the Multimission class were used for the Light Attack aircraft with one exception. The A-6 air conditioning weight was used for both single- and dual-place Attack aircraft because it was inappropriate to assume that the Light Attack aircraft had the same cooling requirements as the supersonic F-18. It should be noted that these weights for a two-place aircraft are not exactly double those of a single-place aircraft, since there is some economy of scale.

The second attack aircraft type is Medium Attack and performs in the same role as the A-7 Corsair II. This aircraft is the Light Attack aircraft redesigned to carry four bombs instead of two, but otherwise meets the same requirements and constraints.

The Medium All-Weather (Medium AW) type is the Medium Attack aircraft redesigned to carry a second crewmember and substantially more avionics/electrical equipment. This resulted in an aircraft similar to the A-6 Intruder which can perform night, all-weather missions, and handle higher threat environments.

The Medium Internal Weapons (Medium IW) type is the Medium AW aircraft redesigned to carry the design weapons internally, with an additional weight and volume penalty.

Table 11. Attack class common technologies and requirements

	1990-TAD	1995-TAD
Radar absorbing material	+0%	+5% (FW only)
Carrier compatible	Yes	Yes
Armor	598 lb	598 lb
Design load factor	6.5	6.5
Wing/tail planform	Conventional/FW	Conventional/FW
Wing fold	150 lb	150 lb

Table 12. Attack aircraft type differentiators

	Light	Medium	Medium AW	Medium IW
Number of crew	1	1	2	2
Number of bombs	2	4	4	4
Weapons carriage	Tandem	Pylon	Pylon	Internal
Weapons related weight (lb)	4079	6661	6661	7261
Internal weapons bay volume (ft^3)	0	0	0	238

2. Flying Wing

The last Attack type is the Medium Flying Wing (Medium FW), which is the Medium IW aircraft redesigned with considerations given to low observables. This aircraft performs the same role as the proposed A-12 Avenger II, but has less range and a smaller bomb capacity.

The Medium FW design had three aerodynamic benefits. Since flying wings eliminate most of the fuselage, the separation drag was reduced by 50%. The interference drag between the fuselage and wing was eliminated for the same reason. And, of course, there was no drag contribution from tail surfaces. These and other aerodynamic considerations are summarized in table 13.

The Medium FW was, however, penalized for internal volume and packaging efficiency. First, the swept-wing Medium FW had a density disadvantage. Not only is the shape difficult for packaging payload and equipment, but only the front half of the wing chord is available due to balance considerations.[7] This packaging inefficiency was modelled by requiring 25% more volume than a conventional pod and wing configuration. Second, 15% root thickness-to-chord ratio (t/c) was selected for the Medium FW to increase the volume available. While this is unusually high, the planform and t/c tapers to the tip, yielding a mean aerodynamic chord t/c of 10% compared to 8% which is a typical value for conventional aircraft.

Additional Medium FW differentiators result from low-observables considerations. The sweep, aspect ratio, and taper ratio were fixed by radar cross-section considerations, while the conventional aircraft's values were optimized for the mission. Also, the Medium FW does not have horizontal or vertical tail surfaces and relies on active controls for stability. Finally, radar absorbing materials were applied to the 1995-TAD Medium FW by assessing a 5% structural weight penalty.

C. Multimission

No single SSF DOC mission provided a combination of Fighter and Attack mission capabilities. A new design mission was therefore created for the Multimission class (fig. 5). It is comprised of a 250 nm cruise at sea level and 0.85 Mach, then a 60 minute loiter at 35,000 ft at best-endurance speed. The mission continues with a 150 nm supersonic dash at 50,000 ft, 2 minutes of combat at 1.5M and 50,000 ft, and a return leg to the carrier of 400 nm at BCAM. All Multimission aircraft loiter at sea level and 0.3 Mach prior to landing to ensure that enough fuel was available to wait for deck/runway availability. Design weapon load was two LRMs, two SRMs, and a gun with 150 rounds of ammunition.

Table 13. Aerodynamic considerations for flying wing designs

	Conventional	Flying wing
Separation drag factor	1.0	0.5
Interference drag factor	1.0	0.0
Wing thickness to chord	0.09	0.15
Taper ratio	0.31	0.0

Three Multimission aircraft were developed: a STOVL Strike Fighter (SSF), a sea-based Naval Fighter/Attack (NFA), and a land-based MultiRole Fighter (MRF). Table 14 lists items which differentiate this aircraft class from the others. The 1990-TAD Multimission aircraft are conventional and carry weapons externally. All three types evolve into a low-observables, ATF-type planform with internal weapons in the 1995-TAD timeframe (see fig. 2).

Table 15 lists items that differentiate between the SSF, NFA, and MRF types. The SSF aircraft was exempt from the waveoff requirement because it can maneuver at low speeds with thrust vectoring and reaction controls. The STOVL propulsion system is described below. The MRF was exempt from the waveoff requirement because it had a long runway available and makes approaches at higher speed. Multimission aircraft in the 1990-TAD timeframe carry the two LRMs on wing pylons and two SRMs on the wing tips. In the 1995-TAD timeframe, Multimission aircraft carry all of the weapons internally.

[7]Balance considerations are relieved somewhat with the advent of digital fly-by-wire flight controls.

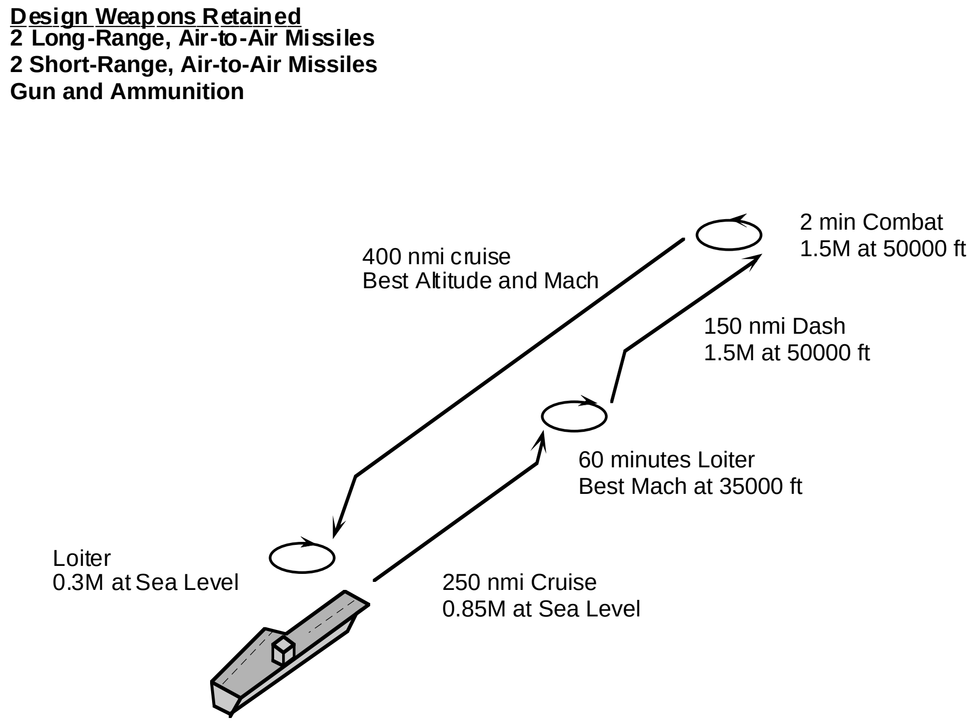

Figure 5. Multimission design mission.

Table 14. Multimission class common technologies and requirements

	1990-TAD	1995-TAD
Radar absorbing material	+ 0%	+ 5%
Internal weapons carriage	No	Yes
Dry supercruise required	No	Yes
Design load factor	7.5	9.0
Maneuver required	3.0g	3.8g
Wing/tail planform	Conventional	Diamond

Table 15. Multimission aircraft type differentiators

	SSF	NFA	MRF
Navalization penalty			
Fuselage structure	0	+30%	0
Landing gear weight	0	+30%	0
Wave off maneuver	No	Yes	No
Wing fold	150 lb	150 lb	
STOVL penalty			
Propulsion weight	+47%	0	0
Landing hover T/W	1.16	N/A	N/A
Reaction control system	Yes	No	No
Duct volume penalty	10%	0	0
Loiter in pattern	10 min	20 min	20 min
Fuselage fineness ratio	9	10	10

To minimize unnecessary differences in this study, the SSF and conventional Multimission aircraft have the same tail designs in each timeframe. This eliminates any differences in ACSYNT's weight and aerodynamic predictions for different types of tails. In addition, the vertical and horizontal tail area for Multimission aircraft were a specified fraction of the wing. The 1990-TAD SSF tail area ratios were reduced to 80% of the MRF and NFA tail area ratios to allow the SSF to benefit from its vectoring cruise nozzle which provides pitch and yaw trim/control. It turned out that, even with its reduced tail area ratio, the SSF aircraft has more tail volume than the conventional aircraft because it has a longer fuselage.

1. STOVL Strike Fighter (SSF)

The SSF aircraft has a number of unique features and sizing constraints. The SSF Multimission aircraft uses the Mixed-Flow/Vectored-Thrust (MFVT) propulsion concept developed during the US/UK ASTOVL study (ref. 2) as shown in figure 6. This system was selected for study based on its simplicity and superior transition performance.

From US/UK ASTOVL study, the propulsion system weighs 47% more than the conventional Multimission engine in both timeframes for STOVL-unique propulsion components (ducts, nozzles, etc.). The mixed flow cycle requires the fan and core to have the same pressure ratio so that the fan and core exhaust flows can be combined in the cruise nozzle. This propulsion system has an afterburning cruise nozzle which is capable of ±20° vectoring in both pitch and yaw. A butterfly valve controls flow into the ducts which supply the variable area, flush-mounted clamshell lift nozzles. The lift nozzles have ±20° vectoring capability fore and aft around vertical to enhance short takeoff performance. Total thrust vectoring is provided by flow shifting between the lift and cruise nozzles combined with the limited rotation capability of the lift nozzles. The lift nozzles are oriented 8° aft from perpendicular to the body, since the aircraft maintains an 8° nose-up pitch attitude on the ground and during hover.

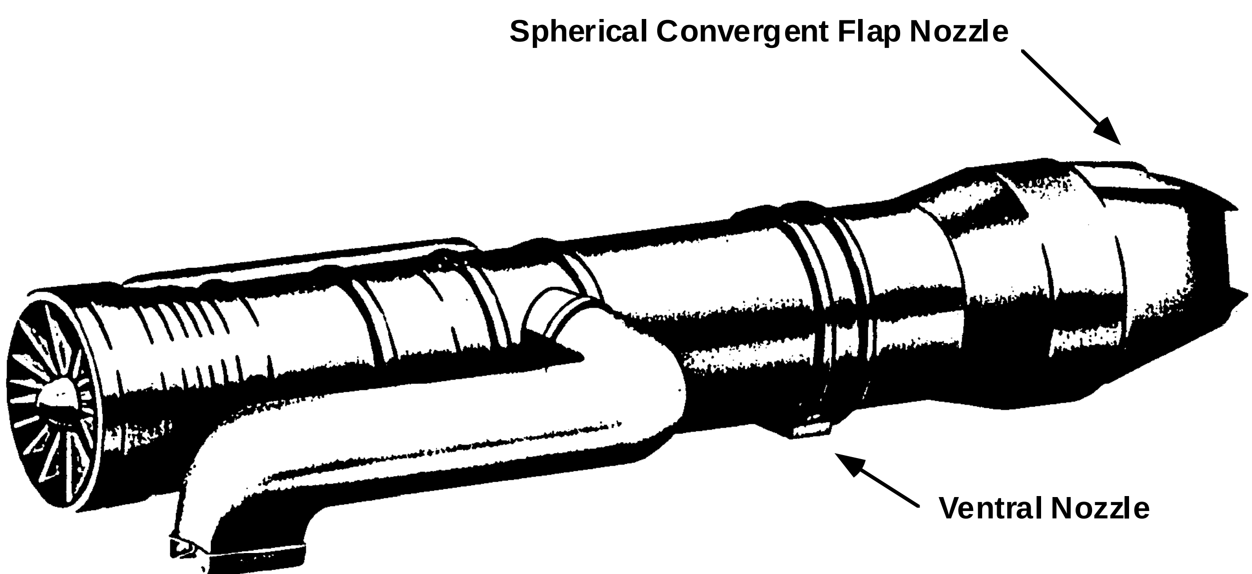

Figure 6. STOVL propulsion system.

The SSF lands vertically with the exhaust completely blocked from the cruise nozzle and most of the flow exiting the lift nozzles and up to 10% of the flow exiting the ventral trim nozzle. Vertical landings are performed with unaugmented, mixed flow.

The MFVT concept can perform takeoff in three modes. The first is a conventional takeoff using maximum afterburner. The second is a maximum nonafterburning power, vectored thrust, short takeoff which provides shorter takeoff rolls than the first method (ref. 13). The third takeoff method begins with maximum afterburner in conventional mode, followed by shutting off the afterburner and vectoring the thrust at, or prior to, rotation. This method should provide the shortest takeoff roll but is more complicated.

This propulsion concept only requires a yaw reaction control system in hover and at low speed because the engine exhaust can be transferred between the right and left lift nozzles for roll and between the lift nozzles and ventral nozzle for pitch. The reaction control system weight will therefore be much less than for typical multi-axis control systems. The reaction control system was scaled as 3.4% of the fuselage weight, based on the US/UK ASTOVL study. No weight penalty for lift improvement devices (fuselage fences) was included.

The SSF's overall density was reduced to 28 lb/ft^3 (about 90% of the conventional aircraft) to account for the large internal-flow transfer ducts associated with the propulsion system. This had the effect of increasing aircraft volume which increased weight, skin friction, and wave drag. The density of the rest of the aircraft, without the STOVL ducts, was still close to the baseline 31 lb/ft^3. This density adjustment was based on the MFVT design from the US/UK ASTOVL program (ref. 2) and accounts for 122 ft^3 of duct volume (two ducts that are 23 inches in diameter and 21 feet long).

Next, to ensure adequate thrust margin, the SSF aircraft was required to hover with an aircraft T/W ≥ 1.16 (Sea Level, Standard Day) at the end of the mission with all weapons retained and 10% fuel.[8] This T/W margin provides a 0.05g vertical acceleration capability with 1.12% thrust loss due to 8.8 lbm/sec compressor air flow bleed for the reaction control system and 8.7% suckdown for hover at 10 ft. Because it was difficult to estimate jet-induced interactions for conceptual design with much precision, the sensitivity of SSF aircraft weight to required hover T/W was evaluated (TOGW proved to be relatively insensitive to higher hover T/W requirements).

The SSF design mission only requires 10 minutes of loiter in the landing pattern since flexible STOVL operational procedures shorten the time required to recover aircraft compared to the conventional carrier recovery cycle. The 1990-TAD SSF required so much additional volume to meet the density requirement that the maximum fuselage length (to fit carrier elevator) was reached. In this case, the body length was held at the maximum and the diameter was increased even though the resulting fineness ratio was no longer consistent with the other aircraft.

[8]This hover condition is the same one that was used in the US/UK ASTOVL program even though the aircraft lands with only a 5% fuel reserve.

Section IV – Results

This section describes the results of sizing the aircraft to the above groundrules. Basic data include weights, dimensions, and maneuver performance for each aircraft. Separate sections cover Attack aircraft comparisons, SSF versus land-based and sea-based conventional Multimission aircraft, operational mission analyses, fallout range performance on all of the SSF DOC missions, and propulsion sensitivities.

A. Basic Aircraft Data

Table 16 presents a summary of the baseline aircraft developed in this study. Detailed weight, propulsion, aerodynamic, maneuver, mission, and geometry data for each aircraft can be found in Appendix A. The last three columns in table 16 indicate some of the constraints for each aircraft. Values are outlined to indicate that the constraint was active. The sizing constraints shown are:

Carrier waveoff capability as modelled by sustained 1.5g turn capability at 0.2M and sea level

ATF levels of up-and-away maneuverability as modelled by sustained turn capability at 0.9M and 30,000 ft with maximum afterburner

Dry supercruise capability as modelled by sustained 1.0g Specific Excess Power (SEP) at 1.5M, 50,000 ft without afterburner

Figure 7 provides an overall comparison at one scale of all of the aircraft generated in this study. Figures 8–12 compare all of the 1990-TAD and 1995-TAD aircraft by class at a larger drawing scale.

A check was made of the maneuver performance of supersonic 1995-TAD aircraft, as summarized in table 17. All of the Multimission aircraft had similar maneuver performance which is reported as “Multimission” in the table. This table also includes a comparison with requirements from the US/UK ASTOVL study of 1995-TAD aircraft. Maneuver performance was determined with an approximation for enhanced lift due to maneuvering flaps.

Aircraft growth factor is used frequently in the following discussion. It indicates the sensitivity of an aircraft design’s TOGW to aircraft size. It is measured by the change in TOGW that results from adding (or deleting) fixed weight to the aircraft. Growth factor = $\Delta TOGW/\Delta W_{fixed}$. It is not feasible to develop an aircraft with a large growth factor because it will rapidly gain weight, or lose range/payload capability, in response to any additional airframe weight added during engineering and manufacturing development. A high growth factor reflects a risky design and means that meeting technology goals for weight reduction becomes very critical.

B. Attack Aircraft Trends

A comparison of the Attack aircraft designs highlights the influence of the differentiators used to define them. In table 16, for example, the conventional external carriage aircraft are similar in wing loading and aircraft T/W, indicating no fundamental difference between them. The Medium IW aircraft has a significantly lower wing loading and T/W, which is mostly due to the reduced parasite drag of the weapons. The Flying Wing’s reduced drag produced the lowest T/W and the lightest TOGW of the medium sized Attack aircraft. Individual Attack aircraft types are discussed below, starting with the influence of payload size.

Table 16. Baseline aircraft summary

Baseline aircraft	TOGW (lb)	Wing loading (psf)	T/W dry	T/W A/B	Structure/ empty	Empty/ gross	Fuel fraction (%)	Body diameteOr (ft)	Body length (ft)	T/W hover	Constraints 0.2M (g)	0.9M (g)	1.5M (SEP)
90 Fighter	57619	69.0	0.51	0.74	0.60	0.56	0.30	5.0	50.4	–	1.9	3.6	–
95 Fighter	53356	67.2	0.58	0.88	0.62	0.56	0.28	4.9	49.0	–	2.0	3.9	0
90 Light Attack	24777	75.2	0.51	–	0.50	0.59	0.22	4.6	38.2	–	1.5	–	–
90 Medium Attack	33438	72.8	0.52	–	0.54	0.57	0.23	4.5	45.2	–	1.5	–	–
90 Medium AW Attack	37573	72.9	0.51	–	0.51	0.59	0.22	4.5	48.2	–	1.5	–	–
90 Medium IW Attack	34486	68.4	0.45	–	0.52	0.60	0.18	4.6	49.8	–	1.5	–	–
90 Medium FW Attack	26392	31.8	0.33	–	0.50	0.59	0.17	4.5	–	–	2.0	–	–
95 Light Attack	21046	73.6	0.51	–	0.52	0.55	0.23	4.5	35.0	–	1.5	–	–
95 Medium Attack	27728	72.9	0.53	–	0.55	0.51	0.24	4.5	40.3	–	1.5	–	–
95 Medium AW Attack	31072	73.8	0.50	–	0.52	0.55	0.23	4.6	44.3	–	1.5	–	–
95 Medium IW Attack	29095	67.3	0.43	–	0.56	0.60	0.18	4.6	45.4	–	1.5	–	–
95 Medium FW Attack	25078	33.4	0.36	–	0.53	0.58	0.16	4.5	–	–	1.9	–	–
90 NFA	64315	81.3	0.57	0.87	0.58	0.48	0.44	6.0	59.9	–	1.5	3.1	–131
90 MRF	53072	91.5	0.59	0.90	0.53	0.45	0.46	5.9	58.5	–	1.5	3.0	–128
90 STOVL	80510	90.0	0.78	1.18	0.48	0.53	0.41	7.1	64.0	1.16	–	3.4	15
95 NFA	49471	66.1	0.77	1.22	0.55	0.49	0.41	5.3	52.7	–	1.7	3.8	0
95 MRF	41604	67.6	0.78	1.24	0.50	0.46	0.42	5.1	51.5	–	1.6	3.8	0
95 STOVL	46276	63.9	0.77	1.22	0.48	0.50	0.40	5.6	56.1	1.19	–	3.8	0

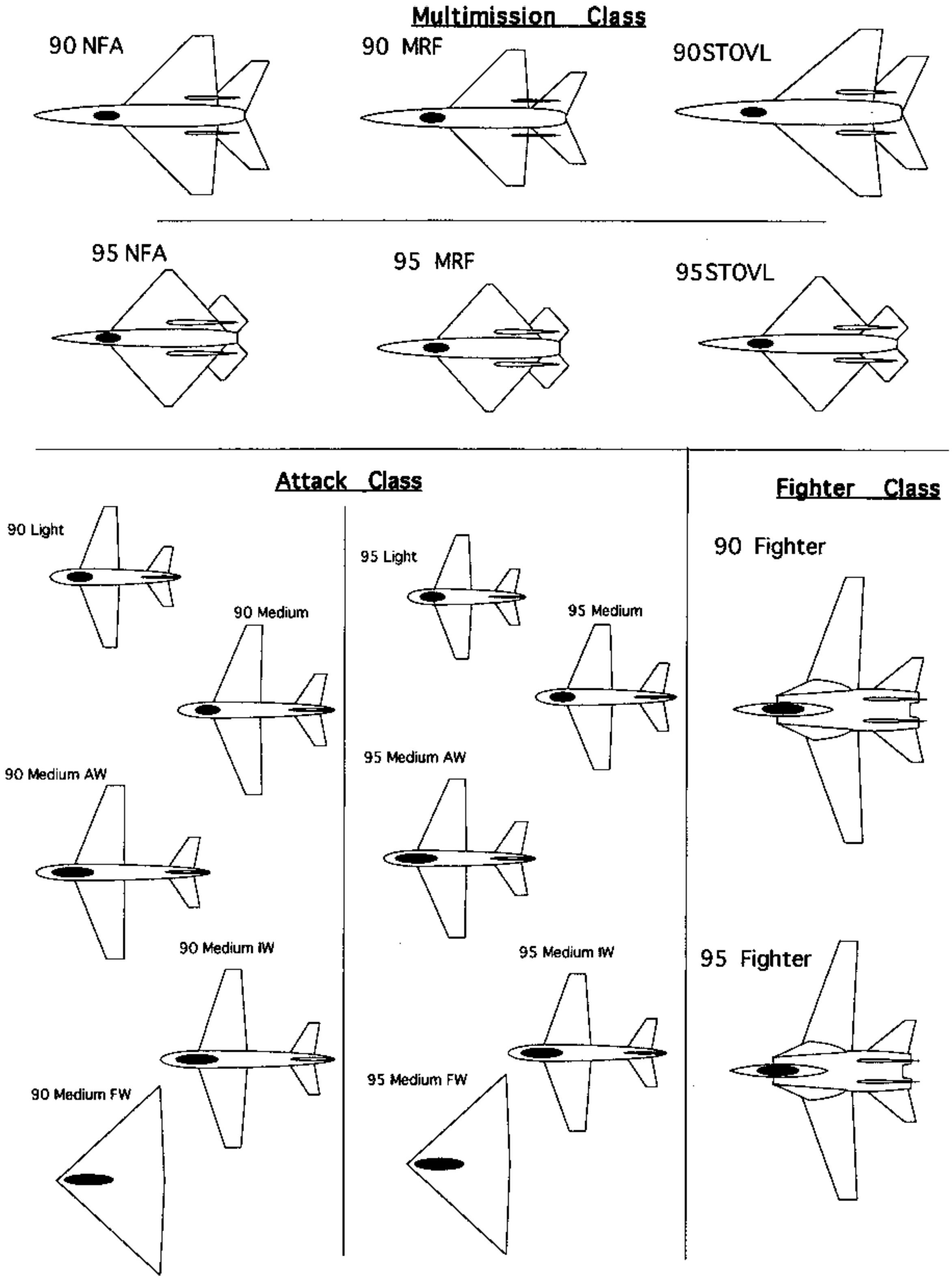

Figure 7. Comparison of aircraft classes.

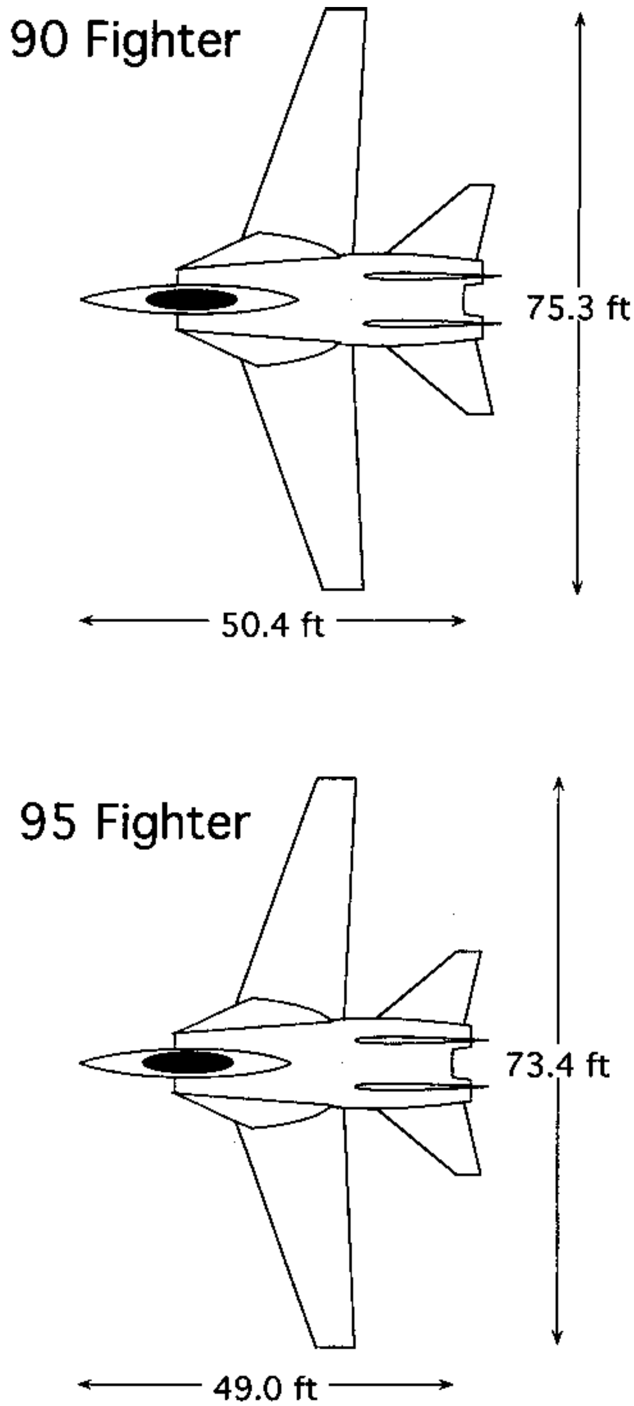

Figure 8. Fighter aircraft dimensions.

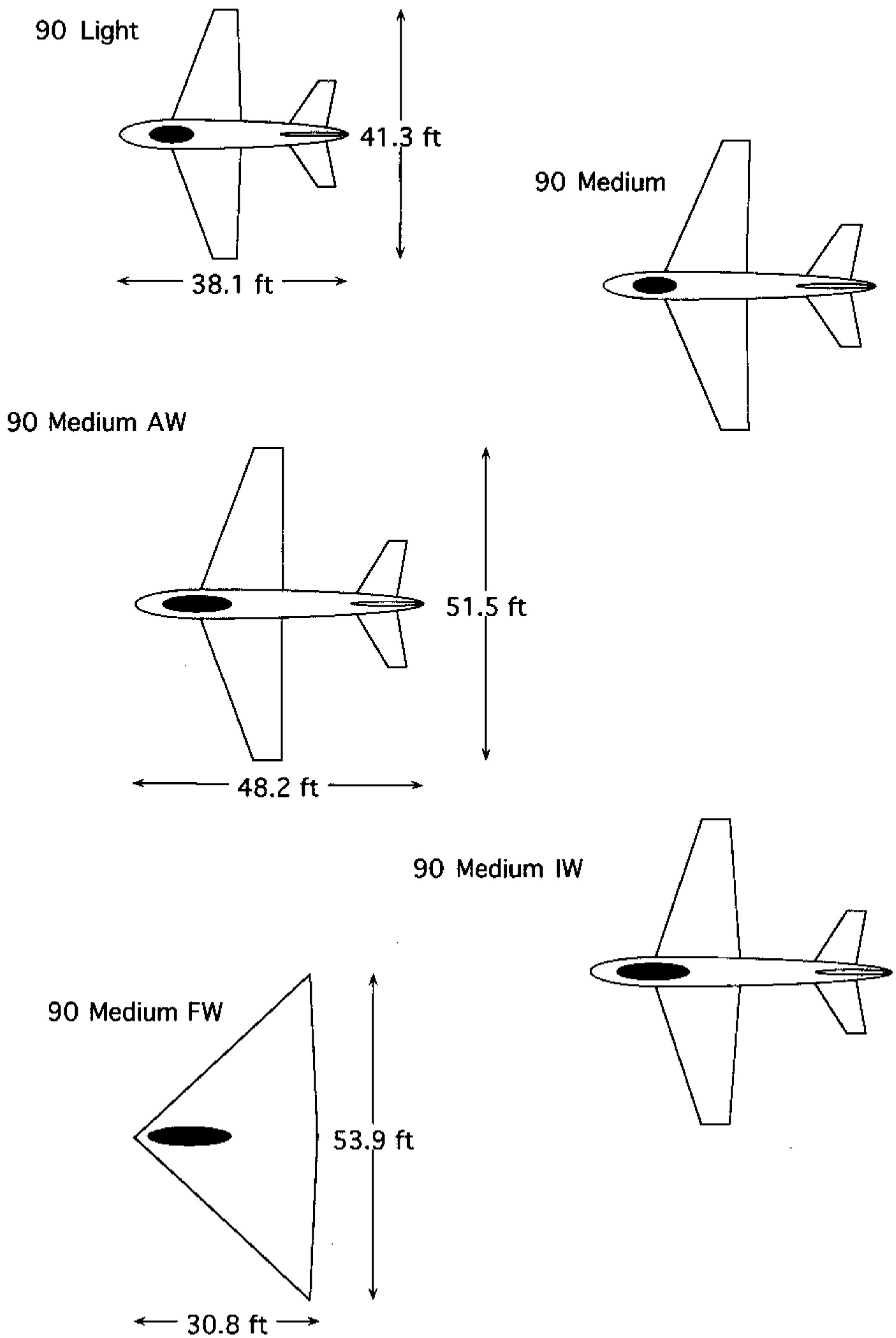

Figure 9. 1990-TAD Attack aircraft dimensions.

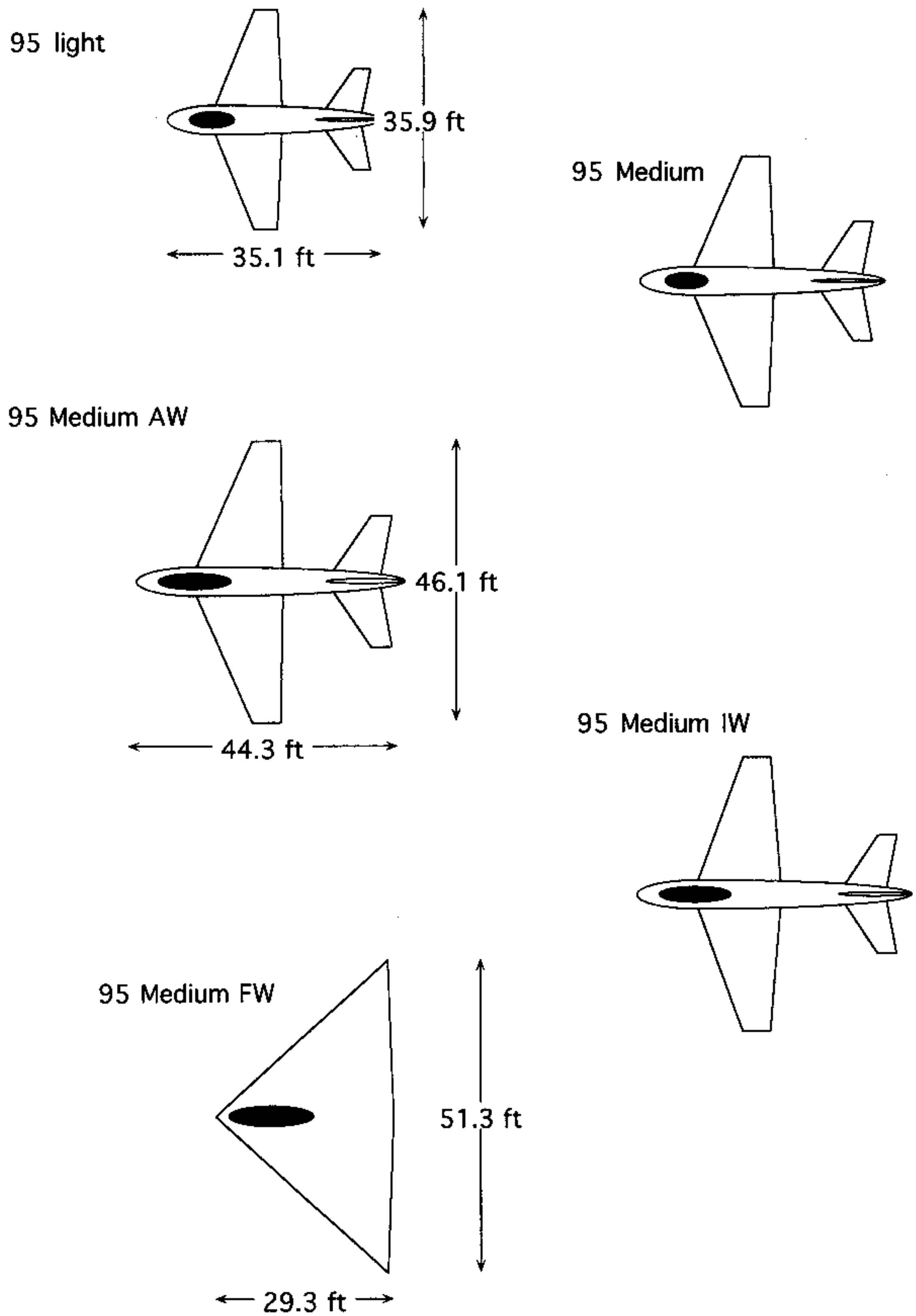

Figure 10. 1995-TAD Attack aircraft dimensions.

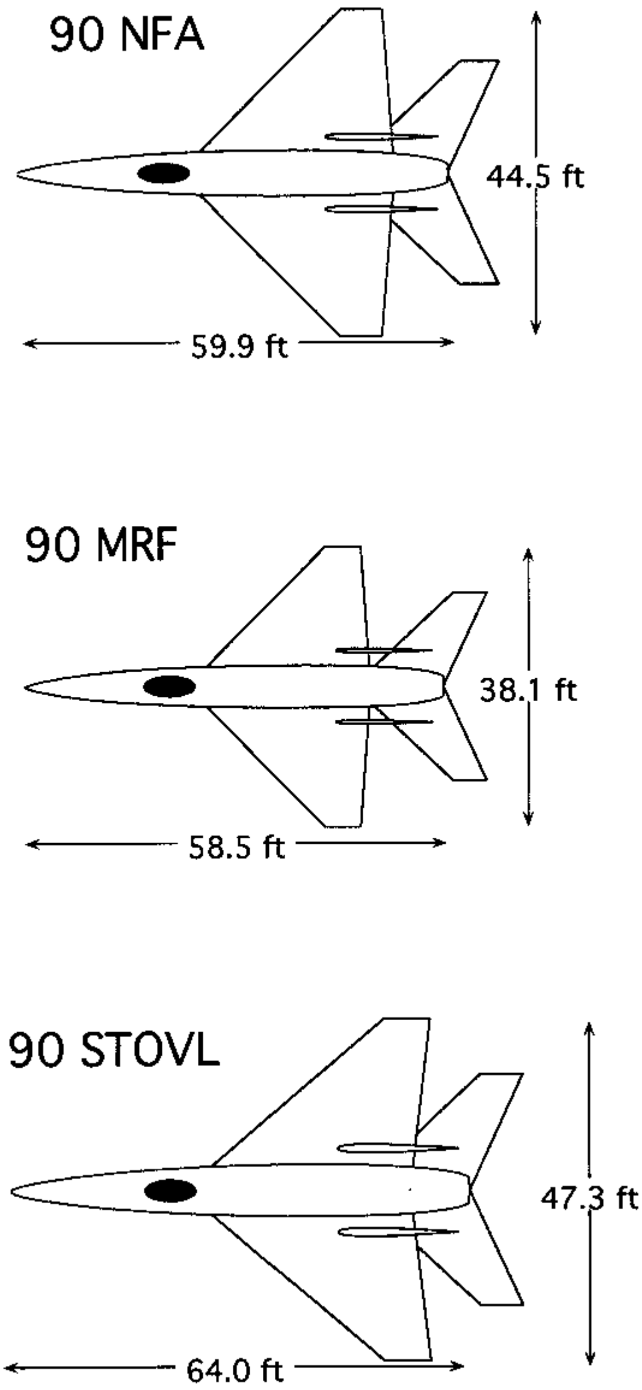

Figure 11. 1990-TAD Multimission aircraft dimensions.

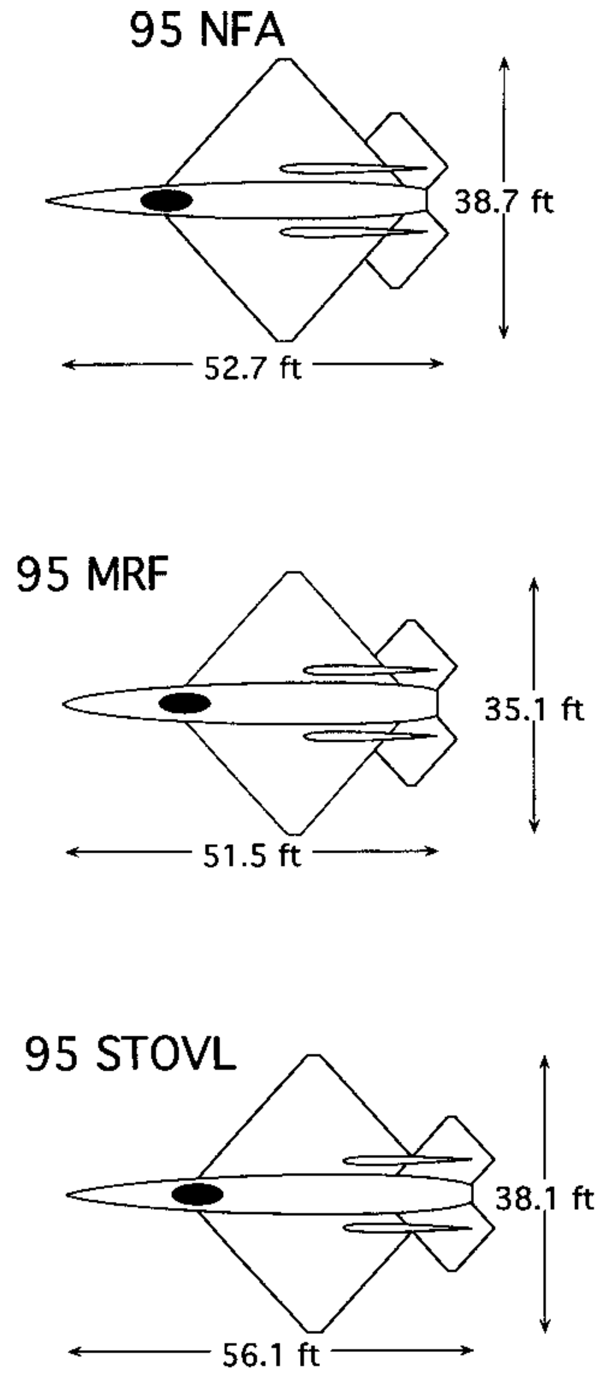

Figure 12. 1995-TAD Multimission aircraft dimensions.

Table 17. Maneuver performance of 1995-TAD Multimission and Fighter aircraft

	Multimission	Fighter
Wing area	724	794
Combat weight*	36606	41832
SLST AB	56610	46818
SLST dry	35731	30930
W/S	51	64
T/W AB	1.55	1.12
T/W dry	0.98	0.74

*Missiles away, 60% fuel

Condition	Required (US/UK ASTOVL)	Multimission	Fighter
Sustained g's			
0.5M SL dry	5	6	8.2
0.9M SL dry	6.1	7.1	9
0.9M 20k AB	6.2	7.3	7.8
1.2M 20k AB	5.5	8.7	8.7
0.2M SL AB		1.5	2.3
0.6M 15k AB		5.8	6.4
0.7M 30k AB		3.7	4.2
0.9M 30k AB		4.9	5.2
1.2M 40k AB		3.9	3.7
1.5M 50k AB		3	1.7
SEP			
1.4M 30k AB	500	902	748
0.9M 20k AB	620	875	573
0.9M SL AB	1000	1341	822
0.9M 30k dry		239	379
1.5M 50k dry		–2	82
0.9M SL dry		503	247

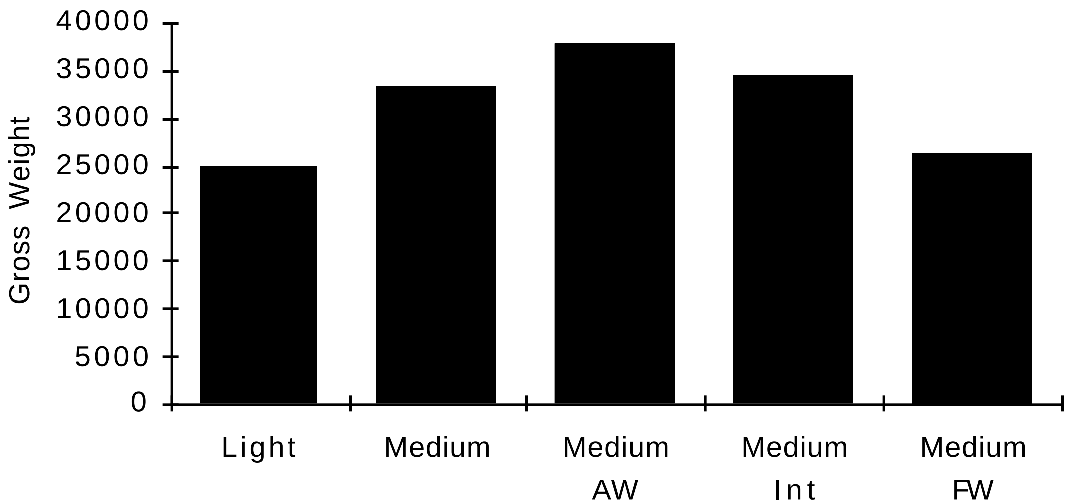

Figure 13. 1990-TAD Attack Aircraft TOGWs.

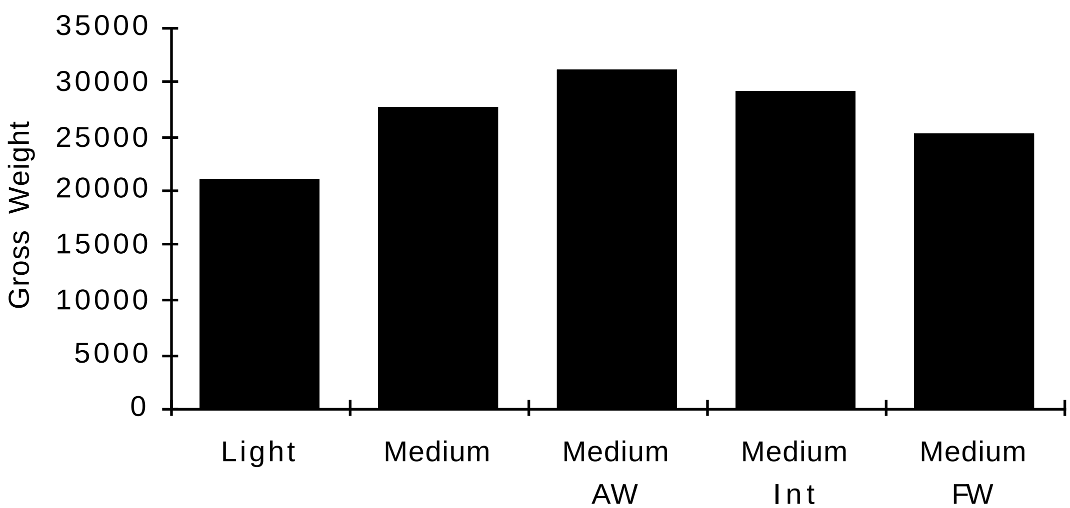

Figure 14. 1995-TAD Attack Aircraft TOGWs.

1. Two vs. Four Bombs

The only difference between the Light and Medium Attack types is the bomb load. Figures 13 and 14 show that carrying four bombs would require two Light Attack aircraft which outweigh a single Medium Attack by a factor of 1.5. This indicates that there is an economy of scale for a larger design payload weight. On the other hand, the additional 2,182 lb of payload results in a gross weight increase of 8,661 lb due to the increased weight and parasite drag, which means that carrying two extra bombs is a relatively severe weight penalty for the Light Attack aircraft.

2. One vs. Two Crewmembers

The sensitivity to having a second crewmember is shown by the difference in TOGW between the Medium and the Medium AW designs (figs. 13 and 14). The second crew-member and additional equipment weight of 1,954 lb yields an increase in gross weight of 4,135 lb (growth factor of 2.1). It was beyond the scope of this study to quantify the increased mission effectiveness of the all-weather aircraft. However, the change between the Light and the Medium designs (two to four bombs) was greater than the change between the Medium and the Medium AW in terms of both weight and growth factor, even though the weight increases were approximately the same for each change. This is partly explained by the fact that there was no direct drag penalty for the additional equipment weight inside the Medium AW while there was a drag penalty for the additional external bombs.

3. External vs. Internal Weapons

Figures 13 and 14 also show that the Medium IW is lighter than the Medium AW. The reduced drag of the internal weapon carriage more than compensates for the increased fuselage weight and volume associated with the internal weapons bays. To understand this, the impact of internal bays is discussed further. Also, keep in mind the assumptions made to model internal weapons carriage.

First, many successful aircraft have internal weapon bays so the benefits outweigh the penalties in at least some cases. Internal bays are competitive when mission requirements favor reduced parasite drag over the additional structure weight and volume. For example, the increased volume (and therefore drag and weight) incurred by carrying weapons internally has less impact for a subsonic aircraft than it might have for an area ruled supersonic aircraft. Also, since the weight of internal bays depends on their size, weapon loads that are small in relation to the aircraft size have a smaller weight penalty.

The internal bay structural weight penalty used for these Attack aircraft was an arbitrary 300 lb per bomb. A sensitivity study was performed to evaluate the impact on TOGW of doubling and tripling the bay structural weight penalty (table 18). It is significant that the Medium IW with double, and the Medium FW with triple, the bay weight are still lighter than the baseline Medium AW design.

There are two reasons why this penalty was not very significant in this study. First, finned weapons increase the internal bay volume required. Tail steering AIM-9 Sidewinders were used for self-defense and it was assumed that folding fin HARM missiles would be available.

Second, fuselage parasite drag did not increase significantly in response to the increased fuselage volume. Separation drag scales with body diameter which scales roughly to the one third power of volume. This means separation drag is very insensitive to volume changes.

Table 18. Attack aircraft sensitivity to internal weapons bay weight

	Baseline penalty	Double penalty	Triple penalty
1990 Medium IW	32459	35185	37478
1990 Medium FW	26392	29093	32201
1995 Medium IW	29095	31103	33736
1995 Medium FW	25077	26875	28913

Skin friction scales with the surface area which scales roughly to the two thirds power of volume. While this is more sensitive than separation drag, it is still not a major penalty. The one source of drag that does vary more or less directly with volume is compressibility, or wave drag. Since the maximum Mach number was 0.85, the effects of compressibility were small.

Another issue with internal bays is that they tend to be operationally restrictive; some loads may be too bulky to carry. In this study, for example, the four cluster bombs used in the Close Air Support (CAS) fallout mission weigh less than half of the design payload weight but still use all four bomb bays. In this case, additional fuel had to be carried externally even though there was volume wasted in each bay.

4. Conventional vs. Medium FW Planform

Figures 13 and 14 also show that the Medium FW designs are lighter than the other Medium Attack aircraft. They also have the lowest aircraft T/W, the lowest fuel weight, and the best waveoff capability of all of the aircraft. This impressive performance resulted from eliminating the vertical and horizontal tails which saved weight, wetted area, and interference drag. The Medium FW traded these penalties for the additional cost and complexity of fly-by-wire control systems and artificial stability that would probably be required to achieve acceptable lateral/directional handling qualities.

Also, the Medium FW does not have to meet tail volume requirements which can size the fuselage on conventional aircraft. All other things being equal, increasing the tail’s moment arm (to reduce tail size) lengthens the fuselage which is less structurally efficient than a shorter fuselage of the same volume.

As stated before, the Medium FW has no interference drag and only half of the separation drag of a conventional fuselage and wing configuration. When clean minimum drag coefficient (C_{Do}) was examined, the Medium FW C_{Do} initially appeared to be very optimistic, with about one third of the drag of the other Attack designs (fig. 15). However, the Medium FW's large wing area artificially reduces C_{Do}.

To better understand this, drag coefficient is again plotted in figure 16, this time normalized by the aircraft total wetted area (C_{Dwet}) rather than wing planform area. Since skin friction typically accounts for 70% of subsonic drag in a well designed aircraft, C_{Dwet} is a better figure of merit for comparing Medium FW and conventional designs. Wetted area is a characteristic area that includes all of the drag-producing airframe components rather than just the wing. C_{Dwet} shows that the Medium FW does not have an excessive drag advantage. The 16% lower C_{Dwet} was expected and was due to the reduced boattail and interference drag of the Medium FW.

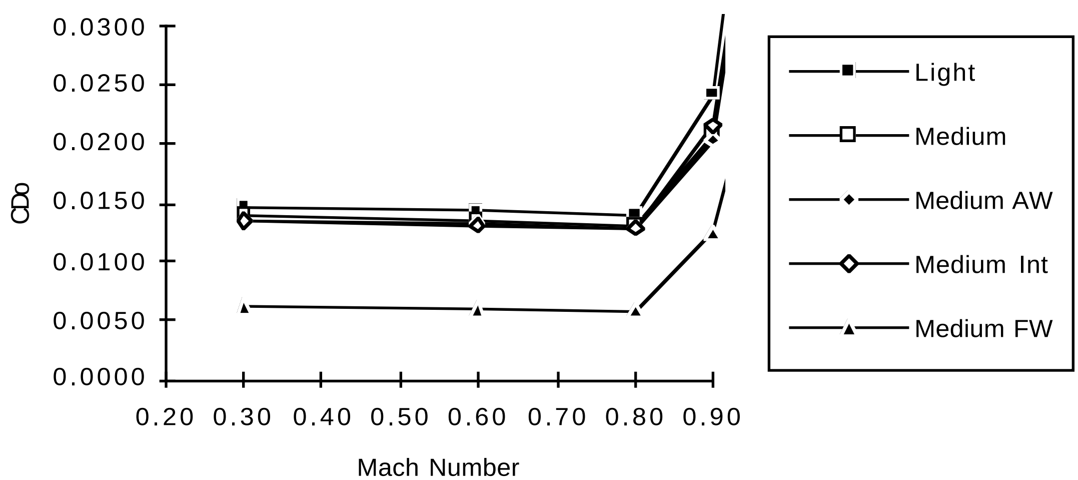

Figure 15. Zero lift drag coefficient vs. Mach number for 1995-TAD Attack aircraft without stores (C_{Do} referenced to wing area).

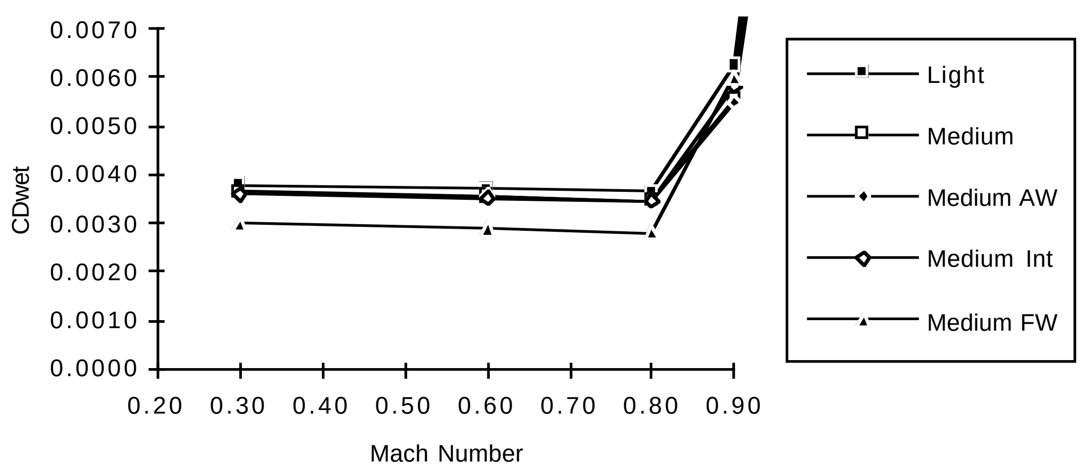

Figure 16. Zero lift drag coefficient vs. Mach number for 1995-TAD Attack aircraft without external stores (C_{Dwet} referenced to total wetted area).

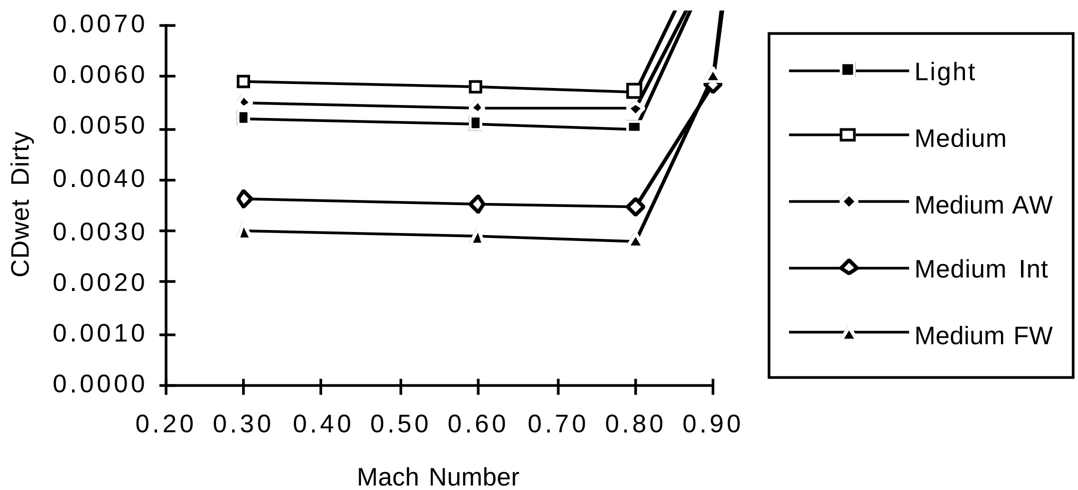

Figure 17. Zero lift drag coefficient vs. Mach number for 1995-TAD Attack aircraft with stores (C_{Dwet} referenced to total aircraft wetted area).

Figure 16 shows that the Medium IW drag was similar to the external carriage designs because the drag plotted does not include stores. Figure 17 compares the drag of these aircraft with weapons, which is perhaps the most appropriate way to compare these aircraft. The aircraft with internal weapons show no increase in zero lift drag, but the parasite drag of the external stores adds 35% to the drag of the other designs. This is why the aircraft T/W for the external carriage designs, and therefore the TOGWs, are higher. Even without the bombs, the drag of just the external carriage equipment typically increases C_{Do} by 17%.

Finally, in the event that our estimated C_{Do} was too low, the sensitivity of the Medium FW to C_{Do} was evaluated. The impact of a 50% increase in minimum drag (from 0.06 to 0.09) was to increase TOGW by 9.9% and the Medium FW was still the lightest aircraft. This also demonstrates that the Medium FW's low C_{Do} contributed less to its low TOGW than did eliminating the vertical tail weight and drag, and the boattail, interference, and external weapon drags.

5. Technology

Figures 13 and 14 do not show much change in Attack aircraft TOGW between the two technology timeframes. Figure 18 combines these data to show the aircraft weights decreasing slightly with improving technology. The improvements with increased technology levels are not very pronounced compared to the supersonic aircraft because the subsonic aircraft are less sensitive to weight changes (low growth factor) and the Interdiction design mission did not challenge the Attack aircraft at the technology levels used.

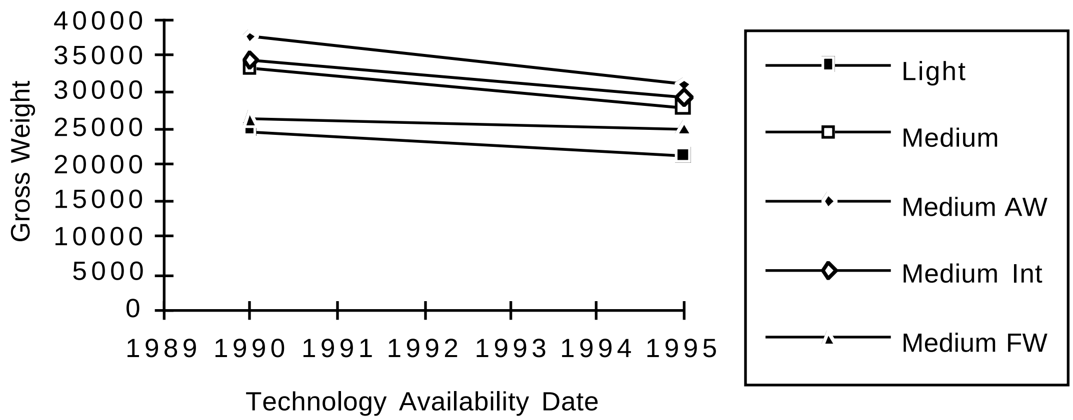

Figure 18. Effect of technology on Attack aircraft.

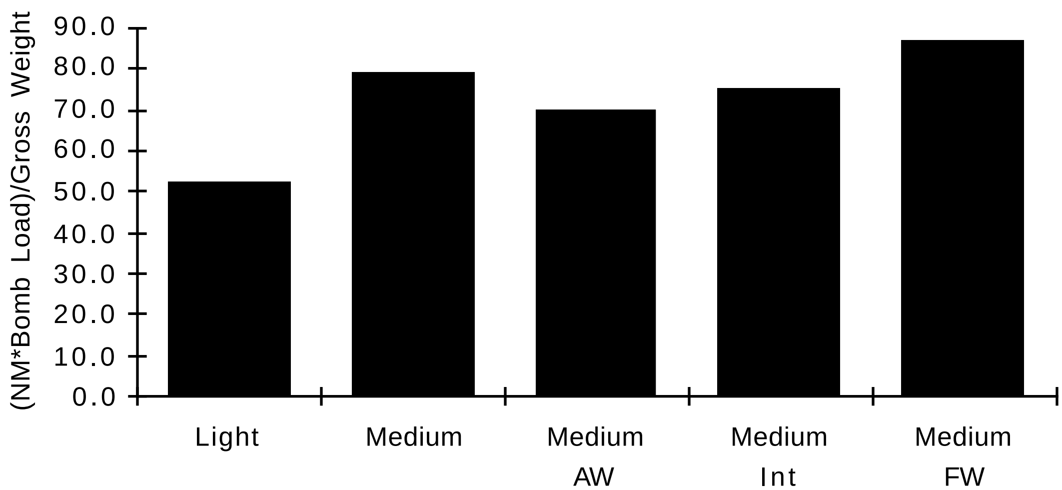

Figure 19. Comparison of range/payload capability of 1995-TAD Attack aircraft on the design mission.

6. Range-Payload Efficiency

Figure 19 compares the relative range-payload efficiency of the 1995-TAD Attack aircraft types on their design mission since they do not have the same weapon load. Since aircraft weight is an indicator of cost, normalizing by TOGW was a simple way of evaluating the relative cost effectiveness of these aircraft. There appears to be an economy of scale for the Medium Attack aircraft since one Medium Attack aircraft has the same range-payload capability as two Light aircraft even though it weighs 65% of the two Light aircraft. This analysis, of course, does not address the increased reliability and operational flexibility of operating two small aircraft compared to a single larger one.

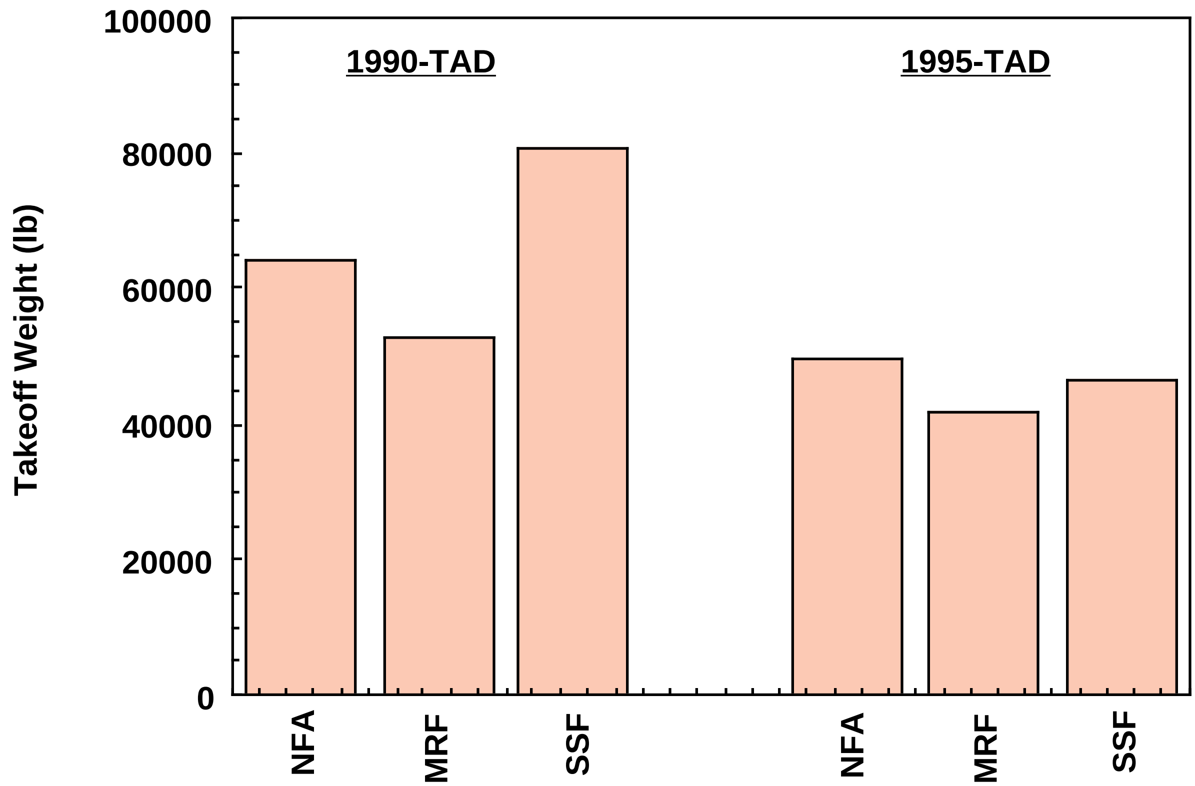

Figure 20. Comparison of baseline Multimission aircraft.

C. Multimission Aircraft Trends

Figure 20 shows that, as expected, the land-based aircraft (MRF) was the lightest in both timeframes. Access to a long runway yields the lightest aircraft design because the carrier slow approach requirement and structural reinforcements are weight drivers for the NFA.

The TOGW trends between the 1990-TAD and 1995-TAD timeframes in figure 20 are driven by the balance between improved technology and tougher requirements. These two trends oppose each other but figure 20 indicates that, for all of the aircraft, the technology improvements used in this study more than compensate for the tougher requirements. Since external weapons and carriage equipment increase drag by 25% over the clean aircraft at 0.6M, it is also reasonable to believe internal weapons benefit the supersonic Multimission aircraft.

Figure 20 also shows the surprising result that the SSF, for all the unique capability it offers, is approximately the same size as the NFA in the 1995-TAD timeframe. Contrast this to the 1990-TAD timeframe where the SSF aircraft is by far the heaviest aircraft, which agrees with the long-held perception that STOVL capability costs a 20% increase in TOGW. Understanding the influence of requirements and technology level on the relative ranking of the SSF aircraft can shed light on this perhaps surprising result.

1. Impact of Requirements

Table 19 summarizes the active sizing constraints for all of the Multimission aircraft. The most important change was that the 1995-TAD SSF's engine was sized, not by hover as in the 1990-TAD timeframe, but by the same dry supercruise requirement that sizes the engine for the other Multimission aircraft. The SSF was relatively insensitive to the additional supercruise and maneuver requirements of the 1995-TAD timeframe because it already had a high aircraft T/W in the 1990-TAD timeframe (its engine was sized for hover without thrust augmentation such as ejectors or burners).

Table 19. Active sizing constraints for Multimission aircraft

	SSF	NFA	MRF
1990-TAD			
Wing size	Unconstrained	Waveoff	Maneuver
Engine size	Hover	Maneuver	Maneuver
1995-TAD			
Wing size	Maneuver	Maneuver	Maneuver
Engine size	1.5M dry	1.5M dry	1.5M dry

To explore this further, figure 21 shows the impact of requiring all three of the 1990-TAD aircraft to perform a dry supercruise. In this case, the aircraft TOGWs are closer because they are all being sized by the same requirements. The SSF weight in this figure is the same as the 1990-TAD SSF in figure 20 because it could already dry supercruise; the weight penalty associated with its higher T/W provides the SSF with additional capability beyond merely improving maneuver and dash performance. Additionally, the dry supercruise requirement has a larger impact on the NFA than on the MRF because of the NFA's navalization weight penalties.

Since the wing and engine for all of the 1995-TAD aircraft were sized by the same requirements (table 19), it was the sum impact of the aircraft differentiators which determines the ranking of these aircraft. In this case, the SSF has a similar TOGW to the NFA because the two aircraft have roughly equal weight "penalties" (structural for the NFA versus propulsion system for the SSF).

It is also interesting to compare these dry supercruise aircraft to the 1990-TAD SSF because the effect of technology improvement is more nearly isolated from the dry supercruise requirement. The effect of changes in the maneuver requirements and weapon carriage is that the 1995-TAD aircraft are about 35% lighter than the 1990-TAD aircraft.

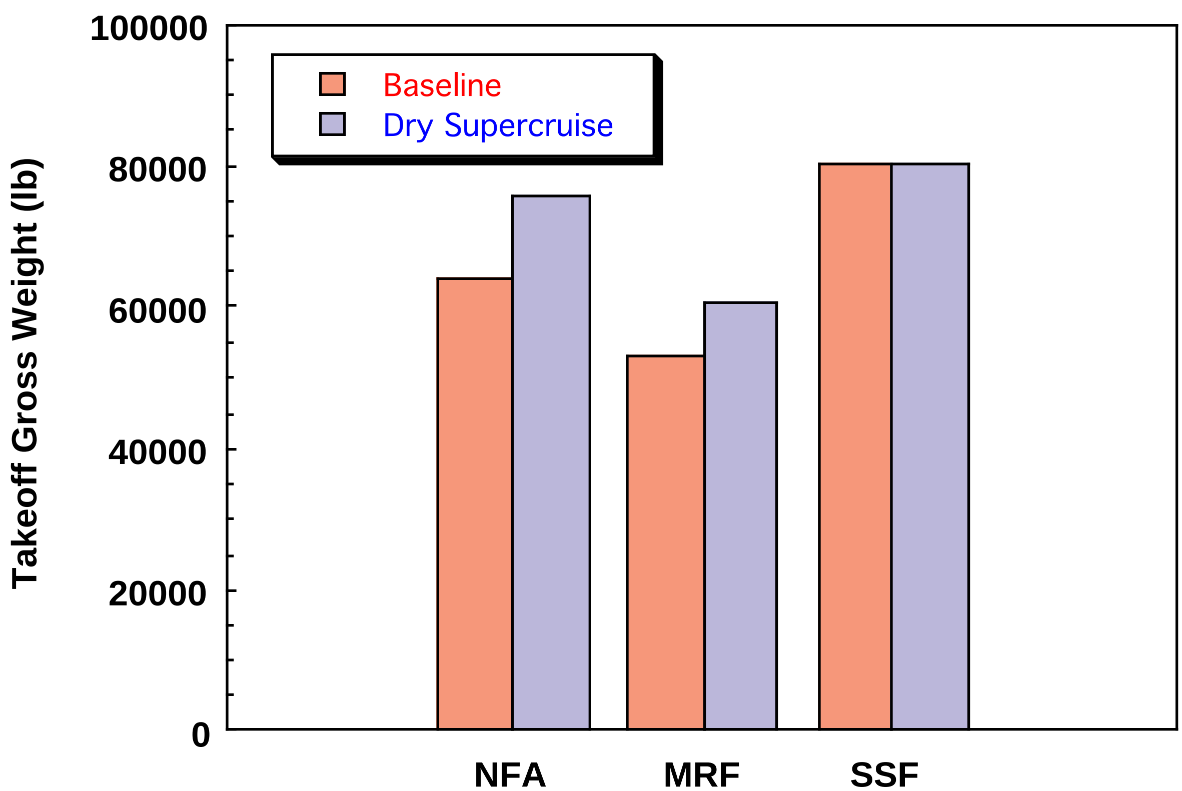

Figure 21. Effect of requiring dry supercruise for 1990-TAD Multimission aircraft.

The impact of allowing the 1990-TAD SSF aircraft to augment its thrust in hover was also evaluated. The 1990-TAD SSF (fig. 20) propulsion system operates in hover mode without augmentation (such as ejectors or burners). This produced the high aircraft T/W which allows the aircraft to perform a dry supercruise. Figure 22 compares the baseline MRF and NFA to an SSF aircraft with thrust augmentation in hover. In this case, the SSF's engine is sized for up-and-away performance like the NFA and its weight is similar to the NFA. Again, the carrier-landing penalties are similar to the STOVL weight penalties. For this study, hover thrust augmentation was provided by afterburners in the lift nozzles without any weight penalty. In other words, this was an ideal augmentation scheme and the resulting aircraft was somewhat optimistic.

These comparisons highlight the tremendous impact mission requirements have on these aircraft. The bottom line is that with dry supercruise, or perhaps some other maneuver requirement, the T/W required for both hover and up-and-away mission requirements are well matched, even for STOVL concepts with little or no augmentation. In this study, the 1995-TAD mission requirements are similar to ATF-level requirements, even though the 1995-TAD technology levels in this study are higher than ATF levels.

It is interesting that the hover sizing of the engine has historically been STOVL's Achilles' heel. Typically, to have sufficient thrust for hover required an oversized engine with its excessive propulsion weight and fuel consumption during cruise. This led to the development of numerous vertical thrust augmentation schemes, all of which increase weight, cost, and development risk (e.g., poor transition performance). With increasing mission requirements for tactical aircraft in the future, hover may cease to be the engine sizing condition and may not be the major STOVL TOGW driver it has been in the past.

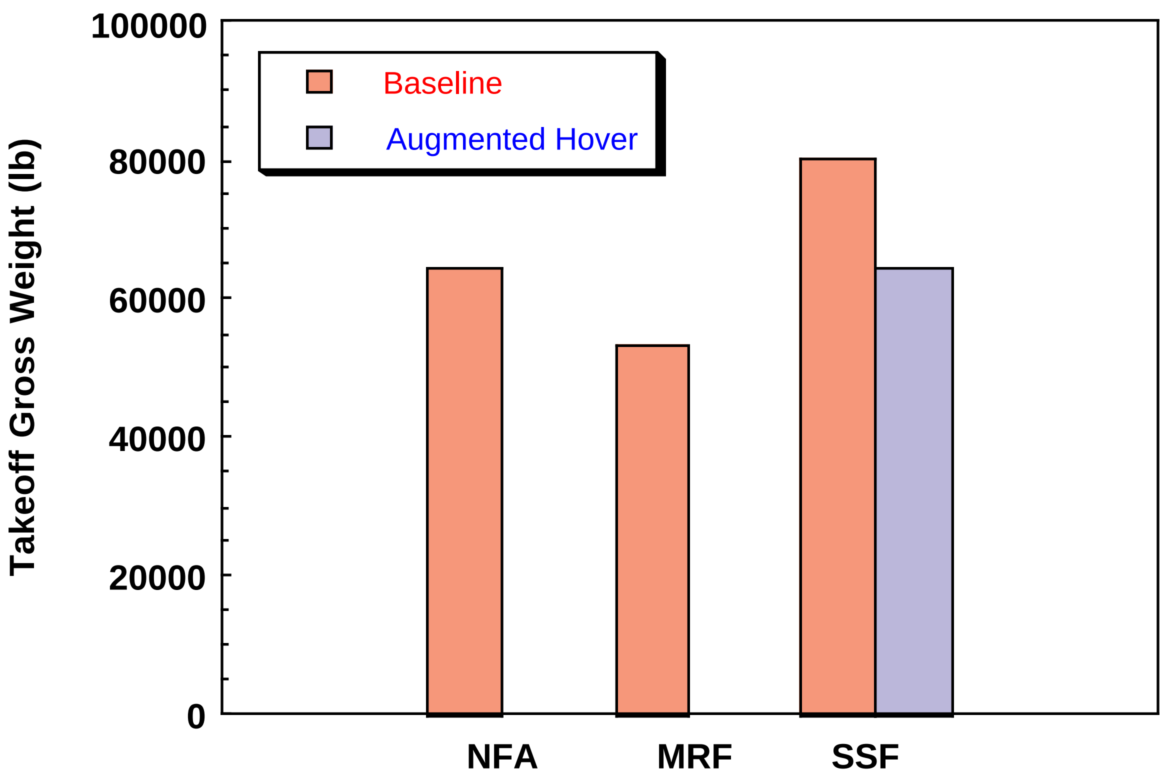

Figure 22. Effect of hover thrust augmentation on 1990-TAD SSF.

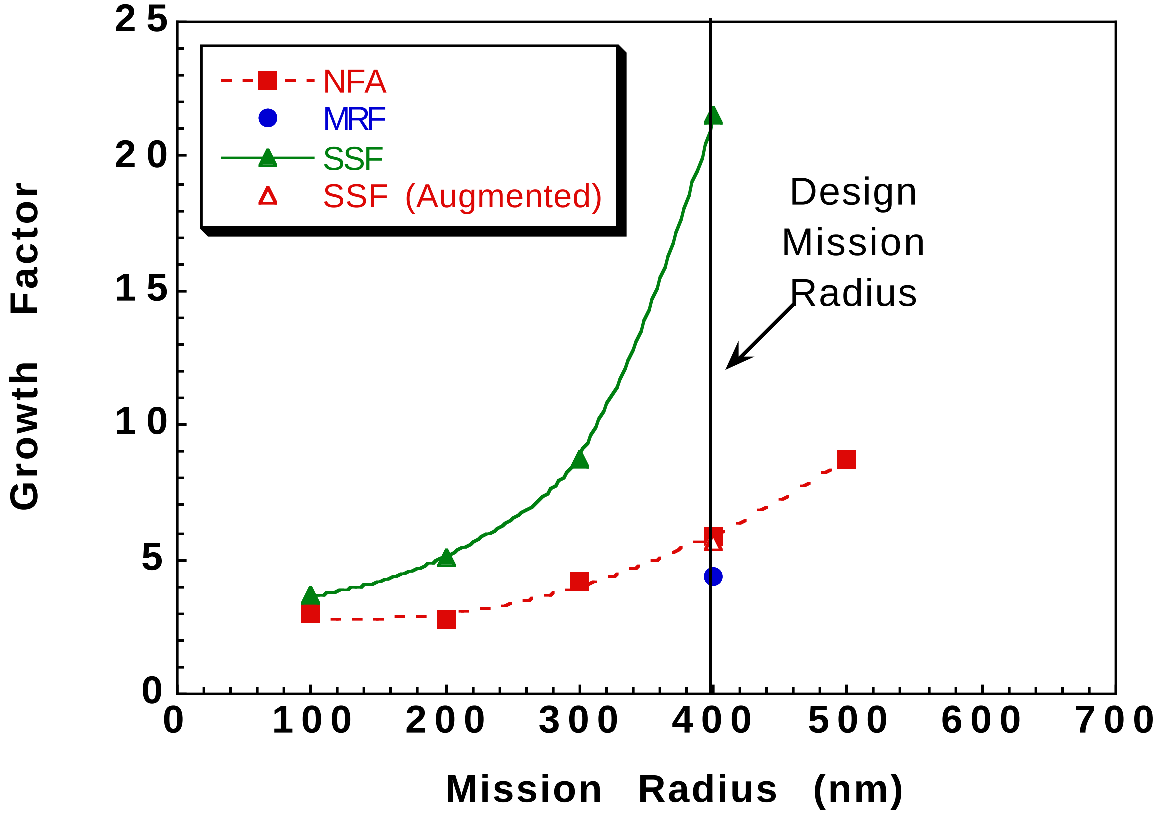

Figure 23. Comparison of growth factor for the 1990-TAD aircraft.

2. Impact of Technology

The impact of changing technology on Multimission aircraft can be understood in terms of aircraft growth factor. In turn, growth factor trends (as a function of aircraft TOGW) can be generated by resizing aircraft with varying mission requirements. The growth factor data for the 1990-TAD aircraft presented in figure 23 were calculated by first sizing each aircraft type for missions of varying length and then resizing the resulting aircraft with an a small fixed weight added.[9] For completeness the growth factor for the augmented SSF (from fig. 22) is also shown. For reference, currently existing aircraft in the Multimission class typically have a growth factor of approximately 3.5–4.0.

At the mission range of interest, the NFA growth factor is fairly high, but the SSF growth factor is unacceptable. The SSF is heavy enough that its TOGW is much more sensitive to mission requirements than the NFA at this range. The SSF growth factor is excessive because it has no thrust augmentation in hover and must support its entire empty weight in hover. This drove engine size up with a subsequent cyclic increase in empty weight, which resulted in the engine being oversized for the up-and-away parts of the mission. Contrast this to conventional aircraft which generate lift relatively efficiently at landing speed with its wings.

Even though STOVL aircraft tend to grow very quickly at comparatively lower requirement levels, all aircraft have mission requirements that result in unacceptable growth factor. For example, 400 nm range appears to be a difficult requirement for the NFA in the 1990-TAD timeframe.

[9]Aircraft also have growth factor trends relating to other requirements such as weapons load, speeds, maneuver requirements, etc.

One option to bring the 1990-TAD SSF's growth factor to a level comparable to the other aircraft's is to reduce the mission requirements. This is historically what has been done to produce a viable STOVL concept without augmentation, such as the Harrier AV-8A which did not have the mission capability of its conventional counterparts. Another option is vertical thrust augmentation to prevent over-sizing the engine. However, development of an augmented propulsion system incurs additional weight, development risk, and cost.

Figure 24 shows the growth factors for the 1995-TAD aircraft. More difficult requirements tend to shift the curves to the left and technology improvements shift the curves to the right. The curves in the figure have shifted to the right so that at the desired mission range, the growth factor for the SSF is nearly the same as the NFA. Improvements in engine T/W and structural weight from the 1990-TAD to 1995-TAD timeframe confer greater benefits on the SSF than the other aircraft because they both directly affect hover weight which was the engine sizer using lower technology. This is an important factor in understanding why the SSF aircraft is in the same weight class as the conventional aircraft in the 1995-TAD timeframe. Note that the MRF still has the lowest growth factor.

Note that if the 1995-TAD range requirement had been increased to 600 nm, for example, the SSF would have again been an unfeasible design without some type of thrust augmentation in hover. This growth factor sensitivity shows that STOVL aircraft competitiveness with conventional aircraft depends on its size. STOVL aircraft will not be competitive with conventional aircraft beyond a certain level of requirements such as mission range.

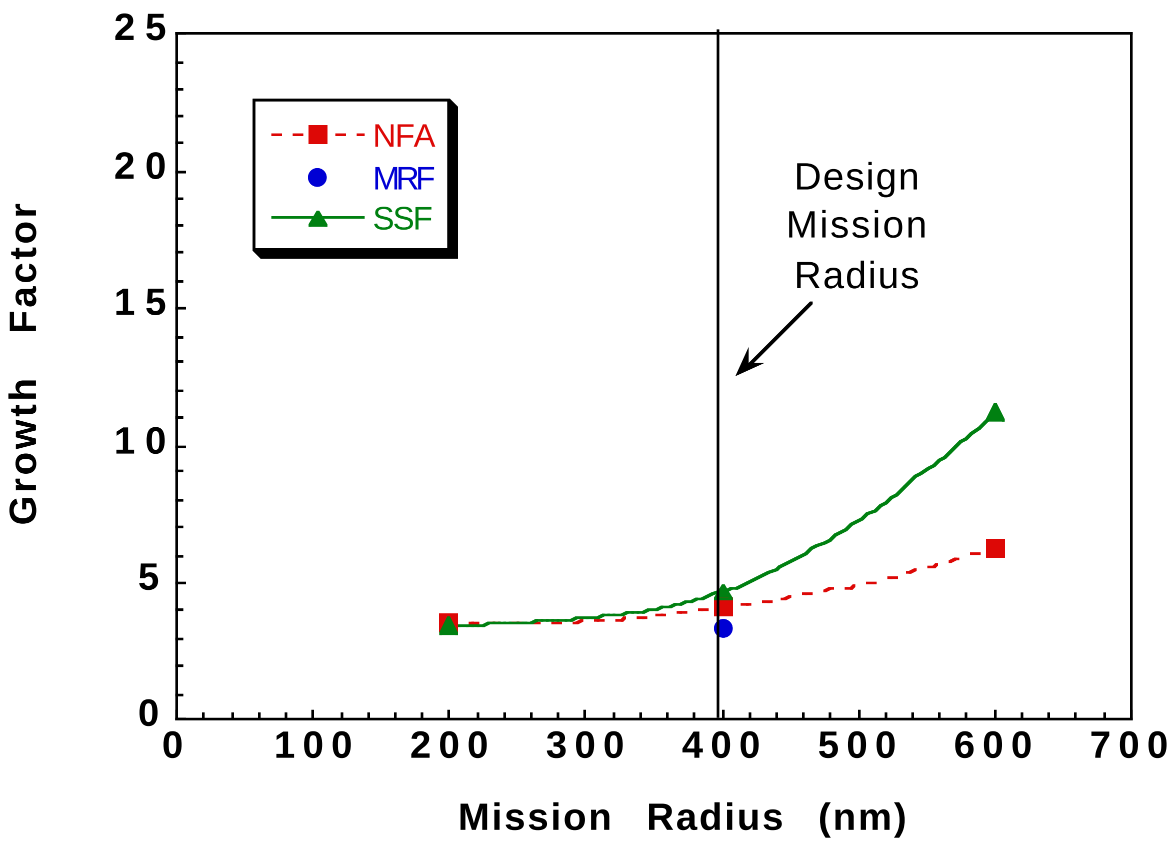

Figure 24. Comparison of growth factors for the 1995-TAD aircraft.

Figure 25 compares the fuel fraction (weight of fuel divided by TOGW) of the 1990-TAD Multimission aircraft to existing inventory aircraft. Both the SSF and NFA have fuel fractions that are considerably higher than existing aircraft at 400 nm and comparable to them at 200 nm. Notice that a reasonable growth factor (fig. 23) also occurs at 200 nm. If a fuel fraction of 30% is taken to be a practical upper limit, one could conclude that the upper limit to mission radius for these aircraft in this timeframe is 200–250 nm and that a growth factor of 5 represents a maximum upper limit.

From the foregoing discussion, it is clear that the SSF aircraft was more sensitive than its conventional counterparts to the 400 nm mission range used in this study. Also, remember that the design mission used in this study was somewhat oversized. These two factors together explain the extreme size of the 1990-TAD SSF.

3. Impact of Hover T/W required

Hover T/W was one of the most important aircraft design parameters for the STOVL aircraft. Unfortunately, this value is made up of several elements that are difficult to estimate at the conceptual design stage (suckdown, hot gas reingestion, power extraction for attitude control, etc.). Since the 1995-TAD SSF's engine was not sized by the required 1.16 hover T/W, the impact of a T/W_{hover} requirement of 1.257 and 1.345 was analyzed. This shows the impact of requiring an increase in hover T/W in the event that, for example, unexpectedly high levels of suckdown were encountered during development. Figure 26 shows the SSF TOGW compared to the baseline NFA and MRF (indicated by horizontal lines). The TOGW of the SSF is relatively insensitive to T/W_{hover}. The SSF was actually lighter than the NFA until a T/W_{hover} of ~1.3 was required. Since this study was conceptual in nature, it is not very important which aircraft was actually lighter, but it is important that the required T/W_{hover} assumed in this study does not invalidate the conclusion that the 1995-TAD SSF is comparable in weight to the NFA.

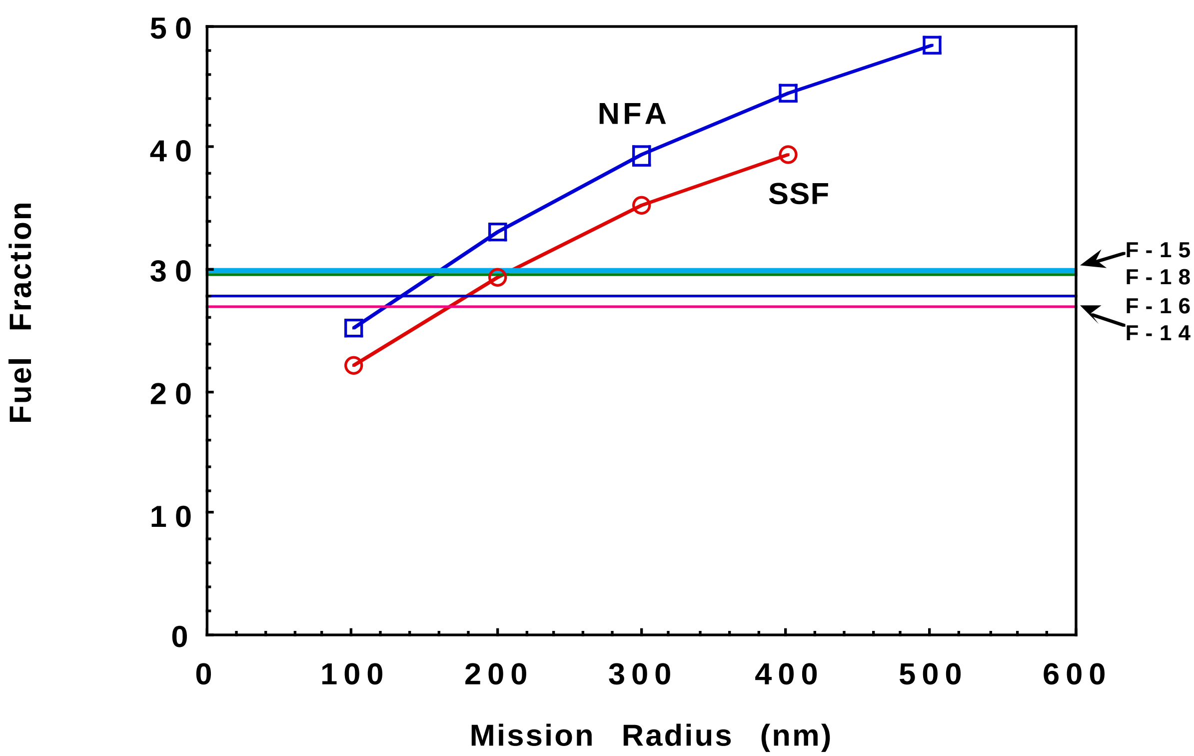

Figure 25. Fuel fraction of 1990-TAD Multimission aircraft as a function of mission radius.

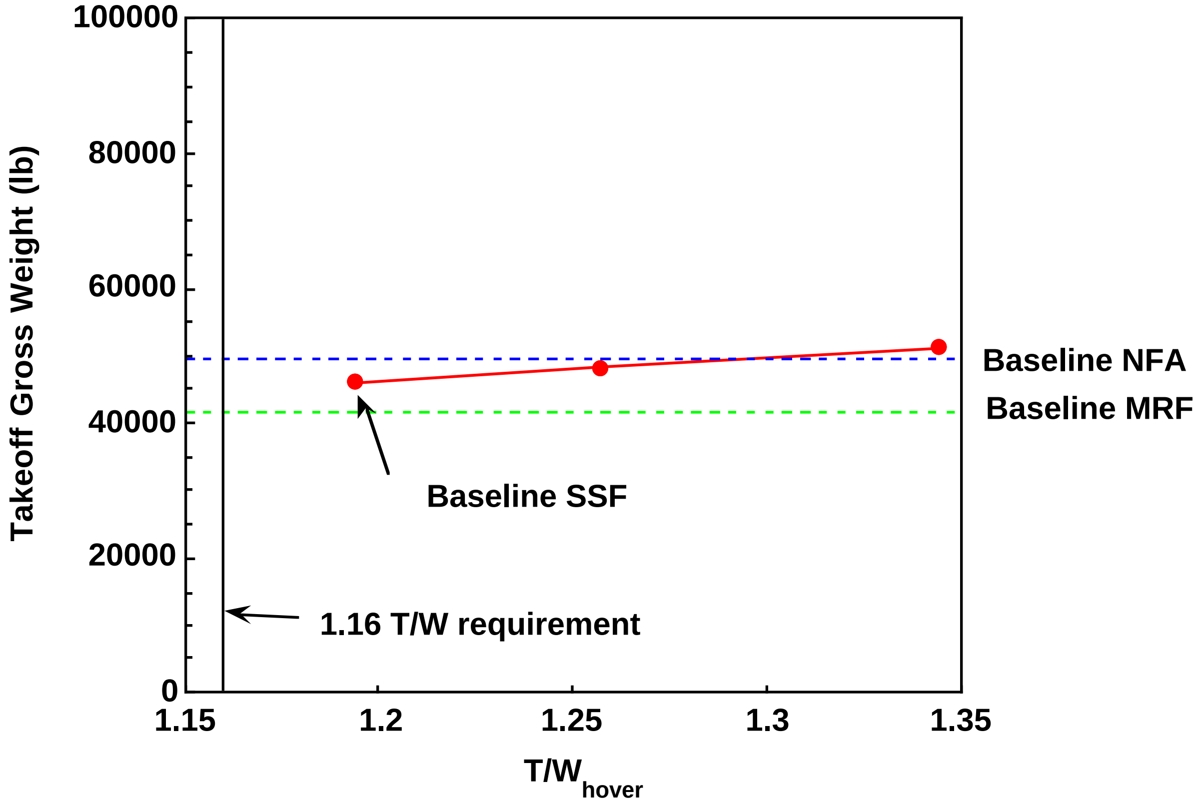

Figure 26. Effect of hover thrust-to-weight on the 1995-TAD SSF aircraft.

D. Operational Mission Performance Data

Some of the aircraft were evaluated to determine their operational capability in the DLI, CAP, and Strike roles. NFA, SSF, and MRF performance is so similar that they are reported here (and in the figures) as “Multimission.” Also, mission radius reported in this section is only for the fallout cruise segment and does not include climb, combat, and acceleration. See Appendix C for a description of these SSF DOC missions.

The Strike and DLI missions were flown exactly as specified in the SSF DOC. The Strike mission was used to determine the mission radius as a function of the number of bombs carried. The DLI mission was used to evaluate the effect of cruise Mach number on mission radius and dash capability. To evaluate CAP capability, the Fighter design mission was used to examine the impact of loiter time on mission radius. The original SSF DOC CAP mission was not used because it did not have a supersonic cruise segment. On all of these fallout missions, weapons were released, as specified in the SSF DOC missions, rather than retained as they are in the design missions.

1. Strike Range vs. Payload

The strike mission operational fallout measures the trade-off between the number of bombs carried and mission radius. Results are shown in figure 27 for the 1995-TAD aircraft. The 50 nm ingress phase was added to the fallout cruise segment so that total radius is reported.

In general, fallout performance at design TOGW with extra payload was poor because a high percentage of fuel was off-loaded to maintain TOGW. Since the Fighter and the Medium Attack aircraft were designed to carry four weapons, fuel was added to maintain design TOGW when carrying only two bombs. Similarly, a payload of four or more bombs exceeds design load for the Light Attack and Multimission aircraft so fuel was removed to maintain design TOGW. For all of the Medium Attack designs, the fifth bomb was mounted on a short, centerline pylon and fuel was removed to maintain design TOGW. The maximum number of bombs carried is ten for the Multimission and eight for the Fighter with dramatic reductions in the fuel load.

Performance of the 1995 Medium FW falls off dramatically when carrying five bombs. This was due to the addition of parasite drag and weight for the fifth bomb and, more importantly, the loss of fuel. Of the total 4,127 lb of design fuel load, only 1,803 lb was used for the original design mission cruise phases. Subtracting 1,291 lb for the fifth bomb and its carriage equipment yields only 512 lb of fuel (a 60% decrease) for the Strike cruise phase. Notice that, at design TOGW, the Multi-mission aircraft can carry four bombs further than the Light Attack aircraft (Attack weighs half as much as the Multimission). This is because the Light Attack aircraft was small and, as a result of its all-subsonic mission, has a low fuel fraction compared to aircraft with supersonic mission segments.

Another important consideration is that an aircraft may not be able to land with all of the bombs it took off with. The Medium Attack aircraft, for example, was designed to meet the 1.5g waveoff maneuver carrying the design bomb load and any extra load must be jettisoned prior to landing. Only the Medium FW has the excess waveoff capability to bring back the extra bomb.

A second method of evaluating strike performance is at an overload TOGW condition (called overload in fig. 27) that takes advantage of the extra capability inherent in Fighter and Multimission aircraft with their high T/W and high structural limits. The range of aircraft operated this way was considerably better than for aircraft with less than design fuel. The maximum overload TOGW (~120% of TOGW) for each aircraft includes full design fuel load and either ten bombs for the Multimission aircraft or eight for the Fighter aircraft. To evaluate an aircraft and hold its maximum overload TOGW constant, bombs were traded for fuel in external tanks to generate these sensitivity numbers. In other words, overload weight is determined by adding the maximum number of bombs. This overload weight is held constant by adding external fuel as

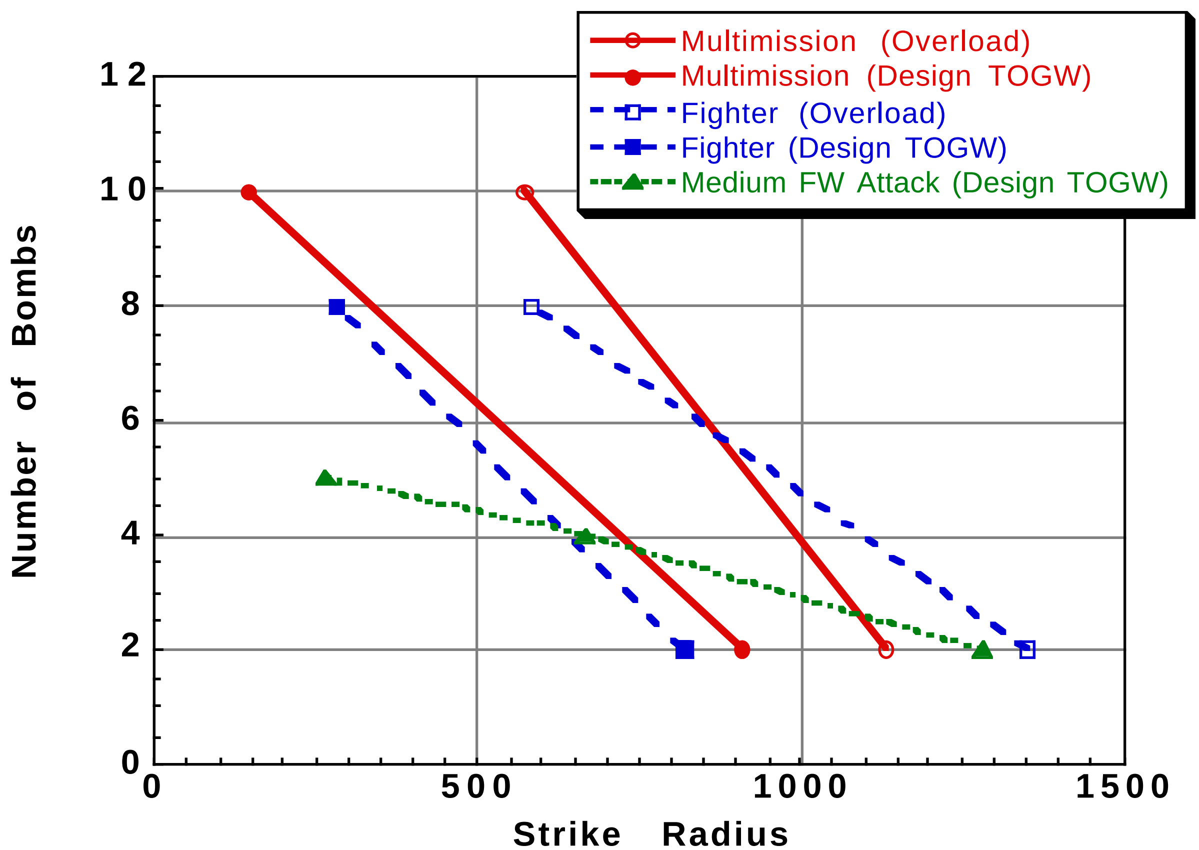

Figure 27. 1995-TAD strike fallout performance.

weapons are removed. External tanks were dropped when all external fuel was consumed. Of course, these aircraft operated above design TOGW have reduced speed and maneuver capability and most cannot land on a carrier with more weapons than their design load because of the increased wing loading.

2. DLI Range vs. Mach Number

The SSF DOC DLI mission was used to evaluate the influence of outbound dash Mach number on mission radius. Since the DLI mission requires two SRMs and four LRMs, the Multimission aircraft carry two additional LRMs and are slightly above design TOGW. Results are shown in figures 28 and 29. Range increases steadily with Mach number until 0.9 Mach because SFC for the low bypass supersonic engines improves more quickly with Mach number than the drag increases. At 0.9M, mission capability falls off dramatically due to the increase in compressibility drag.

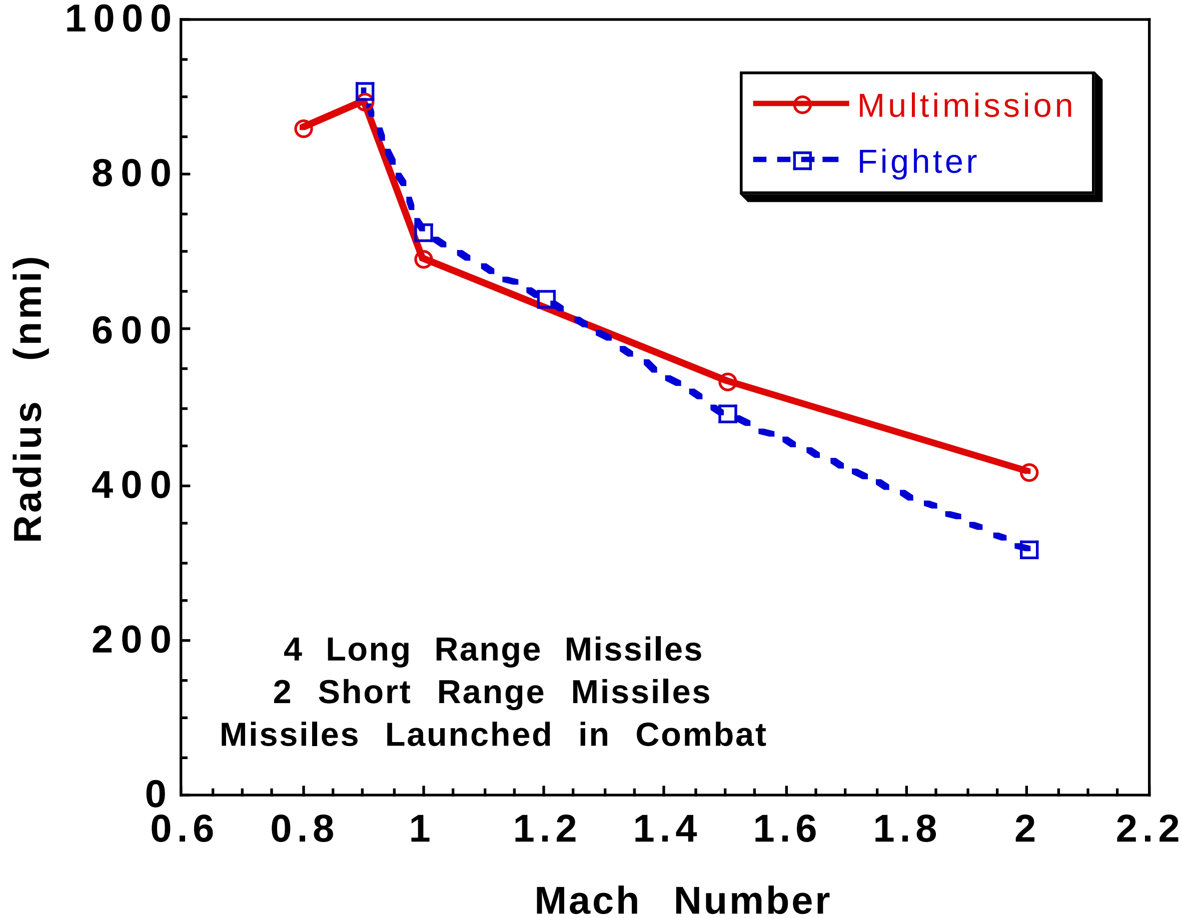

Figure 28. 1990-TAD DLI fallout performance.

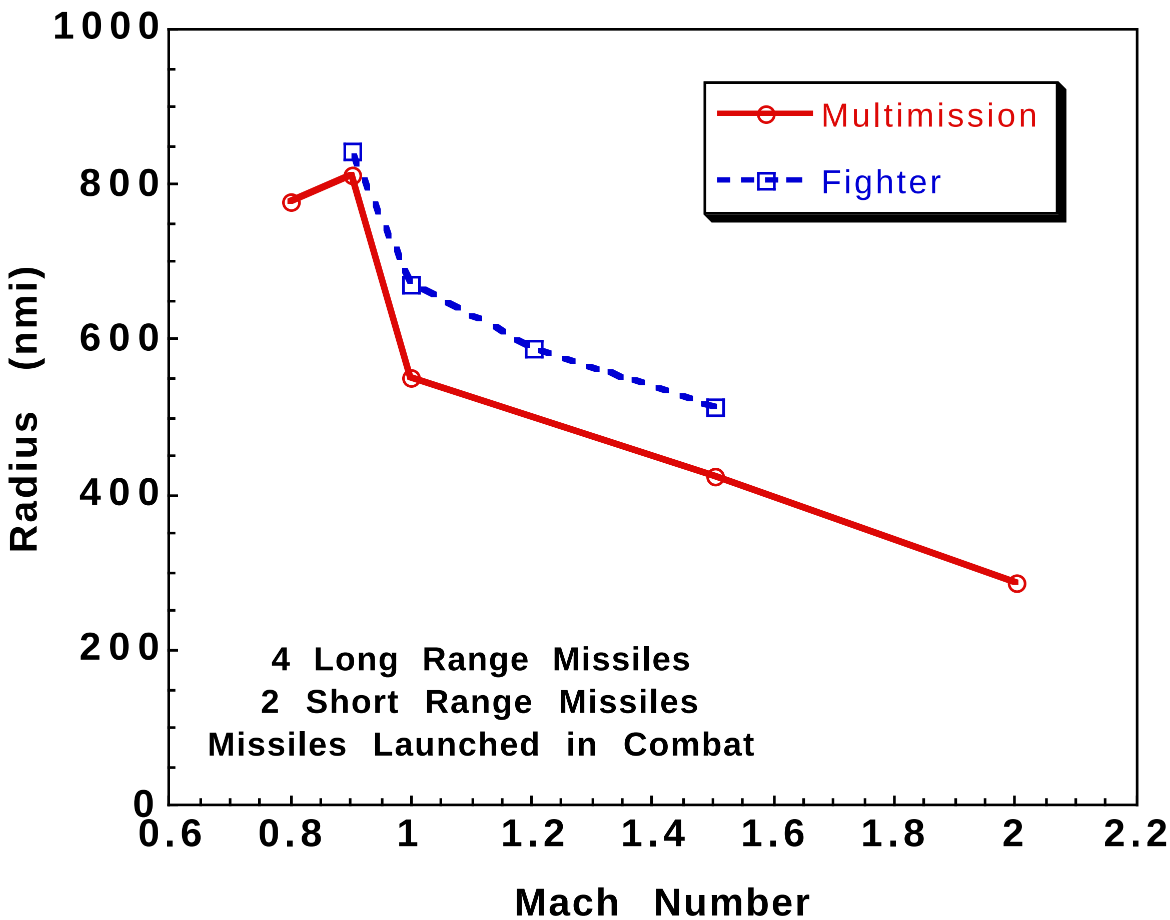

Figure 29. 1995-TAD DLI fallout performance.

In the 1995-TAD timeframe, the performance of the Multimission aircraft is degraded compared to the Fighter. This is because the 1990-TAD Multimission class carries all four LRMs for the DLI mission externally, while stealth versions in the 1995-TAD timeframe carry the second set of LRMs externally. Adding two more LRMs to the existing pylons on the 1990-TAD aircraft was a relatively small addition to total aircraft drag. However, in the 1995-TAD timeframe, the addition of two pylons and the missiles was a significant penalty. The Fighter aircraft has approximately the same performance in both timeframes because it was designed to perform the same mission in each timeframe and there were no configuration changes.

For the Multimission aircraft, an appropriate outbound cruise altitude was determined for each Mach number to ensure efficient engine operation, as shown in figure 30. The Fighter aircraft was able to cruise efficiently at 50,000 ft over the Mach number range examined. Acceleration and climb phases were also modified to preserve mission continuity as cruise altitude and Mach number varied. For example, an aircraft was required to climb to the appropriate cruise altitude and also had to accelerate for combat at 1.5M if cruising below 1.5M. No range credit was given for descent from cruise to combat altitude or for deceleration from cruise to combat Mach number.

3. CAP Range vs. Loiter Time

The trade-off between mission radius and loiter time on station was evaluated for the Fighter and Multimission classes using the Fighter design mission (the modified SSF DOC CAP mission). This fallout was analyzed both with the mission radius held constant and with the dash range held constant. The weapons, two SRMs and two LRMs, were released as specified in the original mission. For the Fighter, the two extra LRMs and mounting hardware were removed and extra fuel was added to maintain design TOGW.

Figures 31 and 32 show results for supersonic dash capability versus loiter time at a fixed mission radius in both timeframes. Supersonic dash range was determined with a fixed 400 nm subsonic cruise out and back to the loiter station. As before, the fighter's fallout performance did not change significantly from the 1990-TAD to the 1995-TAD timeframe. This is because it was designed for the same capability in each timeframe. However, the Multimission aircraft improved in the 1995-TAD timeframe because the weapons were carried internally.

Note that the Fighter flies further on the fallout mission with 60 minutes of loiter than it does on the design mission with 60 minutes of loiter. This is because the fallout weapon load used in the fallout mission is one half of the design weapon load and the weapons are dropped during the fallout mission, reducing weight and drag for the return cruise.

Figures 33 and 34 show very similar results for subsonic mission radius capability versus loiter time with a fixed supersonic dash in both timeframes. The fallout data shown is the mission radius using a constant 100 nm lateral supersonic dash to intercept.

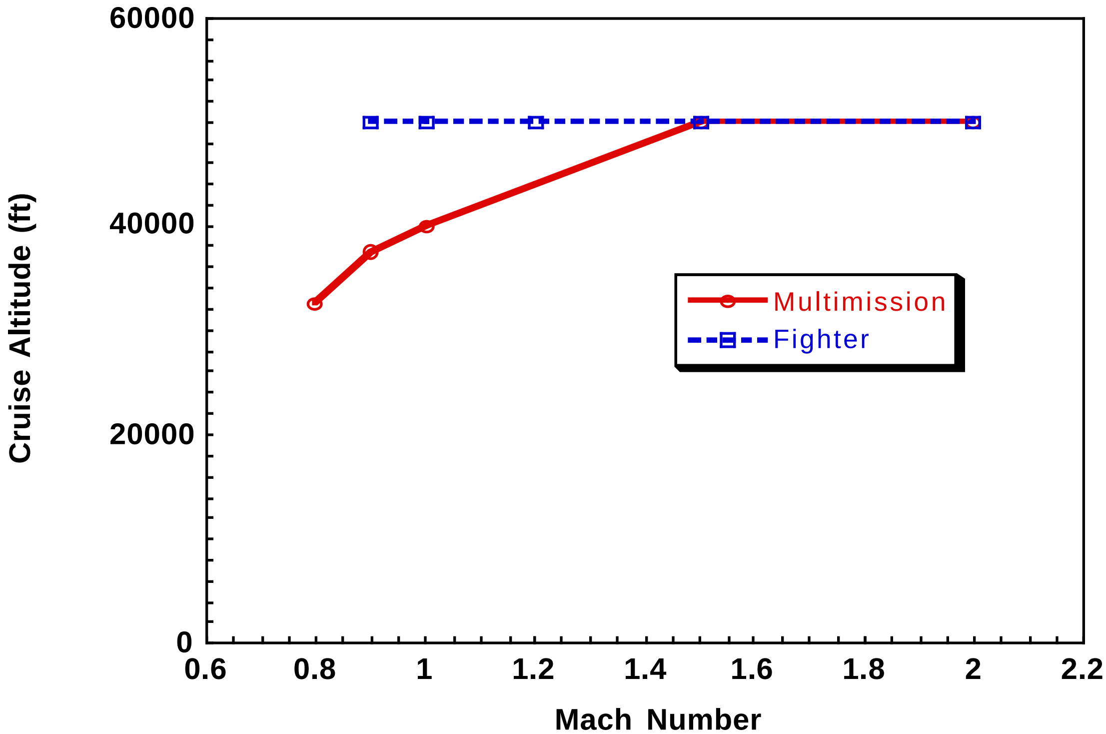

Figure 30. 1995 DLI cruise altitude.

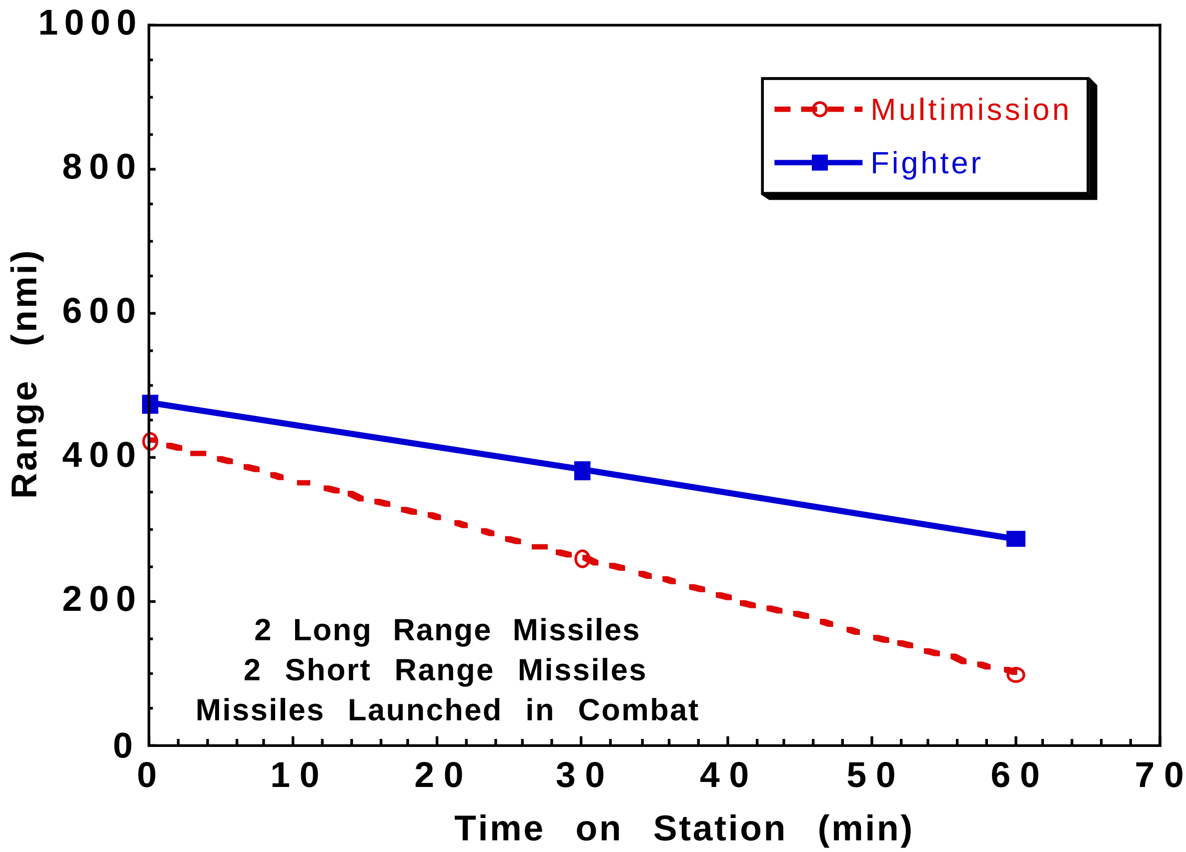

Figure 31. 1990-TAD CAP supersonic dash fallout performance with 400 nmi subsonic cruise.

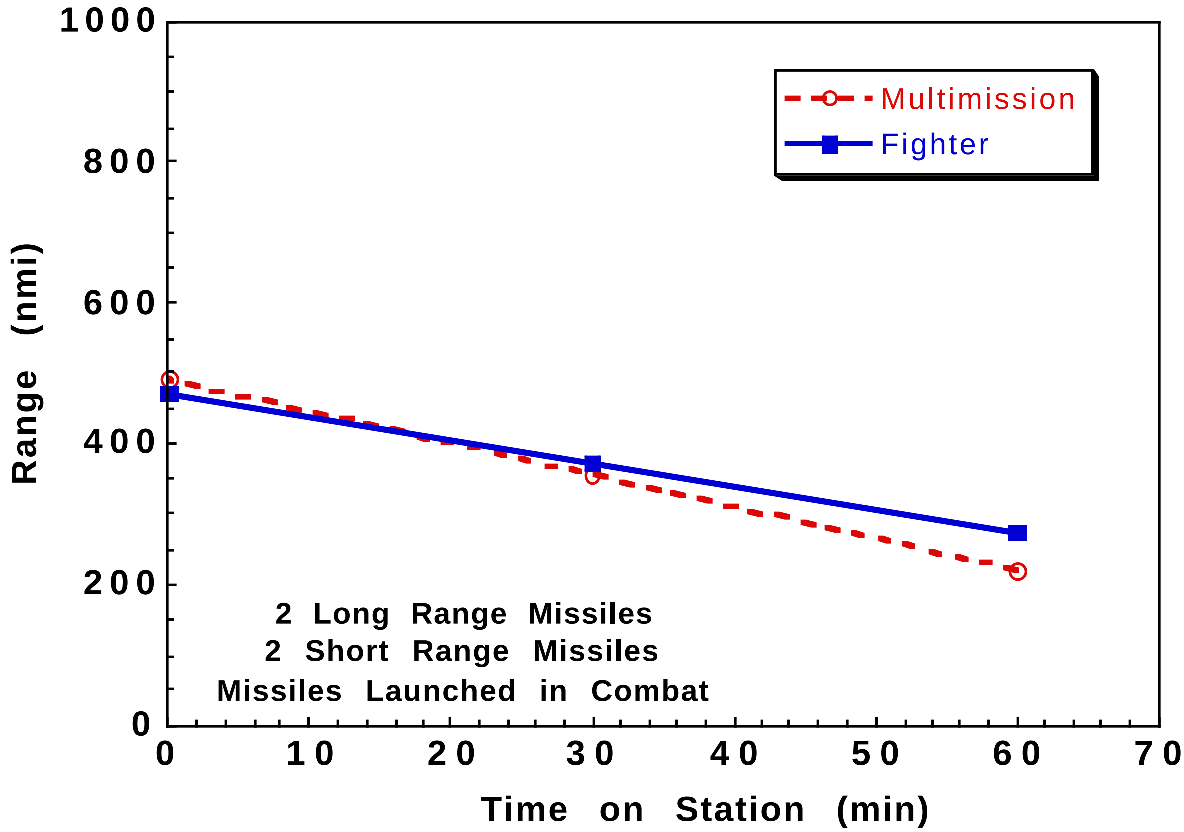

Figure 32. 1995-TAD CAP supersonic dash fallout performance with 400 nmi subsonic cruise.

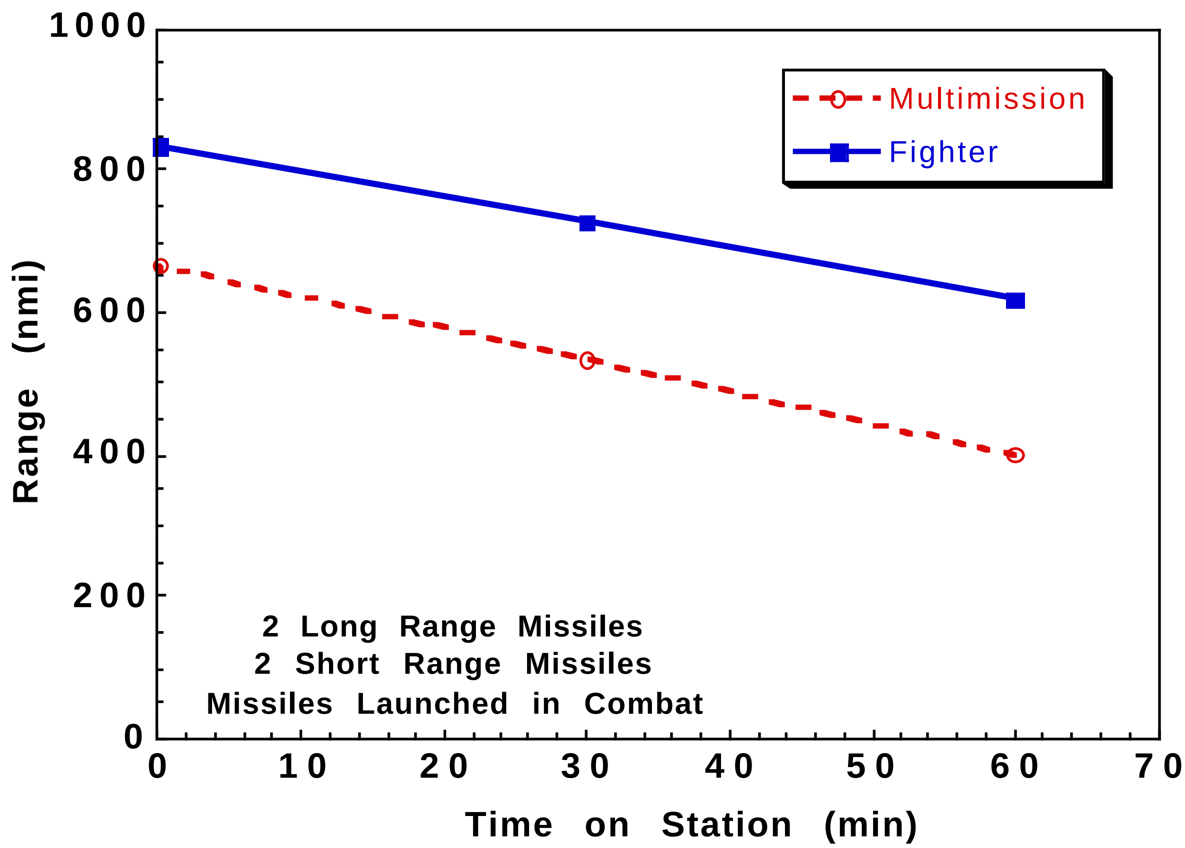

Figure 33. 1990-TAD CAP subsonic cruise fallout performance with 100 nmi supersonic dash.

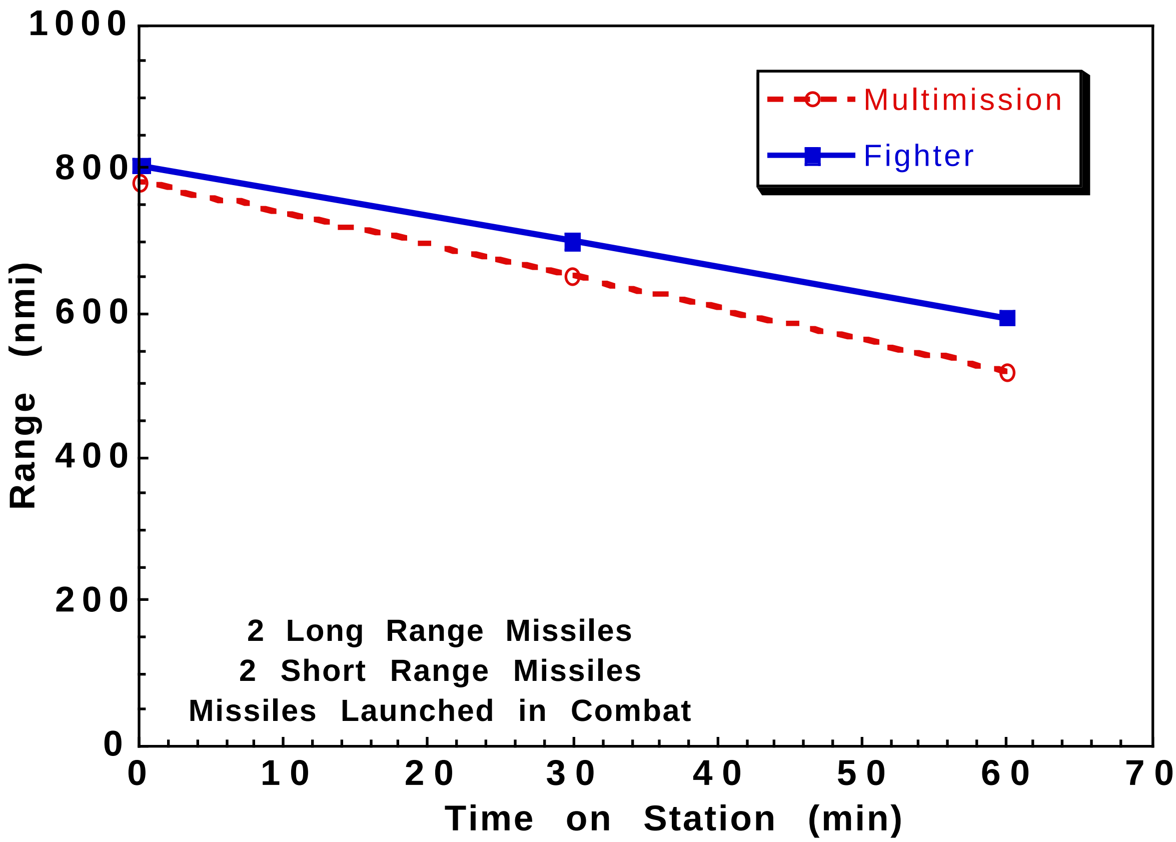

Figure 34. 1995-TAD CAP subsonic cruise performance with 100 nmi supersonic dash.

E. SSF DOC Mission Fallout Range Performance Data

Each aircraft class was evaluated to determine its radius of action on the original SSF DOC missions (see Appendix B for mission definitions). These missions were run as nearly as possible to the SSF DOC specification, and the offensive/defensive weapons were released during combat. The results can be used with the payload specified in each mission to evaluate operational effectiveness.

An attempt was made to keep TOGW within 3% of design by either adding or removing fuel depending on the difference between the DOC mission's weapon load and design weapon load. For the Fighter and Medium Attack aircraft, the SSF DOC weapon loads were lighter than the design weapon load so additional fuel and external tanks were added. For the Light Attack aircraft, the TOGW was within 2% of design with each of the SSF DOC weapon loads so no modifications were made. The Multimission aircraft were slightly above design TOGW on all the missions, except for the reconnaissance and Suppression of Enemy Air Defenses (SEAD) which required additional fuel (carried internally for reconnaissance) to maintain design TOGW. Additional tankage was provided by either a single fuel tank mounted on a short, centerline pylon or a single, form fitting fuel tank mounted in an empty bomb bay. Since the amount of fuel necessary to bring each aircraft up to design TOGW varied, most of the extra tanks were only partially filled. External tanks were dropped when they were empty.

In the following figures, total mission radius is reported consistently for all missions. This means that for missions with a specified 50 nm ingress/egress, the 50 nm was added to the fallout cruise range so that total mission radius is being reported. Also, results for the Medium FW aircraft are used to represent the Attack class because it was the lightest of the Medium Attack aircraft. SSF, NFA, and MRF performance are essentially the same and are reported in this section as “Multimission.” Finally, for the Reconnaissance mission the sensor package was assumed to weigh the same as the gun plus ammunition (899 lb). Table 20 lists the primary weapons for each of the fallout missions.

Table 20. Primary weapons for fallout missions

Fallout mission	Primary weapons load
Multimission design mission	2 LRMs
Deck launched intercept	4 LRMs
Air defense/combat air patrol	2 LRMs
Suppression of enemy air defenses	2 HARMs
Close air support	4 Rockeyes
Interdiction	2 LGBs
Recon	Sensors (899 lb)

1. Aircraft Class Comparison

Figure 35 shows fallout range performance for the 1995-TAD Fighter, Multimission, and Attack classes on subsonic SSF DOC missions. All aircraft classes exceed the DOC range requirements, even the aircraft designed for supersonic flight. This results from the large fuel capacity of the supersonic aircraft and, for the fighter, additional fuel carried because the payload weight for these fallout missions was less than design weapon load. Figure 36 compares the relative range-payload efficiency for the same aircraft and missions. Since aircraft weight is an indicator of cost, normalizing by TOGW was a simple way of evaluating the relative cost effectiveness of these aircraft. This metric shows that, for these subsonic missions, the subsonic aircraft actually have a 2-to-1 advantage in capability versus cost when compared to the supersonic aircraft.

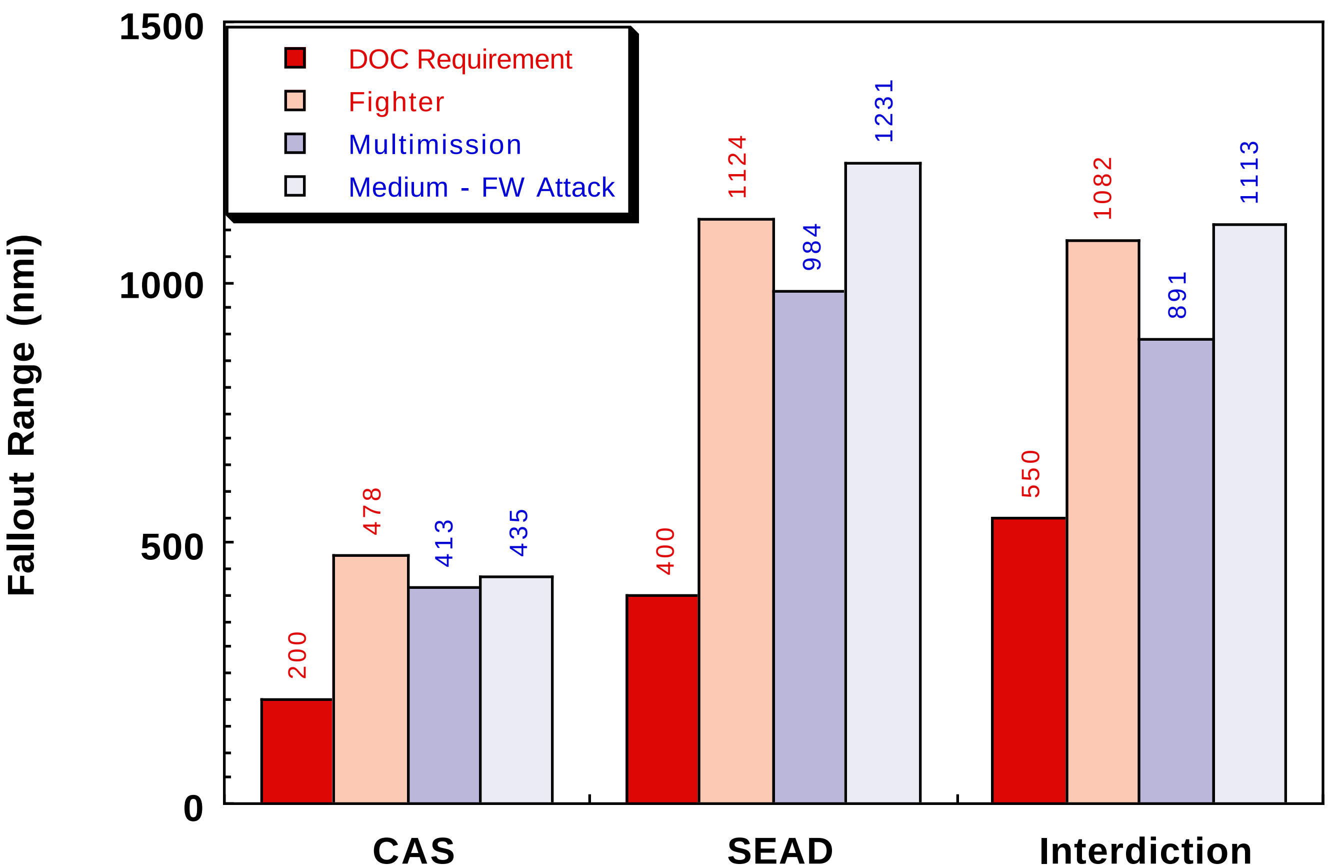

Figure 35. 1995-TAD fallout range performance on the SSF DOC subsonic missions.

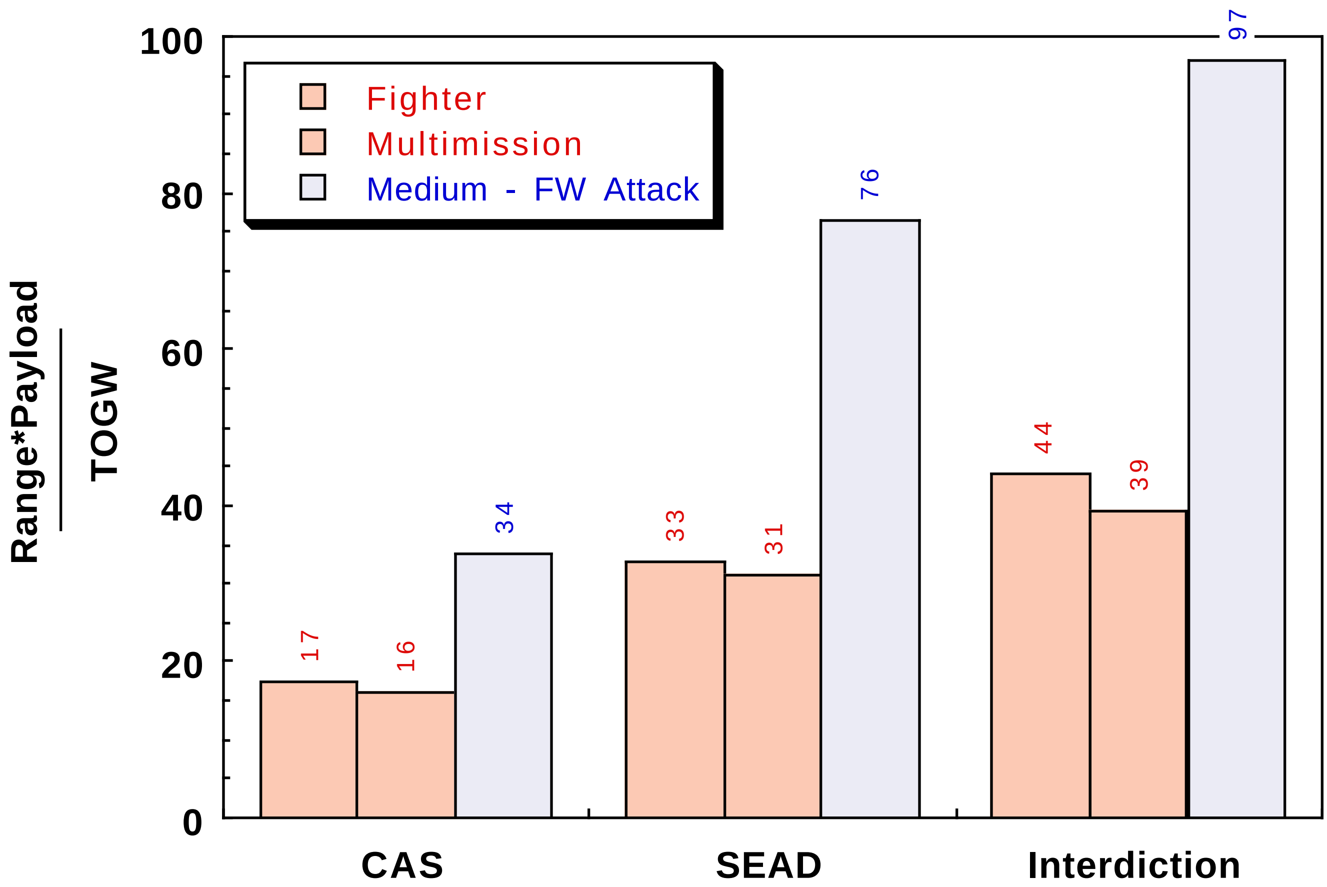

Figure 36. 1995-TAD mission effectiveness on SSF DOC subsonic missions.

Figure 37 shows fallout range performance for the supersonic SSF DOC missions. Both aircraft classes exceed these requirements; the Multimission aircraft range substantially exceeds the requirements because the design mission created for this study was quite demanding. This is shown by the fuel fraction of the Multimission aircraft (0.40–0.45) which is high compared to typical F-14, F-15, F-16, and F-18 fuel fractions (~0.3). Also included in this figure is aircraft performance on the Multimission design mission created for this study. The Multimission aircraft performance is slightly different due to different rules applied to fallout missions. Figure 38 shows the relative range-payload efficiency of the supersonic aircraft on the fallout missions. Comparing figure 36 to figure 38 quantifies the tremendous impact supersonic flight has on aircraft range-payload efficiency. These results also indicate that increasing the ratio of supersonic cruise to subsonic cruise in the Multimission design mission would yield an aircraft with capability that was more balanced for meeting the SSF DOC missions.

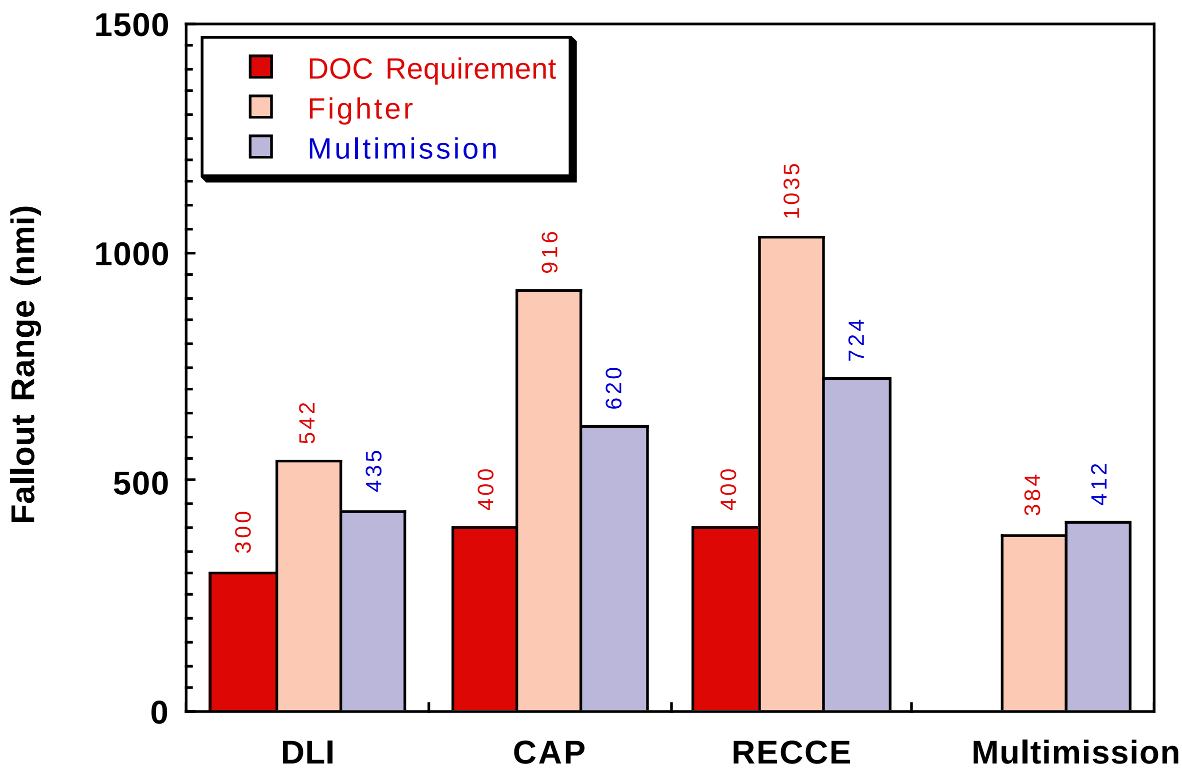

Figure 37. 1995-TAD fallout range performance on the SSF DOC supersonic missions.

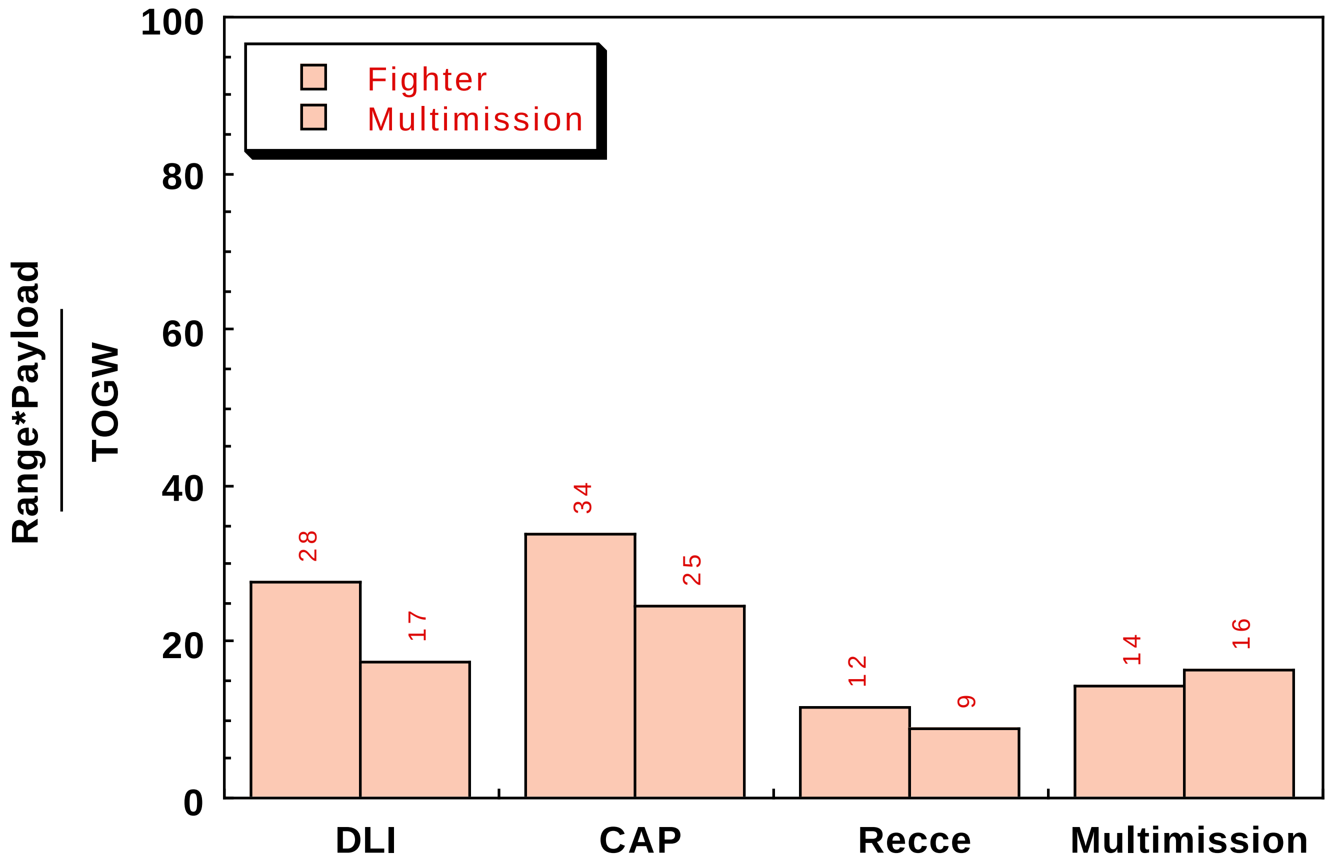

Figure 38. 1995-TAD mission effectiveness on the SSF DOC supersonic missions.

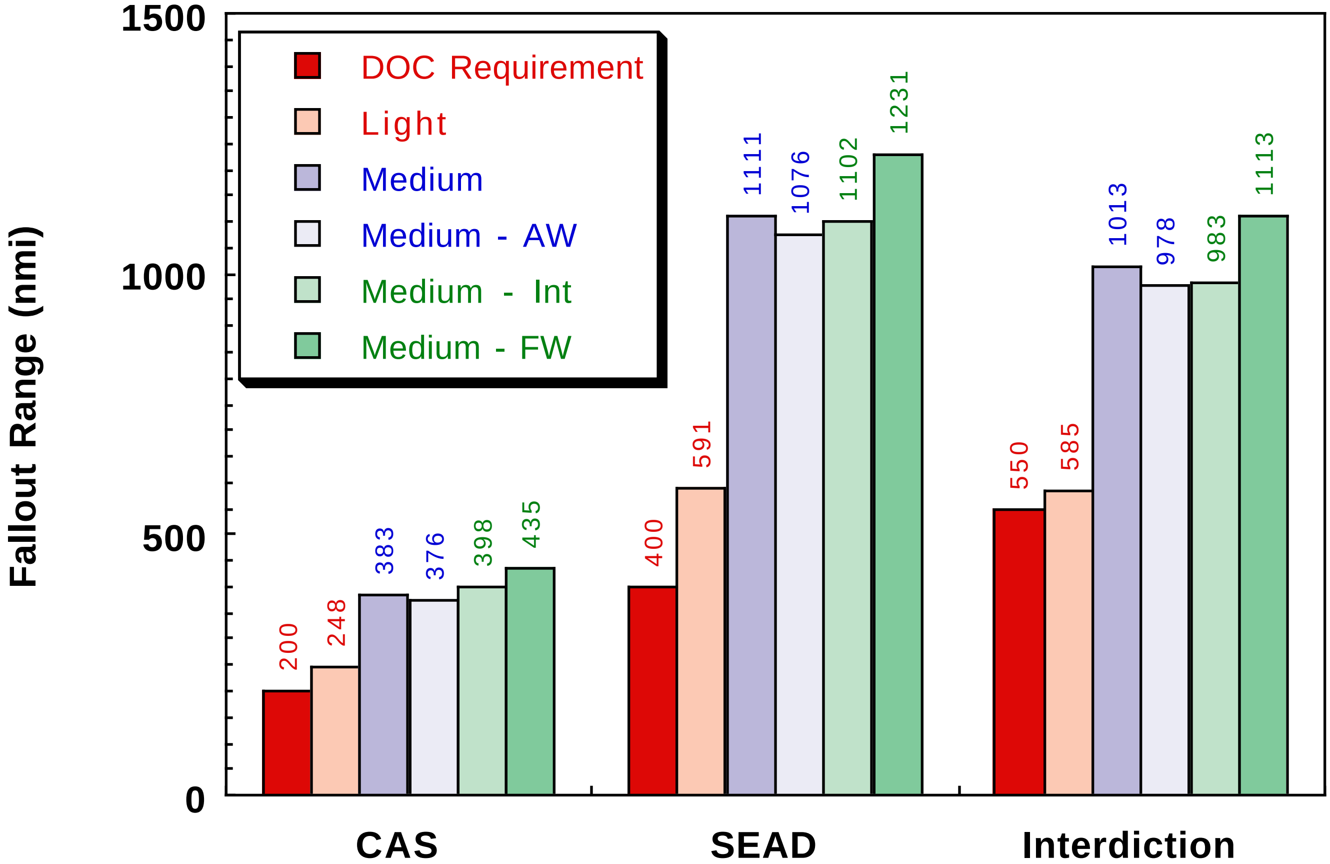

Figure 39. 1995-TAD Attack aircraft fallout range performance on the SSF DOC subsonic missions.

2. Attack Aircraft Comparison

Figure 39 compares the fallout range performance for all of the 1995-TAD Attack aircraft on the subsonic CAS, SEAD, and Interdiction missions. All the Medium aircraft have similar performance.

The CAS mission is unique because it is the only fallout mission that is executed entirely at sea level. The primary weapon load for this mission is four Mark-20 Rockeye Mod II bombs which together are lighter than, but have more drag than, the design weapon loads for each of the aircraft. Figure 39 shows that all aircraft exceed the 200 nm requirement and the Medium Attack designs exceed it by more than a factor of 2.

No fuel was added to the Light Attack because the fallout weapon load only differed from the design load by 138 lb, which is less than the weight of the short pylon required for the drop tank. Therefore, the Light Attack started the mission slightly under design TOGW with full internal fuel.

The Medium and Medium AW aircraft were able to take advantage of the reduced weapon load and carry additional fuel externally as was previously described.

The Medium IW and Medium FW were not able to carry the additional fuel internally because most of each bay was occupied by a Rockeye bomb. Additional fuel was therefore carried in a single drop tank mounted on a short centerline pylon. This arrangement does not interfere with the Medium IW's weapon bay doors because the tank was assumed to be dropped before the bombs. The Medium FW's weapon bays are located outboard of the centerline and do not interfere with the external tank.

The SEAD fallout mission results are also shown in figure 39. The primary weapon load for this mission is two AGM-88A HARM missiles, which is lighter than the design load for each of the Attack aircraft. All aircraft exceed the 400 nm requirement and the Medium designs have more than twice the required range. The Light Attack aircraft did not carry any additional fuel while the Medium designs carried enough to maintain TOGW.

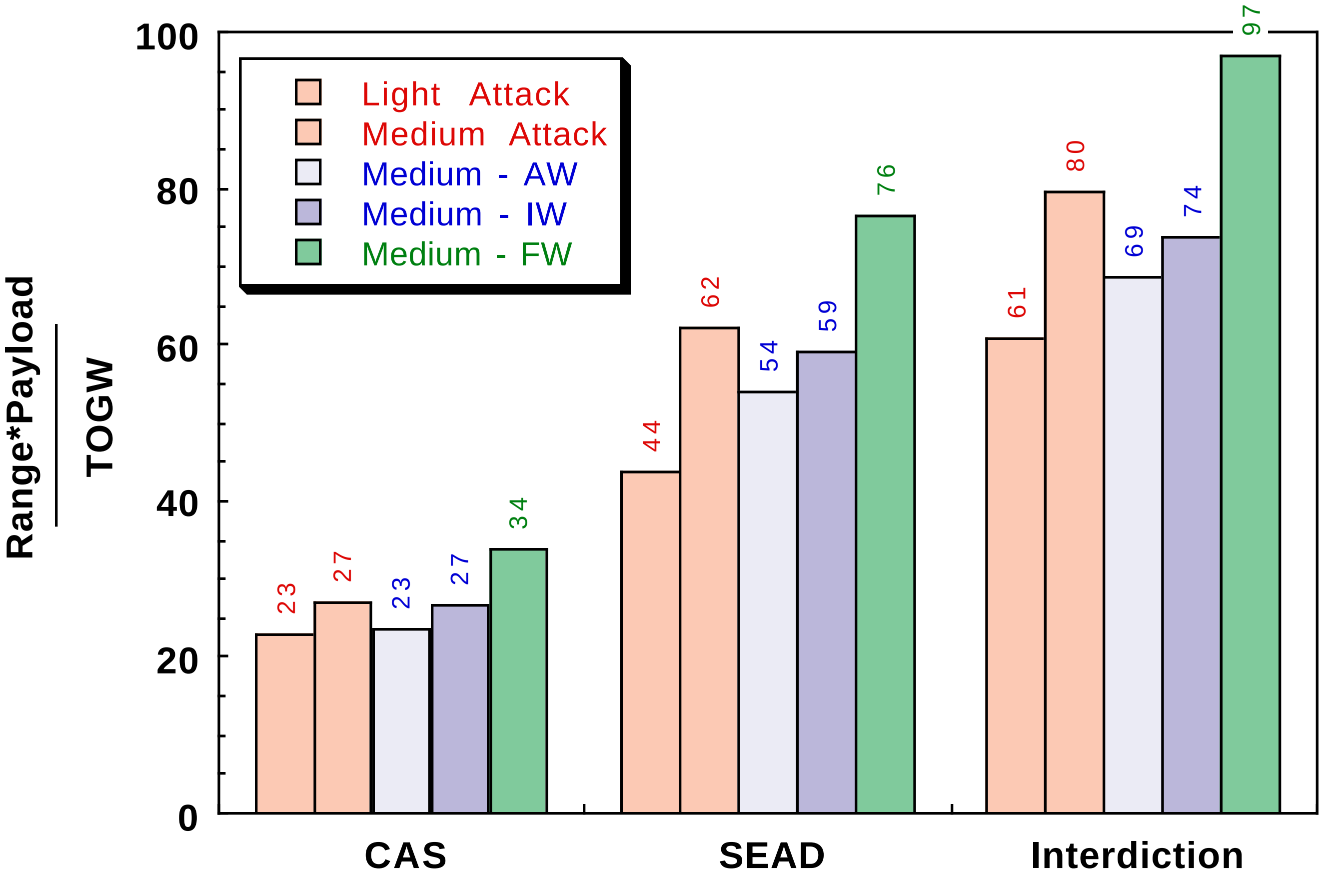

Figure 40. 1995-TAD Attack aircraft mission effectiveness on the SSF DOC subsonic missions.

Since two missiles fit in one of the weapon bays, additional fuel for the Medium IW and Medium FW was placed in the second bay.

The Light Attack aircraft has the least range on the Interdiction mission (fig. 39) because its original design load consists of two bombs so it did not receive any additional fuel like the other aircraft. All of the designs exceed the 550 nm requirement, and the range performance of all of the Medium Attack designs exceeds this requirement by approximately a factor of 2. The Medium FW has the best range.

For comparison with figure 36, figure 40 shows relative range-payload efficiency data for all aircraft in the Attack class.

F. Propulsion Sensitivities

Several independent sensitivities (table 21) were evaluated to understand the influence on TOGW of propulsion modelling in this study. TOGW was quite insensitive to the items examined.

Table 21. Propulsion sensitivities

Sensitivity	ΔTOGW (%)
Twin vs. single engine 1990 Fighter	5.0
Engine weight growth exponent from 1.05 to 1.0 (1995 STOVL)	–1.6
Constant engine T/W for Attack aircraft	~1
Constant core size engines (new T/W and EXWT = 1.0):	
Fighter	0.6
Attack	–1.0
Multimission	–0.6

The first sensitivity assessed the impact of the decision to size all aircraft in this study with a single engine. The single engine in the 1990-TAD Fighter aircraft was replaced by two engines that were scaled 50% in thrust and weight. The resulting aircraft was 4.1% heavier due to engine installation penalties.

The sensitivity of TOGW to engine T/W was evaluated for the Attack aircraft class. All Attack aircraft use the same engine but the engine scale factor varies by as much as a factor of 2. As previously mentioned, engine T/W varies slightly with engine scale. To check the possible impact this T/W variation had on the study, the heaviest Attack aircraft's engine was modified to have the same T/W as the engine in the lightest aircraft. The impact on TOGW was 1%.

Two additional propulsion sensitivities were performed to address whether or not the approach used to generate the engine database had any major effect on this study. First, to evaluate the influence of the engine weight growth exponent on TOGW, the 1995-TAD SSF was resized using an exponent of 1.0 (instead of 1.05) which increased the engine T/W. The TOGW of this aircraft was reduced by only 1.6%. Second, engine families could have been generated by the engine software with either constant inlet mass flow or constant core mass flow. This choice affects engines T/W slightly. A constant inlet mass flow was used to generate the basic, unscaled engine decks used in this study. To determine the impact this had on TOGW, aircraft from each class were resized with new engines that were generated using a constant core mass flow. The resulting change in TOGW was 1% or less for all of the aircraft.

Section V – Conclusions

This study highlights the effect of changing requirements on the penalties associated with STOVL capability and addresses the penalties associated with carrier compatibility. Of course, each of these weight penalties results from increased aircraft capability. This study also identifies the Medium FW as the favored concept for Attack aircraft and examines the impact of internal weapons carriage on subsonic Attack aircraft. The success of this study rests on its ability to establish trends amongst aircraft sized with consistent methods.

A. Multimission Aircraft Comparison

The "STOVL penalty" is largest in a low technology timeframe compared to a land-based aircraft that has no dry supercruise requirement. This accounts for the long held perception that STOVL capability costs a 20% increase in TOGW. However, the SSF has little or no penalty, compared to future technology multimission sea-based aircraft, when dry supercruise is a requirement. In addition, STOVL aircraft derive greater benefits from improved structures, materials, and propulsion system T/W than their conventional counterparts.

The requirements imposed on the 1995-TAD aircraft in this study are similar to current requirements for new aircraft. These dry supersonic cruise and maneuverability requirements result in aircraft with a T/W which is high compared to current inventory aircraft. An SSF aircraft designed to these requirements will require little or no augmentation in hover, thus reducing the cost, risk, and weight penalties associated with STOVL. In fact, in the 1995-TAD timeframe of this study, the SSF weight penalty was comparable to the navalization weight penalty but STOVL aircraft should provide additional operational and safety advantages for carrier operations.

Many of the technologies for STOVL-related systems are already being developed for conventional and/or current aircraft. Examples are 1) high T/W engines, 2) the current development in thrust vectoring/reversing systems (F-15 STOL/Maneuvering Technology Demonstrator (S/MTD)), and 3) advanced control systems for STOVL aircraft (NASA Ames' Harrier V/STOL Research Aircraft, ref 14).

B. Attack Aircraft Comparison

Technology improvements had less effect on the Attack aircraft than on the Multimission aircraft, due primarily to the lower growth factor of subsonic aircraft. The addition of two more laser guided bombs on the Light Attack aircraft had more impact on the TOGW than the addition of a second crewmember.

The Medium FW aircraft is the lightest design in the Medium Attack class mainly because of its reduced interference and boattail drag. It is important to compare the drag coefficient of flying wings to conventional aircraft using C_D based on total wetted area rather than on wing area.

Attack aircraft designs with internal weapons are lighter than those with external weapons, given the assumptions and estimates used in this study. This is because the reduction in stores drag more than compensated for the impact of the increased weight and volume of the internal weapons bays.

C. Design Study Recommendations

Clear conclusions are most easily made when a conceptual aircraft sizing study is performed as a trend or sensitivity study. Attempting to compare study results to existing aircraft requires that study aircraft be sized to the same constraints and requirements as the reference aircraft, which is very difficult. Similarly, it is impossible to predict actual technologies that will be available, so it is more valuable to make reasonable estimates and apply them consistently to all aircraft. It is very important in any conceptual design study to isolate configuration similarities from differentiators that will drive aircraft trends. Similarities, like technology assumptions, can be relatively simple estimates since they are applied to all aircraft, including the reference aircraft. The study results and trends can then be interpreted in terms of the differentiators. It is a good practice to determine TOGW sensitivities to changes in the more important, or less certain, differentiators. In large design studies several organizations may contribute designs to the database. In this case, any similarities that are not important to the study being conducted (e.g., equipment, weapons and carriage, engine decks, or mission details) should be agreed upon as part of the study groundrules and then applied to all designs so that different assumptions do not have to be normalized out of the final designs to allow fair comparison.

References

1. Taylor, T.: Future Carrier Task Force Study. AIAA Aircraft Design Systems Meeting, Hilton Head, N.C., Aug. 24–26, 1992.
2. Samuels, Jeffrey J.: Normalization of U.S. Concepts in the US/UK ASTOVL Fighter Technology Program. NASA TM-103843, 1990. Confidential.
3. Axelson, John A.: Estimation of Transonic Aircraft Aerodynamics. AIAA Paper 75-4996, Aug. 1975.
4. Vanderplaats, G. N.: CONMIN – A Fortran Program for Constrained Function Minimization. NASA TM X-62,282, 1973.
5. Gregory, T. J.: Computerized Preliminary Design at the Early Stages of Vehicle Definition. NASA TM X-62,303, 1973.
6. Jayaram, S.; Myklebust, A.; and Gelhausen, P.: ACSYNT – A Standards-Based System for Parametric Computer Aided Conceptual Design of Aircraft. AIAA Paper 92-1267, Aerospace Design Conference, Irvine, Calif., Feb. 3–6, 1992.
7. Nelms, W. P.; Murphy, R.; and Barlow, A.: Preliminary Analysis of Long-Range Aircraft Designs for Future Heavy Airlift Missions. NASA TM X-73,131, June 1976.
8. Vanderplaats, G.; and Gregory, T.: A Preliminary Assessment of the Effects of Advanced Technology on Supersonic Cruise Tactical Aircraft. Super Cruise Military Aircraft Design Conference, Colorado Springs, Colo., Feb. 17–20, 1976.
9. Gelhausen, P. A.; and Wilson, S. B. III: Supersonic STOVL Fighter Concepts Featuring the Hybrid Tandem-Fan Propulsion System. American Helicopter Society Annual Forum, June 1986.
10. Bertram, M. H.: Calculations of Compressible Average Turbulent Skin Friction. NASA TR-123, 1962.
11. Naval Desired Operating Characteristics for an ASTOVL Fighter/Attack Aircraft. Memorandum for the Deputy Director, Systems and Technology, Defense Advanced Research Project Agency: Memo 05/25-88, Feb. 1988.
12. Snodgrass, R. R.: Drag Prediction Methods for Installed Stores and Missiles. ASD-ENF-TM-84-12. Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson AFB, Nov. 1984.
13. Samuels, Jeffrey J.; Wardwell, Douglas; Guerrero, Lourdes; and Stortz, Michael: Simulation Evaluation of Takeoff Performance of an MFRL STOVL Aircraft. NASA TM-104009, 1992.
14. Franklin, J. A.; and Stortz, M. W.: Flight/Propulsion Control Integration for V/STOL Fighter/Attack Aircraft. American Helicopter Society's National Technical Specialist's Meeting on Tactical V/STOL Aircraft, North Carolina, Sept. 1989.

Appendix A – Detailed Information for Aircraft

Summary Description

Standard English units are used throughout the aircraft data in this appendix unless specifically noted: weight is in pounds, dimensions are in feet, angles are in degrees, time is in minutes, and ranges are in nautical miles. Abbreviations used only in this appendix are listed here rather than in the body of the report. Aircraft are listed in the same order as in the summary data in table 16. For most of the aircraft, instantaneous combat specific excess power (PSI) is positive for one or more maneuver conditions. This is because the turn capability at the 15° alpha limit (ALI) is sustainable. The takeoff fuel allowance is for 10.5 minutes: 10 minutes at idle and 30 seconds at maximum thrust.

General:

TOGW	Takeoff Gross Weight (lb)
W/S	Wing loading (lb/ft^2)
T/W Dry	Aircraft Thrust/Weight – Maximum Dry Thrust
T/W A/B	Aircraft Thrust/Weight – Maximum Afterburning Thrust
N(Z) Ult	Ultimate Load Factor (g)

Engine:

Length	(ft)
Diam.	(ft)
Weight	(lb)
TSLS	Thrust, Sea Level Static (lb)
SFCSLS	Specific Fuel Consumption, Sea Level Static (lb_{fuel}/[lb_{thrust}*hr])

Fuselage:

Length	(ft)
Diameter	(ft)
Volume	(ft^3)
Wetted Area	(ft^2)

Geometry:

T/C	Thickness-to-chord ratio
M.A.	Mean Aerodynamic
L.E.	Leading Edge

Mission Summary:

Alt	(ft)
Fuel	(lb)
Time	(min)
Dist	(nm)
L/D	Lift-to-drag ratio
Thrust	(lb)
SFC	Specific Fuel Consumption (lb_{fuel}/[lb_{thrust}*hr])
Q	Dynamic Pressure (lb/ft^2)
M	Mach Number

Combat:

PS1G	Specific Excess Power for sustained level flight (ft/sec)
NZS	Load factor for sustained level flight (g)
CLS	Lift coefficient for sustained level flight
CDS	Drag coefficient for sustained level flight
ALS	Angle of attack for sustained level flight (deg)
NZI	Load factor for maximum instantaneous maneuver (g)
PSI	Specific Excess Power for maximum instantaneous maneuver (ft/sec)
CLI	Lift coefficient for maximum instantaneous maneuver
CDI	Drag coefficient for maximum instantaneous maneuver
ALI	Angle of attack for maximum instantaneous maneuver (deg)
CBE	Combat Energy (ft)

Weights Description

The individual fixed equipment component weights reported on the detailed weight statements are not adjusted for technology factor; the fixed equipment total is adjusted, however. Therefore, the sum of the individual fixed equipment weights does not equal the total group weight listed. To calculate the individual fixed equipment component weight, multiply the weight shown by the technology factor indicated.

Propulsion Description

Detailed engine data presented are scaled. In the case of engines with afterburners, the first engine point listed as 100% power is for maximum afterburner and the second 100% power point is for maximum dry thrust.

ESF	Engine Scale Factor, relative to engine table at ESF = 1.0
T/W	Thrust/Weight
FFLOW	Fuel flow
WAF	Weight of engine airflow
POWER	Power setting (%)
SFC	Specific fuel consumption ($lb_{fuel}/[lb_{thrust}*hr]$)

Aerodynamics Description

Sample aerodynamics are shown for a few conditions of interest. The buildup of minimum drag is shown along with drag polar information. Note that wing-sweep geometry is shown for the Fighter aircraft.

Cm	Pitching moment coefficient
e	Oswald efficiency factor
CLALPHA	CLα or $\partial C_L/\partial\alpha$
Cdl^.5Alpha	$(CD_{induced})^{\alpha/2}$

Maneuver Performance Description

Maneuver performance is shown for several flight conditions of interest. For each condition, sustained level flight, sustained turn, and instantaneous turn performance are shown. Combat weight is 60% of fuel on board and missiles/bombs away. Note that angle of attack was limited to 15° which can limit the instantaneous maneuver. In this case the instantaneous specific excess power (PS) is positive.

CONDITIONS PS NZ TDOT RADIUS ALPHA C_L C_D

where:	PS	Specific Excess Power (ft/sec)
	NZ	Load factor (g)
	TDOT	Turn rate (deg/sec)
	RADIUS	Turn radius (ft)

Mission Performance Description

Conditions for the end of each mission phase are shown in the following format:

PHASE M H C_L ALPHA WFUEL TIME VEL
SFC(I) THRUST(I) C_D GAMMA W WA Q
SFC(U) THRUST(U) CDINST L/D THR/THA PR X

H	Altitude at the end of the phase (ft)
(I)	Installed
(U)	Uninstalled
CDINST*	Drag Coefficient for Engine Installation
GAMMA	Flight path angle (deg)
THR/THA	Thrust required/Thrust available where 1.00 is maximum dry thrust
PR*	Pressure Recovery
X	Distance in nm
Q	Dynamic pressure associated with Mach number and altitude (lb/ft^2)
VEL	Velocity (ft/sec)
WA*	Engine Airflow (lb/sec)
W	Aircraft weight at the end of the phase (lb)
TIME	Time to complete the segment (sec)
WFUEL	Fuel used in the segment (lb)
ALPHA	Angle of attack at the end of the segment (deg)

*Zero in this study because engine tables were used.

Geometry Description

Aero surface locations listed are referenced as follows: Fuselage station measured from the nose, butt line is measured from the plane of symmetry, and water line measured from the center of the cylindrical fuselage.

The wing plan area listed is the theoretical area to the aircraft centerline. The wing surface area and volume listed are for the exposed part of the wing based on the fuselage maximum diameter and wing vertical location.

The aircraft density reported with the geometry data may differ from the baseline of 31 lb/ft^3. This occurs for two reasons. First, designs with internal ducts or external weapons carriage have a lower density. Second, in some cases, the wing or fuselage was sized by other constraints, in which case the density is less than required for that particular aircraft.

1990 Fighter Summary

Standard English Units

GENERAL		FUSELAGE		
TOGW	57619.	LENGTH	50.4	
W/S	69.0	DIAMETER	5.0	
T/W DRY	0.51	VOLUME	760.5	
T/W A/B	0.74	WETTED AREA	669.3	
CREW	2	FINENESS RATIO	10.0	
N(Z) ULT	9.8			
ENGINE		**WEIGHTS**		
			W	%
NUMBER	1	STRUCT.	19269.	33.4
LENGTH	15.2	PROPUL.	5232.	9.1
DIAM.	3.4	FIX. EQ.	7511.	13.0
WEIGHT	3255.0	FUEL	17024.	29.5
TSLS	29489.	PAYLOAD	8583.	14.9
SFCSLS	0.85			

	WING	HTAIL	VTAIL
AREA	834.5	312.9	87.2
WETTED AREA	1556.6	458.2	174.5
SPAN	75.3	29.7	10.1
L.E. SWEEP	20.0	51.0	57.1
C/4 SWEEP	15.8	44.6	48.0
ASPECT RATIO	6.79	2.81	1.17
TAPER RATIO	0.29	0.18	0.32
T/C ROOT	0.12	0.05	0.05
T/C TIP	0.09	0.04	0.04
ROOT CHORD	17.1	17.9	13.0
TIP CHORD	5.0	3.2	4.2
M.A. CHORD	12.2	12.3	9.4
LOC. OF L.E.	18.2	32.5	37.4

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	656.	10.5					
CLIMB	0.89	50000.	1992.	12.4	102.2	14.72	4709.4	0.992	135.3
CRUISE	0.85	50000.	2605.	49.2	400.0	16.05	3301.6	0.928	123.2
LOITER	0.55	35674.	2650.	60.0	316.6	16.25	3140.3	0.832	103.0
CLIMB	0.89	50000.	753.	2.5	18.1	14.68	8066.2	1.847	135.7
ACCEL	1.50	50000.	1157.	3.4	40.2	5.29	14021.6	1.949	383.7
CRUISE	1.50	50000.	1467.	7.0	100.0	5.20	9001.6	1.393	383.7
COMBAT	1.60	35000.	1664.	3.0	46.1	4.48	20584.0	1.617	894.8
CRUISE	0.80	50000.	2119.	52.3	400.0	16.27	2648.1	0.903	109.1
LOITER	0.30	100.	1006.	20.0	66.1	14.60	2915.8	1.035	132.8

BLOCK TIME = 3.499 HR
BLOCK RANGE = 1490.5 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.60	35000.	332.	3.9	0.124	0.0276	1.1	6.5	-794.	0.393	0.0703	7.2	59689.
0.20	100.	207.	1.9	1.400	0.1274	15.0	1.9	181.	1.400	0.1274	15.0	1244.
0.90	30000.	248.	3.6	0.340	0.0259	3.1	6.5	-1091.	1.092	0.2747	12.6	1489.

1990 Fighter Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	834.5	312.9	87.2	0.0	(SQ.FT.)
SURFACE AREA.......	1556.6	458.2	174.5	0.0	(SQ.FT.)
VOLUME.............	754.5	126.4	26.6	0.0	(CU.FT.)
SPAN...............	75.275	29.654	10.111	0.000	(FT.)
L.E. SWEEP.........	20.000	51.000	53.025	0.000	(DEG.)
C/4 SWEEP..........	15.834	44.598	48.000	0.000	(DEG.)
T.E. SWEEP.........	2.437	13.471	24.594	0.000	(DEG.)
ASPECT RATIO	6.790	2.810	1.173	0.000	
ROOT CHORD.........	17.135	17.932	13.021	0.000	(FT.)
ROOT THICKNESS.....	25.496	10.759	7.813	0.000	(IN.)
ROOT T/C	0.124	0.050	0.050	0.000	
TIP CHORD..........	5.038	3.174	4.219	0.000	(FT.)
TIP THICKNESS......	5.441	1.524	2.025	0.000	(IN.)
TIP T/C	0.090	0.040	0.040	0.000	
TAPER RATIO	0.294	0.177	0.324	0.000	
MEAN AERO CHORD....	12.186	12.273	9.369	0.000	(FT.)
LE ROOT AT.........	18.175	32.468	37.379	0.000	(FT.)
C/4 ROOT AT........	22.458	36.951	40.634	0.000	(FT.)
TE ROOT AT.........	35.309	50.400	50.400	0.000	(FT.)
LE M.A.C. AT.......	23.778	39.489	42.951	0.000	(FT.)
C/4 M.A.C. AT......	26.825	42.557	45.294	0.000	(FT.)
TE M.A.C. AT.......	35.964	51.762	52.320	0.000	(FT.)
Y M.A.C. AT........	15.396	5.686	4.195	0.000	
LE TIP AT..........	31.873	50.778	50.809	0.000	(FT.)
C/4 TIP AT.........	33.133	51.571	51.864	0.000	(FT.)
TE TIP AT..........	36.911	53.952	55.028	0.000	(FT.)
ELEVATION..........	1.764	0.000	2.520	0.000	(FT.)
VOLUME COEFF.		0.484	0.026	0.000	

AIRCRAFT WEIGHT = 57620.148 Lbs.
AIRCRAFT VOLUME = 1694.631 Cu.Ft.
AIRCRAFT DENSITY = 34.002 Lbs./Cu.Ft.

1990 Fighter Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.89 0.99 0.00	50000. 4709. 0.	0.4914 0.0334 0.0000	4.47 0.98 14.72	1991.8 54972.4 1.00	12.37 0.00 0.00	862. 135. 102.
CRUISE	0.85 0.93 0.00	50000. 3302. 4705.	0.5155 0.0321 0.0000	4.45 0.00 16.05	2605.4 52367.0 0.73	49.23 0.00 0.00	823. 123. 400.
LOITER	0.55 0.83 0.00	35674. 3140. 4229.	0.5935 0.0365 0.0000	5.52 0.00 16.25	2650.0 49717.0 0.43	60.00 0.00 0.00	534. 103. 317.
CLIMB	0.89 1.85 0.00	50000. 8066. 0.	0.4315 0.0294 0.0000	3.92 5.55 14.68	753.2 48963.8 1.71	2.47 0.00 0.00	863. 136. 18.
ACCEL	1.50 1.95 0.00	50000. 14022. 19762.	0.1497 0.0283 0.0000	1.20 0.00 5.29	1156.9 47806.9 1.80	3.37 0.00 0.00	1452. 384. 40.
CRUISE	1.50 1.39 0.00	50000. 9002. 14742.	0.1462 0.0281 0.0000	1.12 0.00 5.20	1467.2 46339.6 1.16	6.97 0.00 0.00	1452. 384. 100.
COMBAT	1.60 1.62 0.00	35000. 20584. 42706.	0.1236 0.0276 0.0000	1.06 0.51 4.48	1664.4 44675.2 1.33	3.00 0.00 0.00	1557. 895. 46.
CRUISE	0.80 0.90 0.00	50000. 2648. 3771.	0.4730 0.0291 0.0000	3.81 0.00 16.27	2119.3 42555.9 0.61	52.30 0.00 0.00	774. 109. 400.
LOITER	0.30 1.04 0.00	100. 2916. 4186.	0.3839 0.0263 0.0000	3.83 0.00 14.60	1006.4 41549.6 0.11	20.00 0.00 0.00	335. 133. 66.

FUEL SUMMARIES

MISSION FUEL = 16071.
RESERVE FUEL = 804.
TRAPPED FUEL = 150.

TOTAL FUEL = 17024.

1990 Fighter Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.60	1 G FLIGHT	331.6	1.00	0.00	0.	0.34	0.062	0.0258
H=35000.	SUSTAINED	0.0	3.91	4.47	19957.	1.06	0.124	0.0276
	MAX. INST.	-793.6	6.50	7.60	11732.	7.21	0.393	0.0703
	COMBAT ENERGY = 0.596891E+05							
M= 0.20	1 G FLIGHT	207.3	1.00	0.00	0.	8.79	0.843	0.0570
H= 100.	SUSTAINED	0.0	1.92	13.52	946.	15.00	1.400	0.1274
	MAX. INST.	181.1	1.92	13.52	946.	15.00	1.400	0.1274
	COMBAT ENERGY = 0.124387E+04							
M= 0.90	1 G FLIGHT	248.2	1.00	0.00	0.	1.54	0.171	0.0211
H=30000.	SUSTAINED	0.0	3.58	7.07	7253.	3.11	0.340	0.0259
	MAX. INST.	-1090.6	6.50	13.22	3880.	12.59	1.092	0.2747
	COMBAT ENERGY = 0.148926E+04							

1990 Fighter Aerodynamics

Mach = 0.80   Altitude = 40000.

Parasite Drag	
Friction	.0110
Body	.0019
Wing	.0063
Strakes	.0000
H. Tail	.0016
V. Tail	.0013
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0025
Wave	.0001
External	.0005
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0005
Camber	.0000
Cdmin	.0140

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0140	0.0	0.000	0.00
2.0	0.252	0.0172	14.6	-.009	0.95
3.0	0.375	0.0211	17.8	-.014	0.94
4.0	0.497	0.0264	18.8	-.020	0.94
5.0	0.618	0.0401	15.4	-.025	0.69
6.0	0.709	0.0737	9.6	-.029	0.40
8.0	0.883	0.1165	7.6	-.042	0.36
10.0	1.049	0.1710	6.1	-.057	0.33
12.0	1.206	0.2369	5.1	-.072	0.31
15.0	1.369	0.3933	3.5	-.071	0.23

Slope Factors

ClAlpha	0.0913
Cdl^.5Alpha	0.0411

For a variable sweep wing

c/4 sweep	20.41
yawed aspect ratio	6.747
mean aero chord	12.23
t/c	0.1179
span	75.03

1990 Fighter Aerodynamics

Mach = 1.50 Altitude = 50000.

Parasite Drag		Induced Drag					
Friction	.0085	Alpha	Cl	Cd	L/D	Cm	e
Body	.0016	0.0	0.000	0.0188	0.0	0.000	0.00
Wing	.0045	2.0	0.187	0.0247	7.6	-.051	0.55
Strakes	.0000	3.0	0.234	0.0294	7.9	-.069	0.47
H. Tail	.0014	4.0	0.281	0.0358	7.8	-.086	0.42
V. Tail	.0011	5.0	0.329	0.0439	7.5	-.104	0.39
Canard	.0000	6.0	0.376	0.0537	7.0	-.123	0.37
Pods	.0000	8.0	0.473	0.0788	6.0	-.161	0.34
Engine	.0000	10.0	0.570	0.1117	5.1	-.202	0.32
Cowl	.0000	12.0	0.660	0.1843	3.6	-.176	0.24
Boattail	.0000	15.0	0.769	0.2583	3.0	-.222	0.23
Interference	.0002						
Wave	.0093						
External	.0008						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0008						
Camber	.0000						
Cdmin	.0188						

Slope Factors	
ClAlpha	0.0512
Cdl^.5Alpha	0.0326

For a variable sweep wing

c/4 sweep	60.05
yawed aspect ratio	3.488
mean aero chord	17.00
t/c	0.0868
span	53.95

1990 Fighter Propulsion

PHYSICAL ATTRIBUTES

ESF = 1.000
WEIGHT = 3255.000
LENGTH = 15.200
DIAM = 3.390

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	42645.	1.694	72240.6	315.
100.00	0.000	0.0	29489.	0.847	24977.2	315.
87.50	0.000	0.0	25803.	0.815	21021.2	291.
75.00	0.000	0.0	22117.	0.790	17475.3	265.
62.50	0.000	0.0	18431.	0.756	13929.5	243.
50.00	0.000	0.0	14745.	0.729	10746.2	214.
37.50	0.000	0.0	11058.	0.725	8016.3	180.
25.00	0.000	0.0	7372.	0.717	5286.4	154.
12.50	0.000	0.0	3686.	0.776	2859.5	102.
100.00	0.600	30000.0	16134.	1.840	29686.6	315.
100.00	0.600	30000.0	9594.	0.915	8778.5	315.
87.50	0.600	30000.0	8395.	0.893	7497.6	294.
75.00	0.600	30000.0	7195.	0.864	6216.4	276.
62.50	0.600	30000.0	5996.	0.853	5112.3	247.
50.00	0.600	30000.0	4797.	0.854	4095.7	217.
37.50	0.600	30000.0	3598.	0.856	3079.1	192.
25.00	0.600	30000.0	2398.	0.891	2136.1	158.
12.50	0.600	30000.0	1199.	1.032	1237.7	127.
100.00	0.900	30000.0	20380.	1.862	37953.1	315.
100.00	0.900	30000.0	12018.	1.030	12372.6	315.
87.50	0.900	30000.0	10516.	1.014	10667.5	296.
75.00	0.900	30000.0	9013.	0.995	8965.1	279.
62.50	0.900	30000.0	7511.	0.998	7493.4	253.
50.00	0.900	30000.0	6009.	1.024	6150.9	225.
37.50	0.900	30000.0	4507.	1.067	4808.5	202.
25.00	0.900	30000.0	3004.	1.173	3525.7	174.
12.50	0.900	30000.0	1502.	1.548	2326.0	143.
100.00	1.500	50000.0	14022.	1.949	27325.4	309.
100.00	1.500	50000.0	7771.	1.147	8909.6	309.
87.50	1.500	50000.0	6799.	1.133	7700.6	290.
75.00	1.500	50000.0	5828.	1.130	6585.9	268.
62.50	1.500	50000.0	4857.	1.127	5471.3	249.
50.00	1.500	50000.0	3885.	1.143	4442.2	225.
37.50	1.500	50000.0	2914.	1.213	3534.8	197.
25.00	1.500	50000.0	1943.	1.352	2627.4	175.
12.50	1.500	50000.0	971.	1.814	1761.7	144.

1990 Fighter Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	19269.	8741.	33.44
WING	10622.	4818.	18.44
FUSELAGE	3982.	1806.	6.91
HORIZONTAL TAIL	1156.	524.	2.01
VERTICAL TAIL	746.	338.	1.29
REACTION CONTROL SYSTEM	0.	0.	0.00
WING FOLD	0.	0.	0.00
INTERNAL BAY STRUCTURE	0.	0.	0.00
ALIGHTING GEAR	2764.	1254.	4.80
PROPULSION	5232.	2373.	9.08
ENGINES (1)	3776.	1713.	6.55
FUEL SYSTEM	1456.	660.	2.53
FIXED EQUIPMENT	7511.	3407.	13.04
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.9)			
HYD. + PNEU.	837.	380.	1.45
ELECTRICAL	784.	356.	1.36
AVIONICS	3006.	1364.	5.22
INSTRUMENTATION	169.	77.	0.29
DE-ICE/AIR CONDITION	995.	451.	1.73
AUXILIARY GEAR	200.	91.	0.35
FURNISH. + EQPT.	534.	242.	0.93
FLIGHT CONTROLS	1820.	826.	3.16
FUEL	17024.	7722.	29.55
PAYLOAD	8583.	3893.	14.90
FLIGHT CREW (2)	360.	163.	0.62
ARMAMENT	612.	278.	1.06
AMMUNITION	287.	130.	0.50
LONG RANGE MISSILES	3948.	1791.	6.85
LRM PYLONS & LAUNCHERS	1880.	853.	3.26
SHORT RANGE MISSILES	796.	361.	1.38
SRM LAUNCHERS	700.	318.	1.21
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	57619.	26136.	100.00

1990 Light Attack Summary

Standard English Units

GENERAL		FUSELAGE				WING	HTAIL	VTAIL
TOGW	24777.	LENGTH	38.2		AREA	329.3	76.9	50.2
W/S	75.2	DIAMETER	4.6		WETTED AREA	553.1	98.0	100.7
T/W	0.51	VOLUME	547.8		SPAN	41.3	16.6	7.2
CREW	1	WETTED AREA	505.7		L.E. SWEEP	18.2	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	8.3		C/4 SWEEP	12.8	30.0	30.0
					ASPECT RATIO	5.17	3.57	1.02
					TAPER RATIO	0.31	0.39	0.30
ENGINE		**WEIGHTS**			T/C ROOT	0.09	0.09	0.08
					T/C TIP	0.06	0.07	0.06
NUMBER	1		W	%	ROOT CHORD	12.2	6.7	10.8
LENGTH	10.8	STRUCT.	7356.	29.7	TIP CHORD	3.8	2.6	3.3
DIAM.	3.4	PROPUL.	3248.	13.1	M.A. CHORD	8.7	4.9	7.7
WEIGHT	2077.6	FIX. EQ.	4091.	16.5	LOC. OF L.E.	7.9	27.8	27.4
TSLS	12749.	FUEL	5524.	22.3				
SFCSLS	0.42	PAYLOAD	4559.	18.4				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	130.	10.5					
CLIMB	0.82	36500.	481.	10.2	74.8	12.74	2566.7	0.662	217.1
CRUISE	0.80	36500.	1360.	65.4	500.0	12.75	1814.8	0.680	208.3
CRUISE	0.80	100.	464.	5.7	50.0	3.68	6132.8	0.800	944.6
COMBAT	0.85	100.	197.	2.0	18.7	6.12	7289.8	0.813	1066.4
CRUISE	0.80	100.	463.	5.7	50.0	3.58	6126.9	0.800	944.6
CLIMB	0.81	39500.	453.	10.5	77.0	12.87	2225.6	0.659	186.5
CRUISE	0.80	39500.	1179.	65.4	500.0	12.84	1584.4	0.675	180.4
LOITER	0.30	100.	390.	20.0	66.1	13.53	1481.9	0.789	132.8

BLOCK TIME = 3.082 HR
BLOCK RANGE = 1336.9 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	44.	3.6	0.127	0.0208	0.9	6.5	-106.	0.408	0.0300	2.8	5257.
0.20	100.	104.	1.5	1.372	0.1496	15.0	1.5	86.	1.372	0.1496	15.0	623.

1990 Light Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	329.3	76.9	50.2	0.0	(SQ.FT.)
SURFACE AREA.......	553.1	98.0	100.7	0.0	(SQ.FT.)
VOLUME.............	139.2	22.0	20.1	0.0	(CU.FT.)
SPAN...............	41.268	16.580	7.156	0.000	(FT.)
L.E. SWEEP.........	18.160	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	12.768	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-4.438	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	5.171	3.574	1.020	0.000	
ROOT CHORD.........	12.165	6.694	10.777	0.000	(FT.)
ROOT THICKNESS.....	13.138	7.230	10.216	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	3.795	2.584	3.255	0.000	(FT.)
TIP THICKNESS......	2.733	2.170	2.539	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	8.712	4.942	7.688	0.000	(FT.)
LE ROOT AT.........	7.880	27.788	27.409	0.000	(FT.)
C/4 ROOT AT........	10.921	29.461	30.104	0.000	(FT.)
TE ROOT AT.........	20.045	34.482	38.186	0.000	(FT.)
LE M.A.C. AT.......	10.673	30.266	29.878	0.000	(FT.)
C/4 M.A.C. AT......	12.850	31.501	31.800	0.000	(FT.)
TE M.A.C. AT.......	19.384	35.208	37.566	0.000	(FT.)
Y M.A.C. AT........	8.514	3.533	2.939	0.000	
LE TIP AT..........	14.648	33.602	33.421	0.000	(FT.)
C/4 TIP AT.........	15.597	34.248	34.235	0.000	(FT.)
TE TIP AT..........	18.444	36.185	36.676	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.289	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 24775.445 Lbs.
AIRCRAFT VOLUME = 729.090 Cu.Ft.
AIRCRAFT DENSITY = 33.981 Lbs./Cu.Ft.

1990 Light Attack Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.82	36500.	0.3354	2.40	480.8	10.18	791.
	0.66	2567.	0.0263	1.62	24164.2	0.00	217.
	0.00	0.	0.0000	12.74	1.00	0.00	75.
CRUISE	0.80	36500.	0.3374	2.47	1359.8	65.38	774.
	0.68	1815.	0.0265	0.00	22804.5	0.00	208.
	0.00	4423.	0.0000	12.74	0.71	0.00	500.
CRUISE	0.80	100.	0.0726	0.52	463.7	5.67	893.
	0.80	6133.	0.0197	0.00	22340.8	0.00	945.
	0.00	16987.	0.0000	3.68	0.73	0.00	50.
COMBAT	0.85	100.	0.1269	0.85	197.5	2.00	949.
	0.81	7290.	0.0208	0.15	22143.3	0.00	1066.
	0.00	21242.	0.0000	6.12	0.73	0.00	19.
CRUISE	0.80	100.	0.0704	0.51	463.4	5.67	893.
	0.80	6127.	0.0197	0.00	21679.9	0.00	945.
	0.00	16978.	0.0000	3.58	0.73	0.00	50.
CLIMB	0.81	39500.	0.3427	2.47	453.0	10.52	787.
	0.66	2226.	0.0266	1.59	21226.9	0.00	186.
	0.00	0.	0.0000	12.78	1.00	0.00	77.
CRUISE	0.80	39500.	0.3424	2.51	1179.4	65.38	774.
	0.68	1584.	0.0267	0.00	20047.6	0.00	180.
	0.00	3822.	0.0000	12.84	0.72	0.00	500.
LOITER	0.30	100.	0.4583	4.54	389.8	20.00	335.
	0.79	1482.	0.0339	0.00	19657.8	0.00	133.
	0.00	3276.	0.0000	13.53	0.14	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 5118.
RESERVE FUEL = 256.
TRAPPED FUEL = 150.

TOTAL FUEL = 5524.

1990 Light Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	43.8	1.00	0.00	0.	0.42	0.064	0.0200
H= 100.	SUSTAINED	0.0	3.59	6.70	8117.	0.85	0.127	0.0208
	MAX. INST.	-105.7	6.50	12.48	4355.	2.80	0.408	0.0300
	COMBAT ENERGY = 0.525727E+04							
M= 0.20	1 G FLIGHT	103.8	1.00	0.00	0.	10.71	1.011	0.0891
H= 100.	SUSTAINED	0.0	1.50	9.24	1384.	15.00	1.372	0.1496
	MAX. INST.	86.2	1.50	9.24	1384.	15.00	1.372	0.1496
	COMBAT ENERGY = 0.622524E+03							

1990 Light Attack Propulsion

Mach = 0.90   Altitude = 100.

Parasite Drag	
Friction	.0112
Body	.0037
Wing	.0055
Strakes	.0000
H. Tail	.0011
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0013
Wave	.0138
External	.0051
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0051
Camber	.0000
Cdmin	.0314

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0314	0.0	0.000	0.00
2.0	0.325	0.0378	8.6	-.018	1.01
3.0	0.483	0.0501	9.6	-.028	0.77
4.0	0.582	0.0701	8.3	-.039	0.54
5.0	0.676	0.0874	7.7	-.050	0.50
6.0	0.768	0.1080	7.1	-.062	0.47
8.0	0.937	0.1841	5.1	-.066	0.35
10.0	1.037	0.2381	4.4	-.093	0.32
12.0	1.130	0.2986	3.8	-.124	0.29
15.0	1.253	0.4002	3.1	-.174	0.26

Slope Factors	
ClAlpha	0.0835
Cdl^.5Alpha	0.0405

Mach = 0.60   Altitude = 35000.

Parasite Drag	
Friction	.0118
Body	.0039
Wing	.0057
Strakes	.0000
H. Tail	.0011
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0021
Wave	.0000
External	.0035
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0035
Camber	.0000
Cdmin	.0173

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0173	0.0	0.000	0.00
2.0	0.232	0.0208	11.2	-.011	0.97
3.0	0.345	0.0249	13.8	-.017	0.97
4.0	0.455	0.0306	14.9	-.024	0.96
5.0	0.565	0.0416	13.6	-.032	0.81
6.0	0.652	0.0732	8.9	-.040	0.47
8.0	0.819	0.1140	7.2	-.060	0.43
10.0	0.976	0.1658	5.9	-.082	0.40
12.0	1.124	0.2282	4.9	-.106	0.37
15.0	1.324	0.3398	3.9	-.148	0.33

Slope Factors	
ClAlpha	0.0883
Cdl^.5Alpha	0.0379

1990 Light Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.719
WEIGHT =	2077.642
LENGTH =	10.770
DIAM =	3.426

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	12749.	0.418	5329.2	326.
87.50	0.000	0.0	11156.	0.405	4520.8	303.
75.00	0.000	0.0	9562.	0.399	3819.3	276.
62.50	0.000	0.0	7968.	0.391	3117.7	253.
50.00	0.000	0.0	6375.	0.379	2416.2	233.
37.50	0.000	0.0	4781.	0.378	1808.1	195.
25.00	0.000	0.0	3187.	0.414	1320.6	148.
12.50	0.000	0.0	1594.	0.523	833.2	117.
100.00	0.600	30000.0	3154.	0.592	1867.3	328.
87.50	0.600	30000.0	2760.	0.598	1651.2	311.
75.00	0.600	30000.0	2366.	0.607	1435.1	296.
62.50	0.600	30000.0	1971.	0.618	1219.0	281.
50.00	0.600	30000.0	1577.	0.638	1005.4	266.
37.50	0.600	30000.0	1183.	0.691	817.8	240.
25.00	0.600	30000.0	789.	0.799	630.2	218.
12.50	0.600	30000.0	394.	1.122	442.6	198.
100.00	0.800	30000.0	3466.	0.664	2301.7	328.
87.50	0.800	30000.0	3033.	0.671	2036.2	312.
75.00	0.800	30000.0	2600.	0.681	1770.8	297.
62.50	0.800	30000.0	2166.	0.695	1505.3	283.
50.00	0.800	30000.0	1733.	0.719	1246.4	268.
37.50	0.800	30000.0	1300.	0.784	1018.5	247.
25.00	0.800	30000.0	867.	0.912	790.6	229.
12.50	0.800	30000.0	433.	1.299	562.7	212.
100.00	0.900	30000.0	3591.	0.725	2604.5	328.
87.50	0.900	30000.0	3142.	0.736	2313.1	313.
75.00	0.900	30000.0	2693.	0.751	2021.7	298.
62.50	0.900	30000.0	2244.	0.771	1730.3	285.
50.00	0.900	30000.0	1795.	0.804	1443.6	272.
37.50	0.900	30000.0	1347.	0.887	1194.8	252.
25.00	0.900	30000.0	898.	1.054	946.0	235.
12.50	0.900	30000.0	449.	1.553	697.2	220.

1990 Light Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	7356.	3337.	29.69
WING	2519.	1143.	10.17
FUSELAGE	2349.	1065.	9.48
HORIZONTAL TAIL	587.	266.	2.37
VERTICAL TAIL	212.	96.	0.86
ARMOR	589.	267.	2.38
WING FOLD	150.	68.	0.60
ALIGHTING GEAR	951.	431.	3.84
PROPULSION	3248.	1473.	13.11
ENGINES (1)	2433.	1104.	9.82
FUEL SYSTEM	814.	369.	3.29
FIXED EQUIPMENT	4091.	1856.	16.51
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	208.	94.	0.84
ELECTRICAL	544.	247.	2.20
AVIONICS	1652.	749.	6.67
INSTRUMENTATION	94.	43.	0.38
DE-ICE/AIR CONDITION	398.	181.	1.61
AUXILIARY GEAR	200.	91.	0.81
FURNISH. + EQPT.	375.	170.	1.51
FLIGHT CONTROLS	1074.	487.	4.34
FUEL	5524.	2505.	22.29
PAYLOAD	4559.	2068.	18.40
FLIGHT CREW (1)	180.	82.	0.73
ARMAMENT	612.	278.	2.47
AMMUNITION	287.	130.	1.16
LASER GUIDED BOMBS	2182.	990.	8.81
LGB PYLONS AND EJECTORS	700.	318.	2.83
SHORT RANGE MISSILES	398.	181.	1.61
SRM LAUNCHER	200.	91.	0.81
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	24777.	11239.	100.00

1990 Medium Attack Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	33438.	LENGTH	45.2	AREA	459.6	114.3	72.5
W/S	72.8	DIAMETER	4.5	WETTED AREA	794.4	160.7	145.3
T/W Dry	0.52	VOLUME	670.5	SPAN	48.1	20.2	8.6
CREW	1	WETTED AREA	610.9	L.E. SWEEP	23.5	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	10.0	C/4 SWEEP	18.2	30.0	30.0
				ASPECT RATIO	5.02	3.57	1.02
				TAPER RATIO	0.31	0.39	0.30
				T/C ROOT	0.09	0.09	0.08
				T/C TIP	0.06	0.07	0.06
				ROOT CHORD	14.6	8.2	12.9
				TIP CHORD	4.5	3.2	3.9
				M.A. CHORD	10.4	6.0	9.2
				LOC. OF L.E.	9.3	32.6	32.2

ENGINE		WEIGHTS	W	%
NUMBER	1			
LENGTH	12.6	STRUCT.	10218.	30.6
DIAM.	4.0	PROPUL.	4527.	13.5
WEIGHT	2896.4	FIX. EQ.	4256.	12.7
TSLS	17495.	FUEL	7596.	22.7
SFCSLS	0.42	PAYLOAD	6841.	20.5

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	179.	10.5					
CLIMB	0.79	36500.	659.	10.3	74.4	12.84	3476.9	0.650	201.6
CRUISE	0.80	36500.	1891.	65.4	500.0	12.33	2528.2	0.679	208.3
CRUISE	0.80	100.	649.	5.7	50.0	3.52	8635.0	0.795	944.6
COMBAT	0.85	100.	276.	2.0	18.7	5.85	10251.7	0.809	1066.4
CRUISE	0.80	100.	648.	5.7	50.0	3.41	8626.8	0.795	944.6
CLIMB	0.78	39500.	617.	10.6	76.5	12.97	3016.9	0.642	171.7
CRUISE	0.80	39500.	1637.	65.4	500.0	12.39	2201.8	0.674	180.4
LOITER	0.30	100.	536.	20.0	66.1	13.19	2038.3	0.788	132.8

BLOCK TIME = 3.086 HR
BLOCK RANGE = 1335.9 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	37.	3.3	0.122	0.0209	0.9	6.5	-118.	0.393	0.0301	3.0	4393.
0.20	100.	107.	1.5	1.314	0.1429	15.0	1.5	89.	1.314	0.1429	15.0	639.

1990 Medium Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	459.6	114.3	72.5	0.0	(SQ.FT.)
SURFACE AREA.......	794.4	160.7	145.3	0.0	(SQ.FT.)
VOLUME.............	238.1	39.9	34.8	0.0	(CU.FT.)
SPAN...............	48.055	20.215	8.599	0.000	(FT.)
L.E. SWEEP.........	23.450	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	18.233	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	0.936	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	5.025	3.574	1.020	0.000	
ROOT CHORD.........	14.579	8.162	12.949	0.000	(FT.)
ROOT THICKNESS.....	15.745	8.815	12.276	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	4.549	3.150	3.911	0.000	(FT.)
TIP THICKNESS......	3.275	2.646	3.050	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	10.440	6.026	9.238	0.000	(FT.)
LE ROOT AT.........	9.280	32.646	32.242	0.000	(FT.)
C/4 ROOT AT........	12.925	34.686	35.479	0.000	(FT.)
TE ROOT AT.........	23.859	40.807	45.191	0.000	(FT.)
LE M.A.C. AT.......	13.580	35.667	35.208	0.000	(FT.)
C/4 M.A.C. AT......	16.190	37.173	37.518	0.000	(FT.)
TE M.A.C. AT.......	24.021	41.693	44.446	0.000	(FT.)
Y M.A.C. AT........	9.914	4.307	3.531	0.000	
LE TIP AT..........	19.703	39.734	39.466	0.000	(FT.)
C/4 TIP AT.........	20.840	40.522	40.443	0.000	(FT.)
TE TIP AT..........	24.251	42.885	43.376	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.250	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 33438.113 Lbs.
AIRCRAFT VOLUME = 983.340 Cu.Ft.
AIRCRAFT DENSITY = 34.005 Lbs./Cu.Ft.

1990 Medium Attack Mission Performance

PHASE	M	H	CL	ALPHA	WFUEL	TIME	VEL
	SFC(I)	THRUST(I)	CD	GAMMA	W	WA	Q
	SFC(U)	THRUST(U)	CDINST	L/D	THR/THA	PR	X
CLIMB	0.79	36500.	0.3567	2.91	658.6	10.33	762.
	0.65	3477.	0.0278	1.59	32600.5	0.00	202.
	00.0	0.	0.0000	12.84	1.00	0.00	74.
CRUISE	0.80	36500.	0.3257	2.62	1891.0	65.38	774.
	0.68	2528.	0.0264	0.00	30709.5	0.00	208.
	0.00	6122.	0.0000	3.52	0.75	0.00	500.
CRUISE	0.80	100.	0.0700	0.55	649.0	5.67	893.
	0.79	8635.	0.0199	0.00	30060.6	0.00	945.
	0.00	23633.	0.0000	12.33	0.72	0.00	50.
COMBAT	0.85	100.	0.1223	0.91	276.5	2.00	949.
	0.81	10252.	0.0209	0.12	29784.1	0.00	1066.
	0.00	29148.	0.0000	3.52	0.93	0.00	19.
CRUISE	0.80	100.	0.0679	0.53	648.5	5.67	893.
	0.80	8627.	0.0199	0.00	29135.6	0.00	945.
	0.00	23621.	0.0000	3.41	0.75	0.00	50.
CLIMB	0.78	39500.	0.3663	3.01	616.7	10.62	756.
	0.64	3017.	0.0282	1.58	28518.9	0.00	172.
	0.00	0.	0.0000	12.97	1.00	0.00	76.
CRUISE	0.80	39500.	0.3291	2.64	1636.5	65.38	774.
	0.67	2202.	0.0266	0.00	26882.3	0.00	180.
	0.00	5283.	0.0000	12.39	0.72	0.00	500.
LOITER	0.30	100.	0.4403	4.64	535.5	20.00	335.
	0.79	2038.	0.0334	0.00	26346.8	0.00	133.
	0.00	4502.	0.0000	13.19	0.14	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 7091.
RESERVE FUEL = 355.
TRAPPED FUEL = 150.

TOTAL FUEL = 7596.

1990 Medium Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	36.6	1.00	0.00	0.	0.45	0.061	0.0202
H= 100.	SUSTAINED	0.0	3.31	6.12	8878.	0.91	0.122	0.0209
	MAX. INST.	-117.6	6.50	12.48	4355.	2.98	0.393	0.0301
	COMBAT ENERGY = 0.439305E+04							
M= 0.20	1 G FLIGHT	106.6	1.00	0.00	0.	10.83	0.971	0.0862
H= 100.	SUSTAINED	0.0	1.50	9.23	1386.	15.00	1.314	0.1429
	MAX. INST.	89.2	1.50	9.23	1386.	15.00	1.314	0.1429
	COMBAT ENERGY = 0.639383E+03							

1990 Medium Attack Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag	
Friction	.0107
Body	.0031
Wing	.0054
Strakes	.0000
H. Tail	.0012
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0011
Wave	.0106
External	.0100
Tanks	.0000
Bombs	.0050
Stores	.0000
Extra	.0050
Camber	.0000
Cdmin	.0324

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0324	0.0	0.000	0.00
2.0	0.289	0.0377	7.7	-.018	1.00
3.0	0.431	0.0474	9.1	-.027	0.79
4.0	0.527	0.0661	8.0	-.038	0.52
5.0	0.617	0.0817	7.5	-.049	0.49
6.0	0.705	0.1005	7.0	-.060	0.46
8.0	0.875	0.1472	5.9	-.086	0.42
10.0	1.016	0.2354	4.3	-.090	0.32
12.0	1.105	0.2944	3.8	-.120	0.30
15.0	1.224	0.3938	3.1	-.170	0.26

Slope Factors

ClAlpha	0.0816
Cdl^.5Alpha	0.0401

Mach = 0.60 Altitude = 35000.

Parasite Drag	
Friction	.0112
Body	.0032
Wing	.0057
Strakes	.0000
H. Tail	.0013
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0019
Wave	.0000
External	.0067
Tanks	.0000
Bombs	.0034
Stores	.0000
Extra	.0034
Camber	.0000
Cdmin	.0199

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0199	0.0	0.000	0.00
2.0	0.216	0.0229	9.4	-.011	0.96
3.0	0.321	0.0266	12.0	-.017	0.96
4.0	0.424	0.0318	13.4	-.024	0.96
5.0	0.526	0.0394	13.4	-.032	0.90
6.0	0.613	0.0714	8.6	-.040	0.46
8.0	0.773	0.1098	7.0	-.059	0.42
10.0	0.926	0.1589	5.8	-.081	0.39
12.0	1.069	0.2184	4.9	-.106	0.36
15.0	1.266	0.3256	3.9	-.148	0.33

Slope Factors

ClAlpha	0.0844
Cdl^.5Alpha	0.0369

1990 Medium Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.987
WEIGHT =	2896.399
LENGTH =	12.616
DIAM =	4.013

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	17495.	0.418	7312.7	447.
87.50	0.000	0.0	15308.	0.405	6203.5	415.
75.00	0.000	0.0	13121.	0.399	5240.8	379.
62.50	0.000	0.0	10934.	0.391	4278.1	348.
50.00	0.000	0.0	8747.	0.379	3315.4	320.
37.50	0.000	0.0	6560.	0.378	2481.1	268.
25.00	0.000	0.0	4374.	0.414	1812.2	204.
12.50	0.000	0.0	2187.	0.523	1143.2	160.
100.00	0.600	30000.0	4328.	0.592	2562.3	450.
87.50	0.600	30000.0	3787.	0.598	2265.8	427.
75.00	0.600	30000.0	3246.	0.607	1969.2	406.
62.50	0.600	30000.0	2705.	0.618	1672.7	386.
50.00	0.600	30000.0	2164.	0.638	1379.6	366.
37.50	0.600	30000.0	1623.	0.691	1122.1	330.
25.00	0.600	30000.0	1082.	0.799	864.7	299.
12.50	0.600	30000.0	541.	1.122	607.3	272.
100.00	0.800	30000.0	4756.	0.664	3158.3	450.
87.50	0.800	30000.0	4162.	0.671	2794.1	428.
75.00	0.800	30000.0	3567.	0.681	2429.8	407.
62.50	0.800	30000.0	2973.	0.695	2065.6	388.
50.00	0.800	30000.0	2378.	0.719	1710.4	368.
37.50	0.800	30000.0	1784.	0.784	1397.6	339.
25.00	0.800	30000.0	1189.	0.912	1084.8	314.
12.50	0.800	30000.0	595.	1.299	772.1	291.
100.00	0.900	30000.0	4927.	0.725	3573.8	450.
87.50	0.900	30000.0	4311.	0.736	3174.0	429.
75.00	0.900	30000.0	3695.	0.751	2774.2	409.
62.50	0.900	30000.0	3080.	0.771	2374.4	391.
50.00	0.900	30000.0	2464.	0.804	1980.9	373.
37.50	0.900	30000.0	1848.	0.887	1639.5	346.
25.00	0.900	30000.0	1232.	1.054	1298.1	323.
12.50	0.900	30000.0	616.	1.553	956.7	301.

1990 Medium Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	10218.	4635.	30.56
WING	3776.	1713.	11.29
FUSELAGE	3094.	1403.	9.25
HORIZONTAL TAIL	997.	452.	2.98
VERTICAL TAIL	329.	149.	0.99
ARMOR	589.	267.	1.76
WING FOLD	150.	68.	0.45
ALIGHTING GEAR	1283.	582.	3.84
PROPULSION	4527.	2054.	13.54
ENGINES (1)	3392.	1539.	10.14
FUEL SYSTEM	1135.	515.	3.40
FIXED EQUIPMENT	4256.	1930.	12.73
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.90)			
HYD. + PNEU.	281.	127.	0.84
ELECTRICAL	544.	247.	1.63
AVIONICS	1652.	749.	4.94
INSTRUMENTATION	94.	43.	0.28
DE-ICE/AIR CONDITION	398.	181.	1.19
AUXILIARY GEAR	200.	91.	0.60
FURNISH. + EQPT.	375.	170.	1.12
FLIGHT CONTROLS	1185.	538.	3.54
FUEL	7596.	3446.	22.72
PAYLOAD	6841.	3103.	20.46
FLIGHT CREW (1)	180.	82.	0.54
ARMAMENT	612.	278.	1.83
AMMUNITION	287.	130.	0.86
SHORT RANGE MISSILES	398.	181.	1.19
SRM LAUNCHERS	200.	91.	0.60
LASER GUIDED BOMBS	4364.	1980.	13.05
LGB PYLONS AND EJECTORS	800.	363.	2.39
EXTERNAL TANKS	0.	0.	0.00
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TOTAL WEIGHT	33438.	15168.	100.00

1990 Medium All Weather Attack Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	37573.	LENGTH	48.2	AREA	515.6	121.7	78.7
W/S	72.9	DIAMETER	4.5	WETTED AREA	899.1	172.4	157.9
T/W Dry	0.51	VOLUME	740.0	SPAN	51.5	20.9	9.0
CREW	2	WETTED AREA	663.1	L.E. SWEEP	20.1	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	10.6	C/4 SWEEP	14.8	30.0	30.0
				ASPECT RATIO	5.14	3.57	1.02
				TAPER RATIO	0.31	0.39	0.30
ENGINE		WEIGHTS		T/C ROOT	0.09	0.09	0.08
				T/C TIP	0.06	0.07	0.06
NUMBER	1	W	%	ROOT CHORD	15.3	8.4	13.5
LENGTH	13.2	STRUCT. 11423.	30.4	TIP CHORD	4.8	3.2	4.1
DIAM.	4.2	PROPUL. 4984.	13.3	M.A. CHORD	10.9	6.2	9.6
WEIGHT	3188.5	FIX. EQ. 5930.	15.8	LOC. OF L.E.	10.0	35.1	34.7
TSLS	19171.	FUEL 8215.	21.9				
SFCSLS	0.42	PAYLOAD 7021.	18.7				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	196.	10.5					
CLIMB	0.80	36500.	725.	10.2	74.6	13.27	3830.9	0.655	208.1
CRUISE	0.80	36500.	2036.	65.4	500.0	12.93	2715.7	0.680	208.3
CRUISE	0.80	100.	696.	5.7	50.0	3.73	9191.8	0.800	944.6
COMBAT	0.85	100.	298.	2.0	18.7	6.14	11025.2	0.812	1066.4
CRUISE	0.80	100.	695.	5.7	50.0	3.62	9182.9	0.801	944.6
CLIMB	0.80	39500.	684.	10.6	77.4	13.41	3326.0	0.649	178.4
CRUISE	0.80	39500.	1767.	65.4	500.0	13.03	2372.7	0.676	180.4
LOITER	0.30	100.	584.	20.0	66.1	13.77	2213.8	0.792	132.8

BLOCK TIME = 3.084 HR
BLOCK RANGE = 1337.0 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	42.	3.5	0.123	0.0200	0.9	6.5	-106.	0.395	0.0289	2.9	4982.
0.20	100.	103.	1.5	1.333	0.1422	15.0	1.5	86.	1.333	0.1422	15.0	617.

1990 Medium All Weather Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	515.6	121.7	78.7	0.0	(SQ.FT.)
SURFACE AREA.......	899.1	172.4	157.9	0.0	(SQ.FT.)
VOLUME.............	281.7	43.8	39.4	0.0	(CU.FT.)
SPAN...............	51.472	20.853	8.961	0.000	(FT.)
L.E. SWEEP.........	20.085	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	14.767	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-2.438	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	5.138	3.574	1.020	0.000	
ROOT CHORD.........	15.271	8.419	13.496	0.000	(FT.)
ROOT THICKNESS.....	16.492	9.093	12.794	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	4.764	3.250	4.076	0.000	(FT.)
TIP THICKNESS......	3.430	2.730	3.179	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	10.936	6.216	9.627	0.000	(FT.)
LE ROOT AT.........	9.959	35.078	34.674	0.000	(FT.)
C/4 ROOT AT........	13.777	37.183	38.048	0.000	(FT.)
TE ROOT AT.........	25.230	43.498	48.170	0.000	(FT.)
LE M.A.C. AT.......	13.842	38.194	37.766	0.000	(FT.)
C/4 M.A.C. AT......	16.576	39.748	40.173	0.000	(FT.)
TE M.A.C. AT.......	24.778	44.411	47.393	0.000	(FT.)
Y M.A.C. AT........	10.619	4.443	3.680	0.000	
LE TIP AT..........	19.369	42.390	42.203	0.000	(FT.)
C/4 TIP AT.........	20.561	43.203	43.222	0.000	(FT.)
TE TIP AT..........	24.134	45.640	46.279	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.275	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 37573.547 Lbs.
AIRCRAFT VOLUME = 1104.919 Cu.Ft.
AIRCRAFT DENSITY = 34.006 Lbs./Cu.Ft.

1990 Medium All Weather Attack Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.80	36500.	0.3463	2.70	725.4	10.24	774.
	0.66	3831.	0.0261	1.61	36652.0	0.00	208.
	0.00	0.	0.0000	13.27	1.00	0.00	75.
CRUISE	0.80	36500.	0.3270	2.55	2035.8	65.38	774.
	0.68	2716.	0.0253	0.00	34616.2	0.00	208.
	0.00	6632.	0.0000	12.93	0.71	0.00	500.
CRUISE	0.80	100.	0.0704	0.54	695.5	5.67	893.
	0.80	9192.	0.0189	0.00	33920.7	0.00	945.
	0.00	25499.	0.0000	3.73	0.73	0.00	50.
COMBAT	0.85	100.	0.1231	0.88	298.4	2.00	949.
	0.81	11025.	0.0200	0.14	33622.3	0.00	1066.
	0.00	31942.	0.0000	6.14	0.91	0.00	19.
CRUISE	0.80	100.	0.0683	0.52	695.0	5.67	893.
	0.80	9183.	0.0189	0.00	32927.3	0.00	945.
	0.00	25486.	0.0000	3.62	0.73	0.00	50.
CLIMB	0.80	39500.	0.3553	2.79	684.0	10.59	770.
	0.65	3326.	0.0265	1.58	32243.3	0.00	178.
	0.00	0.	0.0000	13.41	1.00	0.00	77.
CRUISE	0.80	39500.	0.3324	2.59	1766.8	65.38	774.
	0.68	2373.	0.0255	0.00	30476.4	0.00	180.
	0.00	5734.	0.0000	13.03	0.71	0.00	500.
LOITER	0.30	100.	0.4449	4.62	584.1	20.00	335.
	0.79	2214.	0.0323	0.00	29892.3	0.00	133.
	0.00	4908.	0.0000	13.77	0.14	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 7681.
RESERVE FUEL = 384.
TRAPPED FUEL = 150.

TOTAL FUEL = 8215.

1990 Medium All Weather Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	41.5	1.00	0.00	0.	0.44	0.062	0.0193
H= 100.	SUSTAINED	0.0	3.53	6.58	8262.	0.88	0.123	0.0200
	MAX. INST.	-105.8	6.50	12.48	4355.	2.89	0.395	0.0289
	COMBAT ENERGY = 0.498188E+04							
M= 0.20	1 G FLIGHT	102.8	1.00	0.00	0.	10.79	0.982	0.0849
H= 100.	SUSTAINED	0.0	1.50	9.23	1386.	15.00	1.333	0.1422
	MAX. INST.	85.6	1.50	9.23	1386.	15.00	1.333	0.1422
	COMBAT ENERGY = 0.616518E+03							

1990 Medium All Weather Attack Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag	
Friction	.0105
Body	.0029
Wing	.0054
Strakes	.0000
H. Tail	.0011
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0011
Wave	.0112
External	.0044
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0044
Camber	.0000
Cdmin	.0272

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0272	0.0	0.000	0.00
2.0	0.303	0.0328	9.2	-.019	1.00
3.0	0.451	0.0436	10.3	-.029	0.77
4.0	0.548	0.0627	8.7	-.040	0.52
5.0	0.639	0.0790	8.1	-.052	0.49
6.0	0.729	0.0985	7.4	-.064	0.46
8.0	0.903	0.1468	6.2	-.090	0.42
10.0	1.015	0.2299	4.4	-.096	0.31
12.0	1.105	0.2893	3.8	-.128	0.29
15.0	1.227	0.3893	3.2	-.179	0.26

Slope Factors	
ClAlpha	0.0818
Cdl^.5Alpha	0.0401

Mach = 0.60 Altitude = 35000.

Parasite Drag	
Friction	.0110
Body	.0031
Wing	.0057
Strakes	.0000
H. Tail	.0012
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0018
Wave	.0000
External	.0030
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0030
Camber	.0000
Cdmin	.0158

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0158	0.0	0.000	0.00
2.0	0.220	0.0189	11.6	-.012	0.96
3.0	0.327	0.0227	14.4	-.019	0.96
4.0	0.432	0.0279	15.5	-.026	0.96
5.0	0.537	0.0374	14.4	-.034	0.83
6.0	0.623	0.0684	9.1	-.043	0.46
8.0	0.787	0.1075	7.3	-.063	0.42
10.0	0.942	0.1577	6.0	-.086	0.39
12.0	1.088	0.2184	5.0	-.112	0.36
15.0	1.288	0.3276	3.9	-.155	0.33

Slope Factors	
ClAlpha	0.0859
Cdl^.5Alpha	0.0372

1990 Medium All Weather Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	1.081
WEIGHT =	3188.523
LENGTH =	13.207
DIAM =	4.201

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	19171.	0.418	8013.5	490.
87.50	0.000	0.0	16775.	0.405	6797.9	455.
75.00	0.000	0.0	14378.	0.399	5743.0	416.
62.50	0.000	0.0	11982.	0.391	4688.1	381.
50.00	0.000	0.0	9586.	0.379	3633.2	351.
37.50	0.000	0.0	7189.	0.378	2718.9	294.
25.00	0.000	0.0	4793.	0.414	1985.8	223.
12.50	0.000	0.0	2396.	0.523	1252.8	175.
100.00	0.600	30000.0	4743.	0.592	2807.9	493.
87.50	0.600	30000.0	4150.	0.598	2482.9	468.
75.00	0.600	30000.0	3557.	0.607	2158.0	445.
62.50	0.600	30000.0	2964.	0.618	1833.0	423.
50.00	0.600	30000.0	2371.	0.638	1511.8	401.
37.50	0.600	30000.0	1779.	0.691	1229.7	361.
25.00	0.600	30000.0	1186.	0.799	947.6	327.
12.50	0.600	30000.0	593.	1.122	665.5	298.
100.00	0.800	30000.0	5212.	0.664	3461.0	493.
87.50	0.800	30000.0	4561.	0.671	3061.8	469.
75.00	0.800	30000.0	3909.	0.681	2662.7	446.
62.50	0.800	30000.0	3258.	0.695	2263.5	425.
50.00	0.800	30000.0	2606.	0.719	1874.3	403.
37.50	0.800	30000.0	1955.	0.784	1531.5	372.
25.00	0.800	30000.0	1303.	0.912	1188.8	344.
12.50	0.800	30000.0	652.	1.299	846.1	319.
100.00	0.900	30000.0	5400.	0.725	3916.3	493.
87.50	0.900	30000.0	4725.	0.736	3478.2	470.
75.00	0.900	30000.0	4050.	0.751	3040.0	449.
62.50	0.900	30000.0	3375.	0.771	2601.9	429.
50.00	0.900	30000.0	2700.	0.804	2170.7	409.
37.50	0.900	30000.0	2025.	0.887	1796.6	380.
25.00	0.900	30000.0	1350.	1.054	1422.5	354.
12.50	0.900	30000.0	675.	1.553	1048.3	330.

1990 Medium All Weather Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	11423.	5182.	30.40
WING	4325.	1962.	11.51
FUSELAGE	3475.	1576.	9.25
HORIZONTAL TAIL	1079.	489.	2.87
VERTICAL TAIL	364.	165.	0.97
ARMOR	589.	267.	1.57
WING FOLD	150.	68.	0.40
ALIGHTING GEAR	1442.	654.	3.84
PROPULSION	4984.	2261.	13.26
ENGINES (1)	3734.	1694.	9.94
FUEL SYSTEM	1250.	567.	3.33
FIXED EQUIPMENT	5930.	2690.	15.78
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.90)			
HYD. + PNEU.	315.	143.	0.84
ELECTRICAL	817.	370.	2.17
AVIONICS	2790.	1266.	7.43
INSTRUMENTATION	219.	99.	0.58
DE-ICE/AIR CONDITION	398.	181.	1.06
AUXILIARY GEAR	200.	91.	0.53
FURNISH. + EQPT.	613.	278.	1.63
FLIGHT CONTROLS	1236.	561.	3.29
FUEL	8215.	3727.	21.86
PAYLOAD	7021.	3185.	18.69
FLIGHT CREW (2)	360.	163.	0.96
ARMAMENT	612.	278.	1.63
AMMUNITION	287.	130.	0.76
SHORT RANGE MISSILES	398.	181.	1.06
SRM LAUNCHERS	200.	91.	0.53
LASER GUIDED BOMBS	4364.	1980.	11.61
LGB PYLONS AND EJECTORS	800.	363.	2.13
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	37573.	17043.	100.00

1990 Medium Flying Wing Attack Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	26392.	LENGTH	16.0	AREA	829.1	0.0	0.0
W/S	31.8	DIAMETER	4.5	WETTED AREA	1402.1	0.0	0.0
T/W Dry	0.33	VOLUME	188.9	SPAN	53.9	0.2	0.1
CREW	2	WETTED AREA	192.5	L.E. SWEEP	47.7	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	3.6	C/4 SWEEP	39.1	30.0	30.0
				ASPECT RATIO	3.50	3.57	1.02
				TAPER RATIO	0.00	0.39	0.30
ENGINE		WEIGHTS		T/C ROOT	0.15	0.09	0.08
				T/C TIP	0.00	0.07	0.06
NUMBER	1	W	%	ROOT CHORD	30.8	0.1	0.1
LENGTH	8.9	STRUCT. 7733.	29.3	TIP CHORD	0.0	0.0	0.0
DIAM.	2.8	PROPUL. 2162.	8.2	M.A. CHORD	20.5	0.1	0.1
WEIGHT	1383.1	FIX. EQ. 5630.	21.3	LOC. OF L.E.	-2.4	14.4	15.9
TSLS	8653.	FUEL 4446.	16.8				
SFCSLS	0.42	PAYLOAD 6421.	24.3				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	89.	10.5					
CLIMB	0.76	30463.	409.	10.8	74.8	17.85	2255.0	0.649	247.2
CRUISE	0.80	30463.	1131.	63.7	500.0	16.38	1528.9	0.692	276.2
CRUISE	0.80	100.	331.	5.7	50.0	5.54	4441.3	0.788	944.6
COMBAT	0.85	100.	140.	2.0	18.7	9.35	5222.3	0.805	1066.4
CRUISE	0.80	100.	331.	5.7	50.0	5.44	4438.7	0.788	944.6
CLIMB	0.78	39253.	533.	18.8	134.5	20.24	1510.5	0.643	174.2
CRUISE	0.80	39253.	854.	65.4	500.0	19.66	1158.9	0.671	182.5
LOITER	0.30	100.	274.	20.0	66.1	20.93	1078.4	0.763	132.8

BLOCK TIME = 3.204 HR
BLOCK RANGE = 1394.3 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	17.	2.8	0.055	0.0059	0.7	6.5	-81.	0.178	0.0085	2.3	2018.
0.20	100.	62.	2.0	0.882	0.0777	15.0	2.0	33.	0.882	0.0777	15.0	369.

1990 Medium Flying Wing Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	829.1	0.0	0.0	0.0	(SQ.FT.)
SURFACE AREA.......	1402.1	0.0	0.0	0.0	(SQ.FT.)
VOLUME.............	1130.7	0.0	0.0	0.0	(CU.FT.)
SPAN...............	53.868	0.172	0.092	0.000	(FT.)
L.E. SWEEP.........	47.667	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	39.096	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-2.454	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	3.500	3.574	1.020	0.000	
ROOT CHORD.........	30.751	0.070	0.138	0.000	(FT.)
ROOT THICKNESS.....	55.352	0.075	0.131	0.000	(IN.)
ROOT T/C	0.150	0.090	0.079	0.000	
TIP CHORD..........	0.031	0.027	0.042	0.000	(FT.)
TIP THICKNESS......	0.000	0.023	0.033	0.000	(IN.)
TIP T/C	0.001	0.070	0.065	0.000	
TAPER RATIO	0.001	0.386	0.302	0.000	
MEAN AERO CHORD....	20.501	0.051	0.099	0.000	(FT.)
LE ROOT AT.........	-2.408	14.378	15.862	0.000	(FT.)
C/4 ROOT AT........	5.280	14.396	15.896	0.000	(FT.)
TE ROOT AT.........	28.343	14.448	16.000	0.000	(FT.)
LE M.A.C. AT.......	7.457	14.404	15.893	0.000	(FT.)
C/4 M.A.C. AT......	12.583	14.417	15.918	0.000	(FT.)
TE M.A.C. AT.......	27.958	14.456	15.992	0.000	(FT.)
Y M.A.C. AT........	8.987	0.037	0.038	0.000	
LE TIP AT..........	27.158	14.439	15.939	0.000	(FT.)
C/4 TIP AT.........	27.166	14.446	15.949	0.000	(FT.)
TE TIP AT..........	27.189	14.466	15.981	0.000	(FT.)
ELEVATION..........	-0.450	0.000	2.250	0.000	(FT.)
VOLUME COEFF.		0.000	0.000	0.000	

AIRCRAFT WEIGHT = 26392.357 Lbs.
AIRCRAFT VOLUME = 1319.592 Cu.Ft.
AIRCRAFT DENSITY = 20.000 Lbs./Cu.Ft.

1990 Medium Flying Wing Mission Performance

PHASE	M	H	CL	ALPHA	WFUEL	TIME	VEL
	SFC(I)	THRUST(I)	CD	GAMMA	W	WA	Q
	SFC(U)	THRUST(U)	CDINST	L/D	THR/THA	PR	X
CLIMB	0.76	30463.	0.1264	1.73	409.0	10.80	751.
	0.65	2255.	0.0071	1.78	25894.8	0.00	247.
	0.00	0.	0.0000	17.85	1.00	0.00	75.
CRUISE	0.80	30463.	0.1094	1.46	1130.7	63.75	794.
	0.69	1529.	0.0067	0.00	24764.0	0.00	276.
	0.00	3816.	0.0000	16.38	0.66	0.00	500.
CRUISE	0.80	100.	0.0314	0.42	330.8	5.67	893.
	0.79	4441.	0.0057	0.00	24433.3	0.00	945.
	0.00	11940.	0.0000	5.54	0.78	0.00	50.
COMBAT	0.85	100.	0.0552	0.71	140.1	2.00	949.
	0.80	5222.	0.0059	0.09	24293.1	0.00	1066.
	0.00	14418.	0.0000	9.35	0.95	0.00	19.
CRUISE	0.80	100.	0.0308	0.41	330.6	5.67	893.
	0.79	4439.	0.0057	0.00	23962.5	0.00	945.
	0.00	11936.	0.0000	5.44	0.78	0.00	50.
CLIMB	0.78	39253.	0.1618	2.20	532.8	18.85	757.
	0.64	1510.	0.0080	0.87	23429.7	0.00	174.
	0.00	0.	0.0000	20.24	1.00	0.00	134.
CRUISE	0.80	39253.	0.1506	2.02	854.0	65.38	774.
	0.67	1159.	0.0077	0.00	22575.7	0.00	183.
LEWIS	0.00	2728.	0.0000	19.66	0.76	0.00	500.
LOITER	0.30	100.	0.2050	3.21	274.4	20.00	335.
	0.76	1078.	0.0098	0.00	22301.3	0.00	133.
	0.00	2319.	0.0000	20.93	0.15	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 4091.
RESERVE FUEL = 205.
TRAPPED FUEL = 150.

TOTAL FUEL = 4446.

1990 Medium Flying Wing Maneuver Peformance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	16.8	1.00	0.00	0.	0.36	0.028	0.0057
H= 100.	SUSTAINED	0.0	2.84	5.16	10540.	0.71	0.055	0.0059
	MAX. INST.	-80.6	6.50	12.48	4355.	2.33	0.178	0.0085
	COMBAT ENERGY = 0.201773E+04							
M= 0.20	1 G FLIGHT	61.5	1.00	0.00	0.	7.45	0.456	0.0251
H= 100.	SUSTAINED	0.0	2.02	14.51	881.	15.00	0.882	0.0777
	MAX. INST.	33.3	2.02	14.51	881.	15.00	0.882	0.0777
	COMBAT ENERGY = 0.369247E+03							

1990 Medium Flying Wing Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag		Induced Drag					
Friction	.0055	Alpha	Cl	Cd	L/D	Cm	e
Body	.0008	0.0	0.000	0.0118	0.0	0.000	0.00
Wing	.0047	2.0	0.158	0.0141	11.2	0.003	1.00
Strakes	.0000	3.0	0.235	0.0168	14.0	0.004	1.00
H. Tail	.0000	4.0	0.311	0.0206	15.1	0.005	1.00
V. Tail	.0000	5.0	0.385	0.0254	15.2	0.007	1.00
Canard	.0000	6.0	0.459	0.0322	14.3	0.008	0.94
Pods	.0000	8.0	0.570	0.0817	7.0	0.010	0.42
Engine	.0000	10.0	0.671	0.1174	5.7	0.012	0.39
Cowl	.0000	12.0	0.753	0.2076	3.6	0.033	0.26
Boattail	.0000	15.0	0.819	0.2752	3.0	0.035	0.23
Interference	.0000						
Wave	.0063						
External	.0000						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0118						

Slope Factors	
ClAlpha	0.0546
Cdl^.5Alpha	0.0342

Mach = 0.60 Altitude = 35000.

Parasite Drag		Induced Drag					
Friction	.0057	Alpha	Cl	Cd	L/D	Cm	e
Body	.0009	0.0	0.000	0.0058	0.0	0.000	0.00
Wing	.0049	2.0	0.137	0.0075	18.4	0.007	0.99
Strakes	.0000	3.0	0.205	0.0096	21.3	0.010	0.99
H. Tail	.0000	4.0	0.271	0.0125	21.7	0.013	0.99
V. Tail	.0000	5.0	0.336	0.0161	20.9	0.016	0.99
Canard	.0000	6.0	0.400	0.0204	19.6	0.019	0.99
Pods	.0000	8.0	0.525	0.0311	16.9	0.026	0.99
Engine	.0000	10.0	0.648	0.0443	14.6	0.032	0.99
Cowl	.0000	12.0	0.743	0.1411	5.3	0.036	0.37
Boattail	.0000	15.0	0.858	0.2088	4.1	0.042	0.33
Interference	.0000						
Wave	.0000						
External	.0000						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0058						

Slope Factors	
ClAlpha	0.0572
Cdl^.5Alpha	0.0300

1990 Medium Flying Wing Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.488
WEIGHT =	1383.110
LENGTH =	8.873
DIAM =	2.823

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	8653.	0.418	3617.1	221.
87.50	0.000	0.0	7572.	0.405	3068.4	205.
75.00	0.000	0.0	6490.	0.399	2592.3	188.
62.50	0.000	0.0	5408.	0.391	2116.1	172.
50.00	0.000	0.0	4327.	0.379	1639.9	158.
37.50	0.000	0.0	3245.	0.378	1227.2	132.
25.00	0.000	0.0	2163.	0.414	896.4	101.
12.50	0.000	0.0	1082.	0.523	565.5	79.
100.00	0.600	30000.0	2141.	0.592	1267.4	223.
87.50	0.600	30000.0	1873.	0.598	1120.7	211.
75.00	0.600	30000.0	1606.	0.607	974.1	201.
62.50	0.600	30000.0	1338.	0.618	827.4	191.
50.00	0.600	30000.0	1070.	0.638	682.4	181.
37.50	0.600	30000.0	803.	0.691	555.1	163.
25.00	0.600	30000.0	535.	0.799	427.7	148.
12.50	0.600	30000.0	268.	1.122	300.4	134.
100.00	0.800	30000.0	2353.	0.664	1562.2	223.
87.50	0.800	30000.0	2059.	0.671	1382.0	212.
75.00	0.800	30000.0	1764.	0.681	1201.9	201.
62.50	0.800	30000.0	1470.	0.695	1021.7	192.
50.00	0.800	30000.0	1176.	0.719	846.0	182.
37.50	0.800	30000.0	882.	0.784	691.3	168.
25.00	0.800	30000.0	588.	0.912	536.6	155.
12.50	0.800	30000.0	294.	1.299	381.9	144.
100.00	0.500	30000.0	2127.	0.553	1176.5	223.
87.50	0.500	30000.0	1861.	0.558	1038.0	210.
75.00	0.500	30000.0	1595.	0.564	899.5	199.
62.50	0.500	30000.0	1329.	0.572	761.0	189.
50.00	0.500	30000.0	1063.	0.587	624.2	178.
37.50	0.500	30000.0	798.	0.635	506.2	158.
25.00	0.500	30000.0	532.	0.730	388.1	140.
12.50	0.500	30000.0	266.	1.016	270.1	126.

1990 Medium Flying Wing Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	7733.	3508.	29.30
WING	3790.	1719.	14.36
FUSELAGE	992.	450.	3.76
HORIZONTAL TAIL	0.	0.	0.00
VERTICAL TAIL	0.	0.	0.00
ARMOR	589.	267.	2.23
WING FOLD	150.	68.	0.57
INTERNAL BAY STRUCTURE	1200.	544.	4.55
ALIGHTING GEAR	1013.	459.	3.84
PROPULSION	2162.	981.	8.19
ENGINES (1)	1620.	735.	6.14
FUEL SYSTEM	542.	246.	2.05
FIXED EQUIPMENT	5630.	2554.	21.33
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.90)			
HYD. + PNEU.	221.	100.	0.84
ELECTRICAL	817.	370.	3.09
AVIONICS	2790.	1266.	10.57
INSTRUMENTATION	219.	99.	0.83
DE-ICE/AIR CONDITION	398.	181.	1.51
AUXILIARY GEAR	200.	91.	0.76
FURNISH. + EQPT.	613.	278.	2.32
FLIGHT CONTROLS	998.	452.	3.78
FUEL	4446.	2017.	16.84
PAYLOAD	6421.	2912.	24.33
FLIGHT CREW (2)	360.	163.	1.36
ARMAMENT	612.	278.	2.32
AMMUNITION	287.	130.	1.09
SHORT RANGE MISSILES	398.	181.	1.51
SRM LAUNCHERS	200.	91.	0.76
LASER GUIDED BOMBS	4364.	1980.	16.54
LGB PYLONS AND EJECTORS	200.	91.	0.76
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	26392.	11972.	100.00

1990 Medium Internal Attack Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	34486.	LENGTH	49.8	AREA	504.0	111.5	69.7
W/S	68.4	DIAMETER	4.6	WETTED AREA	874.1	154.2	139.8
T/W Dry	0.45	VOLUME	767.5	SPAN	50.5	20.0	8.4
CREW	2	WETTED AREA	685.9	L.E. SWEEP	18.9	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	10.8	C/4 SWEEP	13.4	30.0	30.0
				ASPECT RATIO	5.05	3.57	1.02
				TAPER RATIO	0.31	0.39	0.30
				T/C ROOT	0.09	0.09	0.08
				T/C TIP	0.06	0.07	0.06
				ROOT CHORD	15.2	8.1	12.7
				TIP CHORD	4.8	3.1	3.8
				M.A. CHORD	10.9	6.0	9.1
				LOC. OF L.E.	10.4	36.9	37.1

ENGINE		WEIGHTS	W	%
NUMBER	1			
LENGTH	11.9	STRUCT.	11960.	34.7
DIAM.	3.8	PROPUL.	3983.	11.6
WEIGHT	2548.2	FIX. EQ.	5911.	17.1
TSLS	15486.	FUEL	6211.	18.0
SFCSLS	0.42	PAYLOAD	6421.	18.6

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	158.	10.5					
CLIMB	0.83	36500.	591.	9.5	75.1	16.44	3138.7	0.669	225.5
CRUISE	0.80	36500.	1488.	65.4	500.0	16.68	1955.5	0.691	208.3
CRUISE	0.80	100.	485.	5.7	50.0	5.26	6088.5	0.842	944.6
COMBAT	0.85	100.	206.	2.0	18.7	8.74	7256.0	0.852	1066.4
CRUISE	0.80	100.	484.	5.7	50.0	5.15	6082.7	0.842	944.6
CLIMB	0.84	39500.	580.	10.2	80.6	16.58	2731.5	0.675	200.2
CRUISE	0.80	39500.	1316.	65.4	500.0	16.89	1746.7	0.684	180.4
LOITER	0.30	100.	464.	20.0	66.1	16.83	1733.5	0.804	132.8

BLOCK TIME = 3.065 HR
BLOCK RANGE = 1340.8 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	86.	5.0	0.118	0.0135	0.8	6.5	-57.	0.379	0.0217	2.7	10353.
0.20	100.	85.	1.5	1.333	0.1374	15.0	1.5	67.	1.333	0.1374	15.0	509.

1990 Medium Internal Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	504.0	111.5	69.7	0.0	(SQ.FT.)
SURFACE AREA.......	874.1	154.2	139.8	0.0	(SQ.FT.)
VOLUME.............	273.4	38.4	32.8	0.0	(CU.FT.)
SPAN...............	50.463	19.963	8.433	0.000	(FT.)
L.E. SWEEP.........	18.858	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	13.375	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-4.210	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	5.052	3.574	1.020	0.000	
ROOT CHORD.........	15.226	8.060	12.700	0.000	(FT.)
ROOT THICKNESS.....	16.444	8.705	12.040	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	4.750	3.111	3.836	0.000	(FT.)
TIP THICKNESS......	3.420	2.613	2.992	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	10.904	5.951	9.060	0.000	(FT.)
LE ROOT AT.........	10.428	36.882	37.070	0.000	(FT.)
C/4 ROOT AT........	14.234	38.897	40.245	0.000	(FT.)
TE ROOT AT.........	25.654	44.942	49.770	0.000	(FT.)
LE M.A.C. AT.......	13.984	39.865	39.979	0.000	(FT.)
C/4 M.A.C. AT......	16.710	41.353	42.244	0.000	(FT.)
TE M.A.C. AT.......	24.887	45.816	49.039	0.000	(FT.)
Y M.A.C. AT........	10.411	4.254	3.463	0.000	
LE TIP AT..........	19.046	43.882	44.155	0.000	(FT.)
C/4 TIP AT.........	20.234	44.660	45.114	0.000	(FT.)
TE TIP AT..........	23.796	46.993	47.990	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.313	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 34485.969 Lbs.
AIRCRAFT VOLUME = 1112.232 Cu.Ft.
AIRCRAFT DENSITY = 31.006 Lbs./Cu.Ft.

1990 Medium Internal Attack Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.83	36500.	0.2955	2.17	591.3	9.49	806.
	0.67	3139.	0.0180	1.86	33736.2	0.00	225.
	0.00	0.	0.0000	16.44	1.00	0.00	75.
CRUISE	0.80	36500.	0.3107	2.39	1487.6	65.38	774.
	0.69	1956.	0.0186	0.00	32248.6	0.00	208.
	0.00	5023.	0.0000	16.68	0.63	0.00	500.
CRUISE	0.80	100.	0.0672	0.51	484.7	5.67	893.
	0.84	6088.	0.0128	0.00	31763.9	0.00	945.
	0.00	18630.	0.0000	5.26	0.60	0.00	50.
COMBAT	0.85	100.	0.1180	0.83	206.2	2.00	949.
	0.85	7256.	0.0135	0.42	31557.7	0.00	1066.
	0.00	25801.	0.0000	8.74	0.74	0.00	19.
CRUISE	0.80	100.	0.0658	0.50	484.4	5.67	893.
	0.84	6083.	0.0128	0.00	31073.3	0.00	945.
	0.00	18622.	0.0000	5.15	0.60	0.00	50.
CLIMB	0.84	39500.	0.3009	2.18	579.6	10.19	816.
	0.67	2732.	0.0182	1.69	30493.7	0.00	200.
	0.00	0.	0.0000	16.58	1.00	0.00	81.
CRUISE	0.80	39500.	0.3245	2.50	1316.1	65.38	774.
	0.68	1747.	0.0192	0.00	29177.7	0.00	180.
	0.00	4393.	0.0000	16.89	0.65	0.00	500.
LOITER	0.30	100.	0.4358	4.50	464.4	20.00	335.
	0.80	1734.	0.0259	0.00	28713.2	0.00	133.
	0.00	3893.	0.0000	16.83	0.14	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 5773.
RESERVE FUEL = 289.
TRAPPED FUEL = 150.

TOTAL FUEL = 6211.

1990 Medium Internal Attack Maneuver Performance

ADDITIONAL COMBAT PARAMETERS

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	86.3	1.00	0.00	0.	0.42	0.059	0.0128
H= 100.	SUSTAINED	0.0	5.04	9.60	5662.	0.83	0.118	0.0135
	MAX. INST.	-56.5	6.50	12.48	4355.	2.73	0.379	0.0217
	COMBAT ENERGY = 0.103532E+05							
M= 0.20	1 G FLIGHT	84.8	1.00	0.00	0.	10.57	0.965	0.0772
H= 100.	SUSTAINED	0.0	1.50	9.24	1384.	15.00	1.333	0.1374
	MAX. INST.	67.4	1.50	9.24	1384.	15.00	1.333	0.1374
	COMBAT ENERGY = 0.508714E+03							

1990 Medium Internal Attack Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag	
Friction	.0104
Body	.0031
Wing	.0054
Strakes	.0000
H. Tail	.0010
V. Tail	.0009
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0011
Wave	.0112
External	.0000
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0000
Camber	.0000
Cdmin	.0227

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0227	0.0	0.000	0.00
2.0	0.308	0.0286	10.8	-.019	1.01
3.0	0.459	0.0401	11.5	-.029	0.76
4.0	0.555	0.0593	9.4	-.041	0.53
5.0	0.647	0.0759	8.5	-.053	0.50
6.0	0.737	0.0957	7.7	-.065	0.47
8.0	0.911	0.1448	6.3	-.092	0.43
10.0	1.013	0.2261	4.5	-.099	0.32
12.0	1.103	0.2855	3.9	-.131	0.29
15.0	1.223	0.3854	3.2	-.183	0.26

Slope Factors	
ClAlpha	0.0815
Cdl^.5Alpha	0.0401

Mach = 0.60 Altitude = 35000.

Parasite Drag	
Friction	.0110
Body	.0032
Wing	.0057
Strakes	.0000
H. Tail	.0011
V. Tail	.0009
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0019
Wave	.0000
External	.0000
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0000
Camber	.0000
Cdmin	.0128

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0128	0.0	0.000	0.00
2.0	0.221	0.0160	13.8	-.012	0.97
3.0	0.329	0.0199	16.6	-.019	0.97
4.0	0.435	0.0252	17.3	-.027	0.96
5.0	0.540	0.0355	15.2	-.035	0.81
6.0	0.626	0.0661	9.5	-.044	0.46
8.0	0.789	0.1056	7.5	-.065	0.42
10.0	0.944	0.1561	6.1	-.088	0.39
12.0	1.090	0.2171	5.0	-.114	0.37
15.0	1.288	0.3266	3.9	-.158	0.33

Slope Factors	
ClAlpha	0.0859
Cdl^.5Alpha	0.0373

1990 Medium Internal Attack Propulsion

PHYSICAL ATTRIBUTES

ESF	=	0.874
WEIGHT	=	2548.210
LENGTH	=	11.870
DIAM	=	3.776

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	15486.	0.418	6473.0	396.
87.50	0.000	0.0	13550.	0.405	5491.1	368.
75.00	0.000	0.0	11614.	0.399	4639.0	336.
62.50	0.000	0.0	9678.	0.391	3786.8	308.
50.00	0.000	0.0	7743.	0.379	2934.7	283.
37.50	0.000	0.0	5807.	0.378	2196.2	237.
25.00	0.000	0.0	3871.	0.414	1604.1	180.
12.50	0.000	0.0	1936.	0.523	1012.0	142.
100.00	0.600	30000.0	3831.	0.592	2268.1	398.
87.50	0.600	30000.0	3352.	0.598	2005.6	378.
75.00	0.600	30000.0	2873.	0.607	1743.1	359.
62.50	0.600	30000.0	2394.	0.618	1480.6	342.
50.00	0.600	30000.0	1916.	0.638	1221.2	324.
37.50	0.600	30000.0	1437.	0.691	993.3	292.
25.00	0.600	30000.0	958.	0.799	765.4	264.
12.50	0.600	30000.0	479.	1.122	537.5	241.
100.00	0.800	30000.0	4210.	0.664	2795.7	398.
87.50	0.800	30000.0	3684.	0.671	2473.2	379.
75.00	0.800	30000.0	3158.	0.681	2150.8	360.
62.50	0.800	30000.0	2631.	0.695	1828.4	343.
50.00	0.800	30000.0	2105.	0.719	1514.0	325.
37.50	0.800	30000.0	1579.	0.784	1237.1	300.
25.00	0.800	30000.0	1053.	0.912	960.3	278.
12.50	0.800	30000.0	526.	1.299	683.4	258.
100.00	0.900	30000.0	4362.	0.725	3163.4	398.
87.50	0.900	30000.0	3816.	0.736	2809.5	380.
75.00	0.900	30000.0	3271.	0.751	2455.6	362.
62.50	0.900	30000.0	2726.	0.771	2101.7	346.
50.00	0.900	30000.0	2181.	0.804	1753.4	330.
37.50	0.900	30000.0	1636.	0.887	1451.2	307.
25.00	0.900	30000.0	1090.	1.054	1149.0	286.
12.50	0.900	30000.0	545.	1.553	846.8	267.

1990 Medium Internal Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	11960.	5426.	34.68
WING	3974.	1803.	11.52
FUSELAGE	3488.	1582.	10.12
HORIZONTAL TAIL	920.	417.	2.67
VERTICAL TAIL	314.	143.	0.91
ARMOR	589.	267.	1.71
WING FOLD	150.	68.	0.43
INTERNAL BAY STRUCTURE	1200.	544.	3.48
ALIGHTING GEAR	1323.	600.	3.84
PROPULSION	3983.	1807.	11.55
ENGINES (1)	2984.	1354.	8.65
FUEL SYSTEM	999.	453.	2.90
FIXED EQUIPMENT	5911.	2681.	17.14
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.90)			
HYD. + PNEU.	289.	131.	0.84
ELECTRICAL	817.	370.	2.37
AVIONICS	2790.	1266.	8.09
INSTRUMENTATION	219.	99.	0.63
DE-ICE/AIR CONDITION	398.	181.	1.15
AUXILIARY GEAR	200.	91.	0.58
FURNISH. + EQPT.	613.	278.	1.78
FLIGHT CONTROLS	1241.	563.	3.60
FUEL	6211.	2818.	18.01
PAYLOAD	6421.	2913.	18.62
FLIGHT CREW (2)	360.	163.	1.04
ARMAMENT	612.	278.	1.77
AMMUNITION	287.	130.	0.83
SHORT RANGE MISSILES	398.	181.	1.15
SRM LAUNCHERS	200.	91.	0.58
LASER GUIDED BOMBS	4364.	1980.	12.65
LGB PYLONS AND EJECTORS	200.	91.	0.58
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	34486.	15643.	100.00

1990 MRF Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	53072.	LENGTH	58.5	AREA	580.0	221.3	88.0
W/S	91.5	DIAMETER	5.9	WETTED AREA	883.0	306.8	176.2
T/W DRY	0.59	VOLUME	1179.4	SPAN	38.1	25.8	10.5
T/W WET	0.90	WETTED AREA	897.8	L.E. SWEEP	45.0	47.4	45.9
CREW	1	FINENESS RATIO	10.0	C/4 SWEEP	36.3	43.0	34.0
N(Z) ULT	11.3			ASPECT RATIO	2.50	3.00	1.25
				TAPER RATIO	0.20	0.36	0.38
				T/C ROOT	0.05	0.05	0.05
				T/C TIP	0.04	0.04	0.04
				ROOT CHORD	25.4	12.6	12.1
				TIP CHORD	5.1	4.6	4.6
				M.A. CHORD	17.5	9.2	8.9
				LOC. OF L.E.	22.9	45.9	43.5

ENGINE		WEIGHTS	W	%
NUMBER	1			
LENGTH	16.1	STRUCT.	12600.	23.7
DIAM.	3.6	PROPUL.	5947.	11.2
WEIGHT	3700.0	FIX. EQ.	5330.	10.0
TSLS	31341.	FUEL	24244.	45.7
SFCSLS	0.80	PAYLOAD	4951.	9.3

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	649.	10.5					
CRUISE	0.85	100.	6332.	26.7	250.0	4.61	10458.0	1.357	1066.4
CLIMB	0.91	36000.	857.	3.1	27.6	8.50	9669.2	0.963	276.2
LOITER	0.80	37282.	4670.	60.0	459.0	8.29	5166.6	0.875	201.9
CLIMB	0.89	50000.	1215.	3.5	26.4	6.32	9033.2	1.896	135.7
ACCEL	1.50	50000.	1163.	3.0	35.1	3.51	15115.1	2.100	383.7
CRUISE	1.50	50000.	3232.	10.5	150.0	3.36	10705.9	1.699	383.7
COMBAT	1.50	50000.	1057.	2.0	28.7	4.51	15109.2	2.099	383.7
CRUISE	0.91	44000.	2655.	46.0	400.0	8.76	3640.3	0.918	188.2
LOITER	0.30	100.	1113.	20.0	66.1	9.18	3403.5	0.981	132.8

BLOCK TIME = 2.922 HR
BLOCK RANGE = 1447.7 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	-128.	1.0	0.172	0.0491	2.9	5.4	-2125.	0.909	0.2839	15.0	-767.
1.50	50000.	187.	2.0	0.305	0.0676	5.1	5.9	-2019.	0.909	0.2839	15.0	22479.
0.20	100.	287.	1.5	0.933	0.2472	15.0	1.5	266.	0.933	0.2472	15.0	1720.
0.90	30000.	371.	3.0	0.613	0.1060	8.6	4.8	-741.	0.972	0.2800	15.0	7791.

1990 MRF Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	580.0	221.3	88.0	0.0	(SQ.FT.)
SURFACE AREA.......	883.0	306.8	176.2	0.0	(SQ.FT.)
VOLUME.............	263.0	66.3	25.6	0.0	(CU.FT.)
SPAN...............	38.079	25.768	10.504	0.000	(FT.)
L.E. SWEEP.........	45.000	47.412	40.486	0.000	(DEG.)
C/4 SWEEP..........	36.254	43.000	34.000	0.000	(DEG.)
T.E. SWEEP.........	-3.814	24.997	7.806	0.000	(DEG.)
ASPECT RATIO	2.500	3.000	1.254	0.000	
ROOT CHORD.........	25.386	12.594	12.140	0.000	(FT.)
ROOT THICKNESS.....	15.232	7.557	7.284	0.000	(IN.)
ROOT T/C	0.050	0.050	0.050	0.000	
TIP CHORD..........	5.077	4.584	4.613	0.000	(FT.)
TIP THICKNESS......	2.437	2.200	2.214	0.000	(IN.)
TIP T/C	0.040	0.040	0.040	0.000	
TAPER RATIO	0.200	0.364	0.380	0.000	
MEAN AERO CHORD....	17.488	9.212	8.940	0.000	(FT.)
LE ROOT AT.........	22.922	45.942	43.469	0.000	(FT.)
C/4 ROOT AT........	29.268	49.090	46.504	0.000	(FT.)
TE ROOT AT.........	48.307	58.536	55.609	0.000	(FT.)
LE M.A.C. AT.......	30.326	51.861	47.281	0.000	(FT.)
C/4 M.A.C. AT......	34.698	54.164	49.516	0.000	(FT.)
TE M.A.C. AT.......	47.814	61.073	56.221	0.000	(FT.)
Y M.A.C. AT........	7.404	5.441	4.465	0.000	
LE TIP AT..........	41.961	59.959	52.436	0.000	(FT.)
C/4 TIP AT.........	43.230	61.105	53.589	0.000	(FT.)
TE TIP AT..........	47.038	64.543	57.049	0.000	(FT.)
ELEVATION..........	0.263	-0.293	2.927	0.000	(FT.)
VOLUME COEFF.		0.425	0.059	0.000	

AIRCRAFT WEIGHT = 53068.680 Lbs.
AIRCRAFT VOLUME = 1559.816 Cu.Ft.
AIRCRAFT DENSITY = 34.022 Lbs./Cu.Ft.

1990 MRF Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CRUISE	0.85	100.	0.0779	0.87	6332.1	26.69	949.
	1.36	10458.	0.0169	0.00	46088.1	0.00	1066.
	0.00	24654.	0.0000	4.61	0.38	0.00	250.
CLIMB	0.91	36000.	0.3334	4.19	857.4	3.12	882.
	0.96	9669.	0.0392	4.29	45230.7	0.00	276.
	0.00	0.	0.0000	8.50	1.00	0.00	28.
LOITER	0.80	37282.	0.3656	4.82	4669.7	60.00	774.
	0.88	5167.	0.0441	0.00	40561.0	0.00	202.
	0.00	7705.	0.0000	8.29	0.63	0.00	459.
CLIMB	0.89	50000.	0.5535	7.67	1215.0	3.54	863.
	1.90	9033.	0.0876	3.10	39345.9	0.00	136.
	0.00	0.	0.0000	6.32	1.85	0.00	26.
ACCEL	1.50	50000.	0.1723	2.93	1163.2	3.00	1452.
	2.10	15115.	0.0491	0.00	38182.8	0.00	384.
	0.00	21784.	0.0000	3.51	2.00	0.00	35.
CRUISE	1.50	50000.	0.1618	2.76	3231.8	10.46	1452.
	1.70	10706.	0.0481	0.00	34950.7	0.00	384.
	0.00	17376.	0.0000	3.36	1.42	0.00	150.
COMBAT	1.50	50000.	0.3052	5.12	1057.3	2.00	1452.
	2.10	15109.	0.0676	0.43	33893.4	0.00	384.
	0.00	21784.	0.0000	4.51	2.00	0.00	29.
CRUISE	0.91	44000.	0.2921	3.57	2655.2	45.98	881.
	0.92	3640.	0.0334	0.00	31238.2	0.00	188.
	0.00	5821.	0.0000	8.76	0.55	0.00	400.
LOITER	0.30	100.	0.4054	5.69	1112.9	20.00	335.
	0.98	3403.	0.0442	0.00	30125.2	0.00	133.
	0.00	4998.	0.0000	9.18	0.12	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 22946.
RESERVE FUEL = 1147.
TRAPPED FUEL = 150.

TOTAL FUEL = 24244.

1990 MRF Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	-127.9	1.00	0.00	0.	2.92	0.172	0.0491
H=50000.	SUSTAINED	0.0	1.00	0.061	465095.	0.00	0.000	0.0000
	MAX. INST.	-2125.5	5.35	6.67	12469.	15.00	0.909	0.2839
	COMBAT ENERGY =-0.767419E+03							
M= 1.50	1 G FLIGHT	187.3	1.00	0.00	0.	2.68	0.157	0.0477
H=50000.	SUSTAINED	0.0	1.98	2.17	38308.	5.12	0.305	0.0676
	MAX. INST.	-2018.7	5.90	7.38	11269.	15.00	0.909	0.2839
	COMBAT ENERGY = 0.224793E+05							
M= 0.20	1 G FLIGHT	286.6	1.00	0.00	0.	13.72	0.880	0.2134
H= 100.	SUSTAINED	0.0	1.46	8.73	1465.	15.00	0.933	0.2472
	MAX. INST.	266.4	1.46	8.73	1465.	15.00	0.933	0.2472
	COMBAT ENERGY = 0.171980E+04							
M= 0.90	1 G FLIGHT	371.0	1.00	0.00	0.	2.30	0.210	0.0234
H=30000.	SUSTAINED	0.0	3.04	5.91	8682.	8.61	0.613	0.1060
	MAX. INST.	-741.4	4.77	9.61	5341.	15.00	0.972	0.2800
	COMBAT ENERGY = 0.779068E+04							

1990 MRF Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag		Induced Drag					
Friction	.0110	Alpha	Cl	Cd	L/D	Cm	e
Body	.0035	0.0	0.000	0.0152	0.0	0.000	0.00
Wing	.0041	2.0	0.184	0.0205	9.0	-.010	0.81
Strakes	.0000	3.0	0.254	0.0274	9.3	-.016	0.67
H. Tail	.0016	4.0	0.320	0.0359	8.9	-.022	0.63
V. Tail	.0018	5.0	0.385	0.0466	8.3	-.029	0.60
Canard	.0000	6.0	0.449	0.0597	7.5	-.036	0.58
Pods	.0000	8.0	0.575	0.0929	6.2	-.052	0.54
Engine	.0000	10.0	0.695	0.1353	5.1	-.070	0.51
Cowl	.0000	12.0	0.810	0.1865	4.3	-.090	0.49
Boattail	.0000	15.0	0.972	0.2789	3.5	-.124	0.46
Interference	.0016						
Wave	.0000						
External	.0026			Slope Factors			
Tanks	.0000			ClAlpha			0.0648
Bombs	.0000			Cdl^.5Alpha			0.0342
Stores	.0000						
Extra	.0026						
Camber	.0000						
Cdmin	.0152						

Mach = 0.60 Altitude = 35000.

Parasite Drag		Induced Drag					
Friction	.0115	Alpha	Cl	Cd	L/D	Cm	e
Body	.0036	0.0	0.000	0.0149	0.0	0.000	0.00
Wing	.0043	2.0	0.158	0.0186	8.5	-.005	0.84
Strakes	.0000	3.0	0.234	0.0234	10.0	-.009	0.81
H. Tail	.0017	4.0	0.309	0.0310	10.0	-.013	0.75
V. Tail	.0019	5.0	0.368	0.0428	8.6	-.018	0.62
Canard	.0000	6.0	0.429	0.0546	7.9	-.023	0.59
Pods	.0000	8.0	0.549	0.0845	6.5	-.036	0.55
Engine	.0000	10.0	0.664	0.1229	5.4	-.050	0.52
Cowl	.0000	12.0	0.775	0.1697	4.6	-.067	0.49
Boattail	.0000	15.0	0.930	0.2547	3.6	-.095	0.46
Interference	.0015						
Wave	.0000						
External	.0018			Slope Factors			
Tanks	.0000			ClAlpha			0.0620
Bombs	.0000			Cdl^.5Alpha			0.0327
Stores	.0000						
Extra	.0018						
Camber	.0000						
Cdmin	.0149						

Detailed Aerodynamics Output

1990 MRF Propulsion

PHYSICAL ATTRIBUTES

ESF = 1.150
WEIGHT = 3700.016
LENGTH = 16.086
DIAM = 3.635

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	47584.	1.747	83128.5	362.
100.00	0.000	0.0	31341.	0.796	24946.5	362.
87.50	0.000	0.0	27423.	0.766	20999.8	335.
75.00	0.000	0.0	23506.	0.743	17460.9	307.
62.50	0.000	0.0	19588.	0.711	13921.9	282.
50.00	0.000	0.0	15670.	0.688	10778.9	248.
37.50	0.000	0.0	11753.	0.684	8043.2	211.
25.00	0.000	0.0	7835.	0.677	5307.4	182.
12.50	0.000	0.0	3918.	0.741	2902.6	121.
100.00	0.600	30000.0	18002.	1.897	34150.0	362.
100.00	0.600	30000.0	10007.	0.873	8736.4	362.
87.50	0.600	30000.0	8756.	0.854	7479.8	338.
75.00	0.600	30000.0	7505.	0.829	6223.0	316.
62.50	0.600	30000.0	6254.	0.818	5117.7	285.
50.00	0.600	30000.0	5004.	0.821	4108.3	252.
37.50	0.600	30000.0	3753.	0.826	3098.9	225.
25.00	0.600	30000.0	2502.	0.866	2166.6	187.
12.50	0.600	30000.0	1251.	1.016	1270.7	153.
100.00	0.800	30000.0	21018.	1.894	39809.1	362.
100.00	0.800	30000.0	11584.	0.932	10796.2	362.
87.50	0.800	30000.0	10136.	0.921	9332.9	340.
75.00	0.800	30000.0	8688.	0.906	7869.7	320.
62.50	0.800	30000.0	7240.	0.908	6575.6	292.
50.00	0.800	30000.0	5792.	0.932	5396.8	261.
37.50	0.800	30000.0	4344.	0.971	4218.0	235.
25.00	0.800	30000.0	2896.	1.072	3104.1	202.
12.50	0.800	30000.0	1448.	1.419	2055.3	169.
100.00	0.900	30000.0	22822.	1.913	43662.5	362.
100.00	0.900	30000.0	12438.	0.988	12288.4	362.
87.50	0.900	30000.0	10883.	0.978	10639.0	341.
75.00	0.900	30000.0	9329.	0.964	8989.6	321.
62.50	0.900	30000.0	7774.	0.968	7526.7	293.
50.00	0.900	30000.0	6219.	0.997	6200.6	263.
37.50	0.900	30000.0	4664.	1.045	4874.4	237.
25.00	0.900	30000.0	3110.	1.161	3610.5	206.
12.50	0.900	30000.0	1555.	1.559	2423.3	172.

1990 MRF Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	12600.	5715.	23.74
WING	4693.	2129.	8.84
FUSELAGE	4137.	1877.	7.80
HORIZONTAL TAIL	946.	429.	1.78
VERTICAL TAIL	715.	324.	1.35
REACTION CONTROL SYSTEM	0.	0.	0.00
WING FOLD	150.	68.	0.28
INTERNAL BAY STRUCTURE	0.	0.	0.00
ALIGHTING GEAR	1958.	888.	3.69
PROPULSION	5947.	2697.	11.20
ENGINES (1)	4292.	1947.	8.09
FUEL SYSTEM	1655.	751.	3.12
FIXED EQUIPMENT	5330.	2418.	10.04
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	771.	350.	1.45
ELECTRICAL	544.	247.	1.03
AVIONICS	1652.	749.	3.11
INSTRUMENTATION	94.	43.	0.18
DE-ICE/AIR CONDITION	610.	277.	1.15
AUXILIARY GEAR	200.	91.	0.38
FURNISH. + EQPT.	375.	170.	0.71
FLIGHT CONTROLS	1676.	760.	3.16
FUEL	24244.	10997.	45.68
PAYLOAD	4951.	2246.	9.33
FLIGHT CREW (1)	180.	82.	0.34
ARMAMENT	612.	278.	1.15
AMMUNITION	287.	130.	0.54
LONG RANGE MISSILES	1974.	895.	3.72
LRM PYLONS & LAUNCHERS	1300.	590.	2.45
SHORT RANGE MISSILES	398.	181.	0.75
SRM LAUNCHERS	200.	91.	0.38
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	53072.	24073.	100.00

1990 NFA Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	64315.	LENGTH	59.9	AREA	791.1	301.9	120.0
W/S	81.3	DIAMETER	6.0	WETTED AREA	1248.7	439.9	240.3
T/W DRY	0.57	VOLUME	1272.9	SPAN	44.5	30.1	12.3
T/W WET	0.87	WETTED AREA	943.9	L.E. SWEEP	45.0	47.4	45.9
CREW	1	FINENESS RATIO	10.0	C/4 SWEEP	36.3	43.0	34.0
N(Z) ULT	11.3			ASPECT RATIO	2.50	3.00	1.25
				TAPER RATIO	0.20	0.36	0.38
ENGINE		WEIGHTS		T/C ROOT	0.05	0.05	0.05
				T/C TIP	0.04	0.04	0.04
NUMBER	1	W	%	ROOT CHORD	29.6	14.7	14.2
LENGTH	17.4	STRUCT. 18006.	28.0	TIP CHORD	5.9	5.4	5.4
DIAM.	3.9	PROPUL. 7037.	10.9	M.A. CHORD	20.4	10.8	10.4
WEIGHT	4378.5	FIX. EQ. 5797.	9.0	LOC. OF L.E.	22.5	45.2	42.7
TSLS	36792.	FUEL 28523.	44.3				
SFCSLS	0.80	PAYLOAD 4951.	7.7				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	761.	10.5					
CRUISE	0.85	100.	7553.	26.7	250.0	4.65	12583.1	1.346	1066.4
CLIMB	0.95	36000.	1040.	3.2	27.0	7.90	11800.6	0.976	301.8
LOITER	0.80	37192.	5297.	60.0	459.0	8.92	5855.4	0.878	202.7
CLIMB	0.89	50000.	1354.	3.3	24.9	6.89	10604.2	1.896	135.7
ACCEL	1.50	50000.	1450.	3.2	37.2	3.58	17743.8	2.100	383.7
CRUISE	1.50	50000.	3956.	10.5	150.0	3.43	12879.5	1.732	383.7
COMBAT	1.50	50000.	1240.	2.0	28.7	4.71	17723.4	2.099	383.7
CRUISE	0.91	44000.	3075.	46.0	400.0	9.30	4228.1	0.918	188.2
LOITER	0.30	100.	1296.	20.0	66.1	9.78	3946.4	0.985	132.8

BLOCK TIME = 2.923 HR
BLOCK RANGE = 1447.7 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	-132.	1.0	0.154	0.0432	2.6	5.9	-2358.	0.906	0.2790	15.0	-789.
1.50	50000.	168.	2.0	0.274	0.0582	4.6	6.5	-2286.	0.906	0.2790	15.0	20204.
0.20	100.	281.	1.5	0.911	0.2388	15.0	1.5	245.	0.911	0.2388	15.0	1688.
0.90	30000.	357.	3.1	0.550	0.0866	7.8	5.2	-861.	0.950	0.2717	15.0	7500.

1990 NFA Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	791.1	301.9	120.0	0.0	(SQ.FT.)
SURFACE AREA.......	1248.7	439.9	240.3	0.0	(SQ.FT.)
VOLUME.............	432.1	105.6	40.7	0.0	(CU.FT.)
SPAN...............	44.471	30.094	12.267	0.000	(FT.)
L.E. SWEEP.........	45.000	47.412	40.486	0.000	(DEG.)
C/4 SWEEP..........	36.254	43.000	34.000	0.000	(DEG.)
T.E. SWEEP.........	-3.814	24.997	7.806	0.000	(DEG.)
ASPECT RATIO	2.500	3.000	1.254	0.000	
ROOT CHORD.........	29.647	14.708	14.178	0.000	(FT.)
ROOT THICKNESS.....	17.788	8.825	8.507	0.000	(IN.)
ROOT T/C	0.050	0.050	0.050	0.000	
TIP CHORD..........	5.929	5.354	5.388	0.000	(FT.)
TIP THICKNESS......	2.846	2.570	2.586	0.000	(IN.)
TIP T/C	0.040	0.040	0.040	0.000	
TAPER RATIO	0.200	0.364	0.380	0.000	
MEAN AERO CHORD....	20.424	10.758	10.441	0.000	(FT.)
LE ROOT AT.........	22.538	45.192	42.727	0.000	(FT.)
C/4 ROOT AT........	29.950	48.869	46.272	0.000	(FT.)
TE ROOT AT.........	52.186	59.900	56.905	0.000	(FT.)
LE M.A.C. AT.......	31.185	52.104	47.179	0.000	(FT.)
C/4 M.A.C. AT......	36.291	54.794	49.789	0.000	(FT.)
TE M.A.C. AT.......	51.609	62.863	57.620	0.000	(FT.)
Y M.A.C. AT........	8.647	6.354	5.215	0.000	
LE TIP AT..........	44.774	61.562	53.199	0.000	(FT.)
C/4 TIP AT.........	46.256	62.900	54.546	0.000	(FT.)
TE TIP AT..........	50.703	66.915	58.587	0.000	(FT.)
ELEVATION..........	0.270	-0.299	2.995	0.000	(FT.)
VOLUME COEFF.		0.346	0.046	0.000	

AIRCRAFT WEIGHT = 64314.387 Lbs.
AIRCRAFT VOLUME = 1892.013 Cu.Ft.
AIRCRAFT DENSITY = 33.993 Lbs./Cu.Ft.

1990 NFA Mission Performance

PHASE	M / SFC(I) / SFC(U)	H / THRUST(I) / THRUST(U)	CL / CD / CDINST	ALPHA / GAMMA / L/D	WFUEL / W / THR/THA	TIME / WA / PR	VEL / Q / X
CRUISE	0.85	100.	0.0694	0.81	7553.4	26.69	949.
	1.35	12583.	0.0149	0.00	55999.7	0.00	1066.
	0.00	29336.	0.0000	4.65	0.39	0.00	250.
CLIMB	0.95	36000.	0.2264	2.48	1040.2	3.18	922.
	0.98	11801.	0.0287	5.17	54959.5	0.00	302.
	0.00	0.	0.0000	7.90	1.00	0.00	27.
LOITER	0.80	37192.	0.3257	4.37	5296.9	60.00	774.
	0.88	5855.	0.0365	0.00	49662.6	0.00	203.
	0.00	8800.	0.0000	8.92	0.60	0.00	459.
CLIMB	0.89	50000.	0.4986	7.02	1354.1	3.35	863.
	1.90	10604.	0.0723	3.36	48308.5	0.00	136.
	0.00	0.	0.0000	6.89	1.85	0.00	25.
ACCEL	1.50	50000.	0.1550	2.64	1449.7	3.16	1452.
	2.10	17744.	0.0433	0.00	46858.8	0.00	384.
	0.00	25573.	0.0000	3.58	2.00	0.00	37.
CRUISE	1.50	50000.	0.1456	2.49	3956.1	10.46	1452.
	1.73	12879.	0.0424	0.00	42902.4	0.00	384.
	0.00	20709.	0.0000	3.43	1.45	0.00	37.
COMBAT	1.50	50000.	0.2742	4.61	1239.8	2.00	1452.
	2.10	17723.	0.0582	0.39	41662.6	0.00	384.
	0.00	25573.	0.0000	4.71	2.00	0.00	150.
CRUISE	0.91	44000.	0.2642	3.29	3074.7	45.98	881.
	0.92	4228.	0.0284	0.00	38587.9	0.00	188.
	0.00	6775.	0.0000	9.30	0.54	0.00	400.
LOITER	0.30	100.	0.3672	5.31	1295.5	20.00	335.
	0.98	3946.	0.0376	0.00	37292.4	0.00	133.
	0.00	5809.	0.000	9.78	0.12	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 27022.
RESERVE FUEL = 1351.
TRAPPED FUEL = 150.

TOTAL FUEL = 28523.

1990 NFA Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	-131.5	1.00	0.00	0.	2.63	0.154	0.0432
H=50000.	SUSTAINED	0.0	1.00	0.06	1465095.	0.00	0.000	0.0000
	MAX. INST.	-2358.4	5.92	7.41	11233.	15.00	0.906	0.2790
	COMBAT ENERGY =-0.789198E+03							
M= 1.50	1 G FLIGHT	168.4	1.00	0.00	0.	2.41	0.141	0.0421
H=50000.	SUSTAINED	0.0	1.97	2.16	38533.	4.61	0.274	0.0582
	MAX. INST.	-2285.8	6.52	8.18	10174.	15.00	0.906	0.2790
	COMBAT ENERGY = 0.202039E+05							
M= 0.20	1 G FLIGHT	281.4	1.00	0.00	0.	12.12	0.798	0.1494
H= 100.	SUSTAINED	0.0	1.52	9.40	1360.	15.00	0.911	0.2388
	MAX. INST.	245.4	1.52	9.40	1360.	15.00	0.911	0.2388
	COMBAT ENERGY = 0.168833E+04							
M= 0.90	1 G FLIGHT	357.2	1.00	0.00	0.	2.13	0.187	0.0202
H=30000.	SUSTAINED	0.0	3.13	6.11	8398.	7.84	0.550	0.0866
	MAX. INST.	-861.2	5.21	10.52	4877.	15.00	0.950	0.2717
	COMBAT ENERGY = 0.750046E+04							

1990 NFA Aerodynamics

Mach = 0.80 Altitude = 40000.

Parasite Drag	
Friction	.0104
Body	.0027
Wing	.0042
Strakes	.0000
H. Tail	.0016
V. Tail	.0018
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0014
Wave	.0000
External	.0013
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0013
Camber	.0000
Cdmin	.0131

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0131	0.0	0.000	0.00
2.0	0.165	0.0173	9.5	-.005	0.83
3.0	0.245	0.0228	10.7	-.009	0.79
4.0	0.302	0.0319	9.5	-.013	0.62
5.0	0.365	0.0418	8.7	-.017	0.59
6.0	0.427	0.0540	7.9	-.022	0.57
8.0	0.548	0.0850	6.4	-.033	0.53
10.0	0.665	0.1249	5.3	-.045	0.50
12.0	0.777	0.1734	4.5	-.059	0.48
15.0	0.934	0.2615	3.6	-.083	0.45

Slope Factors	
ClAlpha	0.0622
Cdl^.5Alpha	0.0332

Mach = 1.50 Altitude = 50000.

Parasite Drag	
Friction	.0089
Body	.0023
Wing	.0036
Strakes	.0000
H. Tail	.0014
V. Tail	.0016
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0003
Wave	.0225
External	.0023
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0023
Camber	.0000
Cdmin	.0341

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0341	0.0	0.000	0.00
2.0	0.117	0.0382	3.1	-.026	0.43
3.0	0.176	0.0434	4.1	-.039	0.43
4.0	0.237	0.0507	4.7	-.052	0.43
5.0	0.298	0.0602	5.0	-.066	0.43
6.0	0.360	0.0719	5.0	-.080	0.44
8.0	0.483	0.1020	4.7	-.108	0.44
10.0	0.607	0.1411	4.3	-.137	0.44
12.0	0.728	0.1889	3.9	-.166	0.44
15.0	0.906	0.2770	3.3	-.208	0.43

Slope Factors	
ClAlpha	0.0604
Cdl^.5Alpha	0.0329

1990 NFA Propulsion

PHYSICAL ATTRIBUTES

ESF = 1.350
WEIGHT = 4378.459
LENGTH = 17.428
DIAM = 3.939

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	55859.	1.747	97585.6	425.
100.00	0.000	0.0	36792.	0.796	29285.0	425.
87.50	0.000	0.0	32193.	0.766	24652.0	394.
75.00	0.000	0.0	27594.	0.743	20497.5	360.
62.50	0.000	0.0	22995.	0.711	16343.1	331.
50.00	0.000	0.0	18396.	0.688	12653.5	291.
37.50	0.000	0.0	13797.	0.684	9442.0	248.
25.00	0.000	0.0	9198.	0.677	6230.4	213.
12.50	0.000	0.0	4599.	0.741	3407.4	142.
100.00	0.600	30000.0	21133.	1.897	40089.1	425.
100.00	0.600	30000.0	11748.	0.873	10255.7	425.
87.50	0.600	30000.0	10279.	0.854	8780.6	397.
75.00	0.600	30000.0	8811.	0.829	7305.2	371.
62.50	0.600	30000.0	7342.	0.818	6007.8	335.
50.00	0.600	30000.0	5874.	0.821	4822.8	296.
37.50	0.600	30000.0	4405.	0.826	3637.8	264.
25.00	0.600	30000.0	2937.	0.866	2543.4	220.
12.50	0.600	30000.0	1468.	1.016	1491.7	180.
100.00	0.900	30000.0	26791.	1.913	51255.9	425.
100.00	0.900	30000.0	14601.	0.988	14425.6	425.
87.50	0.900	30000.0	12776.	0.978	12489.3	400.
75.00	0.900	30000.0	10951.	0.964	10553.0	377.
62.50	0.900	30000.0	9126.	0.968	8835.7	344.
50.00	0.900	30000.0	7301.	0.997	7278.9	309.
37.50	0.900	30000.0	5475.	1.045	5722.2	278.
25.00	0.900	30000.0	3650.	1.161	4238.5	241.
12.50	0.900	30000.0	1825.	1.559	2844.8	201.
100.00	1.500	50000.0	17744.	2.100	37256.7	421.
100.00	1.500	50000.0	8870.	1.126	9987.7	421.
87.50	1.500	50000.0	7761.	1.113	8638.4	399.
75.00	1.500	50000.0	6653.	1.112	7397.9	373.
62.50	1.500	50000.0	5544.	1.111	6157.4	349.
50.00	1.500	50000.0	4435.	1.138	5048.8	318.
37.50	1.500	50000.0	3326.	1.212	4032.4	285.
25.00	1.500	50000.0	2218.	1.360	3016.1	258.
12.50	1.500	50000.0	1109.	1.896	2102.7	217.

1990 NFA Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	18006.	8442.	28.00
WING	6526.	2960.	10.15
FUSELAGE	5885.	2670.	9.15
HORIZONTAL TAIL	1322.	600.	2.06
VERTICAL TAIL	1038.	471.	1.61
REACTION CONTROL SYSTEM	0.	0.	0.00
WING FOLD	150.	68.	0.23
INTERNAL BAY STRUCTURE	0.	0.	0.00
ALIGHTING GEAR	3085.	1399.	4.80
PROPULSION	7037.	3193.	10.94
ENGINES (1)	5079.	2304.	7.90
FUEL SYSTEM	1958.	888.	3.05
FIXED EQUIPMENT	5797.	2630.	9.01
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.9)			
HYD. + PNEU.	935.	424.	1.45
ELECTRICAL	544.	247.	0.85
AVIONICS	1652.	749.	2.57
INSTRUMENTATION	94.	43.	0.15
DE-ICE/AIR CONDITION	610.	277.	0.95
AUXILIARY GEAR	200.	91.	0.31
FURNISH. + EQPT.	375.	170.	0.58
FLIGHT CONTROLS	2032.	922.	3.16
FUEL	28523.	12938.	44.35
PAYLOAD	4951.	1974.	7.70
FLIGHT CREW (1)	180.	82.	0.28
ARMAMENT	612.	278.	0.95
AMMUNITION	287.	130.	0.45
LONG RANGE MISSILES	1974.	895.	3.07
LRM PYLONS & LAUNCHERS	1300.	318.	0.49
SHORT RANGE MISSILES	398.	181.	0.62
SRM LAUNCHERS	200.	91.	0.31
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	64315.	29173.	100.00

1990 STOVL Summary

Standard English Units

GENERAL

TOGW	80510.
W/S	90.0
T/W DRY	0.78
T/W WET	1.18
CREW	1
N(Z) ULT	11.3

FUSELAGE

LENGTH	64.0
DIAMETER	7.1
VOLUME	1871.1
WETTED AREA	1179.5
FINENESS RATIO	9.0

	WING	HTAIL	VTAIL
AREA	894.6	341.4	135.7
WETTED AREA	1369.7	477.7	271.7
SPAN	47.3	32.0	13.0
L.E. SWEEP	50.0	47.4	45.9
C/4 SWEEP	42.8	43.0	34.0
ASPECT RATIO	2.50	3.00	1.25
TAPER RATIO	0.20	0.36	0.38
T/C ROOT	0.05	0.05	0.05
T/C TIP	0.04	0.04	0.04
ROOT CHORD	31.5	15.6	15.1
TIP CHORD	6.3	5.7	5.7
M.A. CHORD	21.7	11.4	11.1
LOC. OF L.E.	24.1	48.4	45.7

ENGINE

NUMBER	1
LENGTH	22.7
DIAM.	5.1
WEIGHT	11262.
TSLS	62682.
SFCSLS	0.80

WEIGHTS

	W	%
STRUCT.	20602.	25.6
PROPUL.	15831.	19.7
FIX. EQ.	6469.	8.0
FUEL	32656.	40.6
PAYLOAD	4951.	6.1

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	1297.	10.5					
CRUISE	0.85	100.	9970.	26.7	250.0	5.11	14185.8	1.575	1066.4
CLIMB	0.92	35000.	1032.	1.8	15.3	8.70	20537.0	0.968	298.0
LOITER	0.79	36433.	7086.	60.0	454.3	8.45	7634.9	0.896	206.4
CLIMB	0.89	50000.	1202.	1.7	12.6	6.23	18066.5	1.896	135.7
ACCEL	1.50	50000.	1117.	1.5	16.9	4.06	30230.2	2.100	383.7
CRUISE	1.50	50000.	2811.	10.5	150.0	3.97	14349.4	1.116	383.7
COMBAT	1.50	50000.	1197.	2.0	28.7	5.21	21261.7	1.689	383.7
CRUISE	0.91	41000.	4274.	46.0	400.0	9.17	5621.1	0.959	217.2
LOITER	0.30	100.	970.	10.0	33.1	9.13	5534.2	1.052	132.8

BLOCK TIME = 2.672 HR
BLOCK RANGE = 1363.1 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	15.	1.1	0.190	0.0440	2.2	5.3	-1994.	0.903	0.2778	15.0	90.
0.90	30000.	513.	3.4	0.616	0.1130	9.8	4.3	-451.	0.882	0.2446	15.0	3081.
1.50	50000.	414.	2.8	0.322	0.0618	4.2	5.7	-1716.	0.903	0.2778	15.0	49656.

1990 STOVL Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	894.6	341.4	135.7	0.0	(SQ.FT.)
SURFACE AREA.......	1369.7	477.7	271.7	0.0	(SQ.FT.)
VOLUME.............	506.3	127.0	48.9	0.0	(CU.FT.)
SPAN...............	47.291	32.002	13.045	0.000	(FT.)
L.E. SWEEP.........	50.000	47.412	40.486	0.000	(DEG.)
C/4 SWEEP..........	42.772	43.000	34.000	0.000	(DEG.)
T.E. SWEEP.........	7.130	24.997	7.806	0.000	(DEG.)
ASPECT RATIO	2.500	3.000	1.254	0.000	
ROOT CHORD.........	31.527	15.641	15.077	0.000	(FT.)
ROOT THICKNESS.....	18.916	9.385	9.046	0.000	(IN.)
ROOT T/C	0.050	0.050	0.050	0.000	
TIP CHORD..........	6.305	5.693	5.729	0.000	(FT.)
TIP THICKNESS......	3.027	2.733	2.750	0.000	(IN.)
TIP T/C	0.040	0.040	0.040	0.000	
TAPER RATIO	0.200	0.364	0.380	0.000	
MEAN AERO CHORD....	21.719	11.440	11.103	0.000	(FT.)
LE ROOT AT.........	24.118	48.359	45.723	0.000	(FT.)
C/4 ROOT AT........	32.000	52.269	49.493	0.000	(FT.)
TE ROOT AT.........	55.645	64.000	60.800	0.000	(FT.)
LE M.A.C. AT.......	35.077	55.710	50.458	0.000	(FT.)
C/4 M.A.C. AT......	40.507	58.570	53.233	0.000	(FT.)
TE M.A.C. AT.......	56.796	67.150	61.560	0.000	(FT.)
Y M.A.C. AT........	9.195	6.757	5.546	0.000	
LE TIP AT..........	52.298	65.767	56.859	0.000	(FT.)
C/4 TIP AT.........	53.874	67.190	58.292	0.000	(FT.)
TE TIP AT..........	58.603	71.460	62.588	0.000	(FT.)
ELEVATION..........	0.000	-0.355	3.550	0.000	(FT.)
VOLUME COEFF.		0.317	0.041	0.000	

AIRCRAFT WEIGHT = 80510.859 Lbs.
AIRCRAFT VOLUME = 2602.273 Cu.Ft.
AIRCRAFT DENSITY = 30.939 Lbs./Cu.Ft.

1990 STOVL Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CRUISE	0.85	100.	0.0761	0.98	9970.1	26.69	949.
	1.57	14186.	0.0149	0.00	69243.8	0.00	1066.
	0.00	40648.	0.0000	5.11	0.26	0.00	250.
CLIMB	0.92	35000.	0.2921	4.12	1032.2	1.77	898.
	0.97	20537.	0.0336	9.77	68211.5	0.00	298.
	0.00	0.	0.0000	8.70	1.00	0.00	15.
LOITER	0.79	36433.	0.3495	5.21	7086.4	60.00	765.
	0.90	7635.	0.0413	0.00	61125.1	0.00	206.
	0.00	12186.	0.0000	8.45	0.45	0.00	454.
CLIMB	0.89	50000.	0.5345	8.36	1202.0	1.73	863.
	1.90	18066.	0.0858	7.32	59923.2	0.00	136.
	0.00	0.	0.0000	6.23	1.85	0.00	13.
ACCEL	1.50	50000.	0.1717	1.96	1116.8	1.46	1452.
	2.10	30230.	0.0423	0.00	58806.4	0.00	384.
	0.00	43569.	0.0000	4.06	2.00	0.00	17.
CRUISE	1.50	50000.	0.1659	1.87	2810.8	10.46	1452.
	1.12	14349.	0.0418	0.00	55995.0	0.00	384.
	0.00	27489.	0.0000	3.97	0.95	0.00	150.
COMBAT	1.50	50000.	0.3217	4.23	1197.1	2.00	1452.
	1.69	21262.	0.0618	1.12	54797.9	0.00	384.
	0.00	43569.	0.0000	5.21	1.41	0.00	29.
CRUISE	0.91	41000.	0.2653	3.68	4274.4	45.98	881.
	0.96	5621.	0.0289	0.00	50523.5	0.00	217.
	0.00	10098.	0.0000	9.17	0.37	0.00	400.
LOITER	0.30	100.	0.4252	6.60	970.3	10.00	335.
	1.05	5534.	0.0466	0.00	49553.2	0.00	133.
	0.00	8505.	0.0000	9.13	0.10	0.00	33.

FUEL SUMMARIES

MISSION FUEL = 30958.
RESERVE FUEL = 1548.
TRAPPED FUEL = 150.

TOTAL FUEL = 32656.

1990 STOVL Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	15.0	1.00	0.00	0.	1.95	0.171	0.0423
H=50000.	SUSTAINED	0.0	1.12	0.64	130096.	2.24	0.190	0.0440
	MAX. INST.	-1994.2	5.34	6.66	12498.	15.00	0.903	0.2778
	COMBAT ENERGY = 0.897338E+02							
M= 0.90	1 G FLIGHT	513.4	1.00	0.00	0.	2.72	0.212	0.0215
H=30000.	SUSTAINED	0.0	3.36	6.60	7769.	9.81	0.616	0.1130
	MAX. INST.	-450.6	4.34	8.70	5898.	15.00	0.882	0.2446
	COMBAT ENERGY = 0.308067E+04							
M= 1.50	1 G FLIGHT	413.8	1.00	0.00	0.	1.82	0.163	0.0416
H=50000.	SUSTAINED	0.0	2.77	3.28	25343.	4.23	0.322	0.0618
	MAX. INST.	-1715.7	5.68	7.09	11729.	15.00	0.903	0.2778
	COMBAT ENERGY = 0.496556E+05							

1990 STOVL Aerodynamics

Mach = 0.80 Altitude = 40000.

Parasite Drag	
Friction	.0104
Body	.0030
Wing	.0041
Strakes	.0000
H. Tail	.0016
V. Tail	.0018
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0015
Wave	.0000
External	.0002
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0002
Camber	.0000
Cdmin	.0121

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0121	0.0	0.000	0.00
2.0	0.151	0.0157	9.6	-.004	0.82
3.0	0.223	0.0207	10.8	-.006	0.74
4.0	0.280	0.0286	9.8	-.009	0.61
5.0	0.338	0.0374	9.0	-.012	0.58
6.0	0.396	0.0482	8.2	-.016	0.55
8.0	0.508	0.0758	6.7	-.024	0.52
10.0	0.617	0.1116	5.5	-.033	0.49
12.0	0.722	0.1555	4.6	-.044	0.46
15.0	0.870	0.2359	3.7	-.064	0.43

Slope Factors	
ClAlpha	0.0580
Cdl^.5Alpha	0.0315

Mach = 1.50 Altitude = 50000.

Parasite Drag	
Friction	.0089
Body	.0026
Wing	.0035
Strakes	.0000
H. Tail	.0013
V. Tail	.0015
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0004
Wave	.0227
External	.0004
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0004
Camber	.0000
Cdmin	.0324

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0324	0.0	0.000	0.00
2.0	0.175	0.0391	4.5	-.028	0.57
3.0	0.240	0.0461	5.2	-.041	0.53
4.0	0.306	0.0557	5.5	-.055	0.51
5.0	0.372	0.0680	5.5	-.069	0.49
6.0	0.438	0.0830	5.3	-.084	0.48
8.0	0.569	0.1211	4.7	-.116	0.46
10.0	0.699	0.1703	4.1	-.149	0.45
12.0	0.826	0.2304	3.6	-.184	0.44
15.0	0.903	0.2744	3.3	-.201	0.43

Slope Factors	
ClAlpha	0.0602
Cdl^.5Alpha	0.0328

1990 STOVL Propulsion

PHYSICAL ATTRIBUTES	
ESF =	2.300
WEIGHT =	11262.499
LENGTH =	22.749
DIAM =	5.141

HOVER PERFORMANCE	DRY	WET	
T =	59381.	59381.	lb
T/W =	5.272	5.272	
FFLOW =	795.	795.	lb/hr
SFC =	0.803	0.803	lb/(lb-hr)
TF/T =	0.000	0.000	

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	95167.	1.747	166256.9	725.
100.00	0.000	0.0	62682.	0.796	49893.0	725.
87.50	0.000	0.0	54847.	0.766	41999.6	671.
75.00	0.000	0.0	47011.	0.743	34921.7	614.
62.50	0.000	0.0	39176.	0.711	27843.8	564.
50.00	0.000	0.0	31341.	0.688	21557.9	497.
37.50	0.000	0.0	23506.	0.684	16086.3	422.
25.00	0.000	0.0	15670.	0.677	10614.8	364.
12.50	0.000	0.0	7835.	0.741	5805.1	241.
100.00	0.600	30000.0	36004.	1.897	68300.0	725.
100.00	0.600	30000.0	20014.	0.873	17472.7	725.
87.50	0.600	30000.0	17513.	0.854	14959.5	676.
75.00	0.600	30000.0	15011.	0.829	12446.0	632.
62.50	0.600	30000.0	12509.	0.818	10235.4	570.
50.00	0.600	30000.0	10007.	0.821	8216.6	505.
37.50	0.600	30000.0	7505.	0.826	6197.8	450.
25.00	0.600	30000.0	5004.	0.866	4333.3	375.
12.50	0.600	30000.0	2502.	1.016	2541.4	306.
100.00	0.900	30000.0	45644.	1.913	87324.9	725.
100.00	0.900	30000.0	24876.	0.988	24576.9	725.
87.50	0.900	30000.0	21767.	0.978	21278.0	682.
75.00	0.900	30000.0	18657.	0.964	17979.2	643.
62.50	0.900	30000.0	15548.	0.968	15053.4	587.
50.00	0.900	30000.0	12438.	0.997	12401.1	526.
37.50	0.900	30000.0	9329.	1.045	9748.9	474.
25.00	0.900	30000.0	6219.	1.161	7221.1	411.
12.50	0.900	30000.0	3110.	1.559	4846.7	343.
100.00	1.500	50000.0	30230.	2.100	63474.3	718.
100.00	1.500	50000.0	15112.	1.126	17016.1	718.
87.50	1.500	50000.0	13223.	1.113	14717.3	679.
75.00	1.500	50000.0	11334.	1.112	12603.9	635.
62.50	1.500	50000.0	9445.	1.111	10490.4	595.
50.00	1.500	50000.0	7556.	1.138	8601.6	542.
37.50	1.500	50000.0	5667.	1.212	6870.1	486.
25.00	1.500	50000.0	3778.	1.360	5138.6	439.
12.50	1.500	50000.0	1889.	1.896	3582.4	369.

1990 STOVL Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	20602.	9620.	25.59
WING	8991.	4078.	11.17
FUSELAGE	5584.	2533.	6.94
HORIZONTAL TAIL	1533.	695.	1.90
VERTICAL TAIL	1202.	545.	1.49
REACTION CONTROL SYSTEM	171.	78.	0.21
WING FOLD	150.	68.	0.19
INTERNAL BAY STRUCTURE	0.	0.	0.00
ALIGHTING GEAR	2971.	1348.	3.69
PROPULSION	15831.	7183.	19.66
ENGINES (1)	12411.	5630.	15.42
FUEL SYSTEM	3420.	1551.	4.25
FIXED EQUIPMENT	6469.	2935.	8.04
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.9)			
HYD. + PNEU.	1170.	531.	1.45
ELECTRICAL	544.	247.	0.68
AVIONICS	1652.	749.	2.05
INSTRUMENTATION	94.	43.	0.12
DE-ICE/AIR CONDITION	610.	277.	0.76
AUXILIARY GEAR	200.	91.	0.25
FURNISH. + EQPT.	375.	170.	0.47
FLIGHT CONTROLS	2543.	1154.	3.16
FUEL	32656.	14813.	40.56
PAYLOAD	4951.	1974.	6.15
FLIGHT CREW (1)	180.	82.	0.22
ARMAMENT	612.	278.	0.76
AMMUNITION	287.	130.	0.36
LONG RANGE MISSILES	1974.	895.	2.45
LRM PYLONS & LAUNCHERS	1300.	318.	0.87
SHORT RANGE MISSILES	398.	181.	0.49
SRM LAUNCHERS	200.	91.	0.25
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	80510.	36519.	100.00

1995 Fighter Summary

Standard English Units

GENERAL		FUSELAGE				WING	HTAIL	VTAIL
TOGW	53356.	LENGTH	49.0		AREA	794.0	297.8	82.9
W/S	67.2	DIAMETER	4.9		WETTED AREA	1481.5	436.6	166.0
T/W DRY	0.58	VOLUME	702.3		SPAN	73.4	28.9	9.9
T/W A/B	0.88	WETTED AREA	634.0		L.E. SWEEP	20.0	51.0	57.1
CREW	2	FINENESS RATIO	10.0		C/4 SWEEP	15.8	44.6	48.0
N(Z) ULT	13.5				ASPECT RATIO	6.79	2.81	1.17
					TAPER RATIO	0.29	0.18	0.32
ENGINE		WEIGHTS			T/C ROOT	0.12	0.05	0.05
					T/C TIP	0.09	0.04	0.04
NUMBER	1		W	%	ROOT CHORD	16.7	17.5	12.7
LENGTH	15.3	STRUCT.	18718.	35.1	TIP CHORD	4.9	3.1	4.1
DIAM.	3.5	PROPUL.	4382.	8.2	M.A. CHORD	11.9	12.0	9.1
WEIGHT	2768.9	FIX. EQ.	6926.	13.0	LOC. OF L.E.	17.6	31.5	36.2
TSLS	30930.	FUEL	14746.	27.6				
SFCSLS	0.80	PAYLOAD	8583.	16.1				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	649.	10.5					
CLIMB	0.88	50000.	1633.	9.8	82.0	15.28	4745.0	0.945	131.9
CRUISE	0.85	50000.	2288.	49.2	400.0	15.86	3110.6	0.881	123.2
LOITER	0.55	35644.	2362.	60.0	316.7	16.13	2949.6	0.790	103.1
CLIMB	0.89	50000.	674.	2.0	14.5	14.44	8800.8	1.878	135.7
ACCEL	1.50	50000.	885.	2.3	27.4	5.17	16149.5	1.934	383.7
CRUISE	1.50	50000.	1151.	7.0	100.0	5.10	8649.8	1.141	383.7
COMBAT	1.60	35000.	1402.	3.0	46.1	4.39	19814.2	1.415	894.8
CRUISE	0.80	50000.	1940.	52.3	400.0	16.11	2535.5	0.864	109.1
LOITER	0.30	100.	918.	20.0	66.1	14.43	2797.9	0.984	132.8

BLOCK TIME = 3.432 HR
BLOCK RANGE = 1455.4 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	1.	1.0	0.149	0.0286	1.2	5.3	-2340.	0.768	0.2649	15.0	6.
1.60	35000.	549.	4.8	0.123	0.0279	1.0	9.0	-1845.	0.541	0.1200	10.5	98837.
0.20	100.	244.	2.0	1.399	0.1275	15.0	2.0	217.	1.399	0.1275	15.0	1465.
0.90	30000.	305.	3.9	0.580	0.0638	5.6	7.2	-1466.	1.180	0.3501	15.0	1832.

1995 Fighter Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	794.0	297.8	82.9	0.0	(SQ.FT.)
SURFACE AREA.......	1481.5	436.6	166.0	0.0	(SQ.FT.)
VOLUME.............	700.4	117.3	24.7	0.0	(CU.FT.)
SPAN...............	73.425	28.925	9.863	0.000	(FT.)
L.E. SWEEP.........	20.000	51.000	53.025	0.000	(DEG.)
C/4 SWEEP..........	15.834	44.598	48.000	0.000	(DEG.)
T.E. SWEEP.........	2.437	13.471	24.594	0.000	(DEG.)
ASPECT RATIO	6.790	2.810	1.173	0.000	
ROOT CHORD.........	16.714	17.491	12.701	0.000	(FT.)
ROOT THICKNESS.....	24.870	10.495	7.621	0.000	(IN.)
ROOT T/C	0.124	0.050	0.050	0.000	
TIP CHORD..........	4.914	3.096	4.115	0.000	(FT.)
TIP THICKNESS......	5.307	1.486	1.975	0.000	(IN.)
TIP T/C	0.090	0.040	0.040	0.000	
TAPER RATIO	0.294	0.177	0.324	0.000	
MEAN AERO CHORD....	11.887	11.971	9.139	0.000	(FT.)
LE ROOT AT.........	17.634	31.459	36.249	0.000	(FT.)
C/4 ROOT AT........	21.812	35.831	39.424	0.000	(FT.)
TE ROOT AT.........	34.347	48.950	48.950	0.000	(FT.)
LE M.A.C. AT.......	23.100	38.307	41.684	0.000	(FT.)
C/4 M.A.C. AT......	26.071	41.300	43.969	0.000	(FT.)
TE M.A.C. AT.......	34.987	50.278	50.823	0.000	(FT.)
Y M.A.C. AT........	15.018	5.546	4.092	0.000	
LE TIP AT..........	30.996	49.318	49.349	0.000	(FT.)
C/4 TIP AT.........	32.224	50.092	50.378	0.000	(FT.)
TE TIP AT..........	35.910	52.414	53.464	0.000	(FT.)
ELEVATION..........	1.713	0.000	2.447	0.000	(FT.)
VOLUME COEFF.		0.480	0.025	0.000	

AIRCRAFT WEIGHT = 53354.504 Lbs.
AIRCRAFT VOLUME = 1569.422 Cu.Ft.
AIRCRAFT DENSITY = 33.996 Lbs./Cu.Ft.

1995 Fighter Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.88 0.94 0.00	50000. 4745. 0.	0.4909 0.0321 0.0000	4.41 1.55 15.28	1632.8 51072.3 1.00	9.80 0.00 0.00	851. 132. 82.
CRUISE	0.85 0.88 0.00	50000. 3111. 4550.	0.5045 0.0318 0.0000	4.36 0.00 15.86	2287.9 48784.4 0.67	49.23 0.00 0.00	823. 123. 400.
LOITER	0.55 0.79 0.00	35644. 2950. 4062.	0.5811 0.0360 0.0000	5.40 0.00 16.13	2361.6 46422.7 0.40	60.00 0.00 0.00	534. 103. 317.
CLIMB	0.89 1.88 0.00	50000. 8801. 0.	0.4218 0.0292 0.0000	3.83 7.09 14.44	674.0 45748.7 1.83	1.99 0.00 0.00	863. 136. 14.
ACCEL	1.50 1.93 0.00	50000. 16150. 22403.	0.1476 0.0286 0.0000	1.15 0.00 5.17	884.8 44863.9 1.85	2.34 0.00 0.00	1452. 384. 27.
CRUISE	1.50 1.14 0.00	50000. 8650. 14884.	0.1447 0.0284 0.0000	1.09 0.00 5.10	1151.0 43712.6 0.99	6.97 0.00 0.00	1452. 384. 100.
COMBAT	1.60 1.41 0.00	35000. 19814. 49750.	0.1225 0.0279 0.0000	1.04 0.83 4.39	1401.6 42311.0 1.14	3.00 0.00 0.00	1557. 895. 46.
CRUISE	0.80 0.86 0.00	50000. 2536. 3689.	0.4714 0.0293 0.0000	3.80 0.00 16.11	1939.7 40371.3 0.57	52.30 0.00 0.00	774. 109. 400.
LOITER	0.30 0.98 0.00	100. 2798. 4060.	0.3828 0.0265 0.0000	3.82 0.00 14.43	917.9 39453.5 0.09	20.00 0.00 0.00	335. 133. 66.

FUEL SUMMARIES

MISSION FUEL = 13901.
RESERVE FUEL = 695.
TRAPPED FUEL = 150.

TOTAL FUEL = 14746.

1995 Fighter Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	1.0	1.00	0.00	0.	1.15	0.147	0.0285
H=50000.	SUSTAINED	0.0	1.02	0.23	368643.	1.18	0.149	0.0286
	MAX. INST.	-2339.6	5.27	6.56	12677.	15.00	0.768	0.2649
	COMBAT ENERGY = 0.617048E+01							
M= 1.60	1 G FLIGHT	549.1	1.00	0.00	0.	0.34	0.062	0.0262
H=35000.	SUSTAINED	0.0	4.80	5.56	16048.	1.04	0.123	0.0279
	MAX. INST.	-1845.2	9.00	10.59	8424.	10.49	0.541	0.1200
	COMBAT ENERGY = 0.988371E+05							
M= 0.20	1 G FLIGHT	244.1	1.00	0.00	0.	8.78	0.842	0.0571
H= 100.	SUSTAINED	0.0	1.96	13.95	917.	15.00	1.399	0.1275
	MAX. INST.	216.6	1.96	13.95	917.	15.00	1.399	0.1275
	COMBAT ENERGY = 0.146481E+04							
M= 0.90	1 G FLIGHT	305.3	1.00	0.00	0.	1.52	0.168	0.0213
H=30000.	SUSTAINED	0.0	3.93	7.83	6554.	5.57	0.580	0.0638
	MAX. INST.	-1465.6	7.16	14.61	3512.	15.00	1.180	0.3501
	COMBAT ENERGY = 0.183170E+04							

1995 Fighter Aerodynamics

Mach = 0.80 Altitude = 40000.

Parasite Drag		Induced Drag					
Friction	.0110	Alpha	Cl	Cd	L/D	Cm	e
Body	.0019	0.0	0.000	0.0141	0.0	0.000	0.00
Wing	.0063	2.0	0.252	0.0173	14.6	-.008	0.95
Strakes	.0000	3.0	0.375	0.0211	17.7	-.013	0.94
H. Tail	.0016	4.0	0.496	0.0264	18.8	-.019	0.94
V. Tail	.0013	5.0	0.618	0.0402	15.4	-.025	0.69
Canard	.0000	6.0	0.708	0.0737	9.6	-.029	0.40
Pods	.0000	8.0	0.883	0.1165	7.6	-.041	0.36
Engine	.0000	10.0	1.049	0.1710	6.1	-.056	0.33
Cowl	.0000	12.0	1.205	0.2369	5.1	-.071	0.31
Boattail	.0000	15.0	1.369	0.3932	3.5	-.070	0.23
Interference	.0025						
Wave	.0001						
External	.0005						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0005						
Camber	.0000						
Cdmin	.0141						

Slope Factors	
ClAlpha	0.0912
Cdl^.5Alpha	0.0410

For a variable sweep wing

c/4 sweep	20.41
yawed aspect ratio	6.747
mean aero chord	11.92
t/c	0.1179
span	73.19

1995 Fighter Aerodynamics

Mach = 1.50 Altitude = 50000.

Parasite Drag	
Friction	.0085
Body	.0016
Wing	.0045
Strakes	.0000
H. Tail	.0014
V. Tail	.0011
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0002
Wave	.0093
External	.0009
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0009
Camber	.0000
Cdmin	.0189

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0189	0.0	0.000	0.00
2.0	0.187	0.0247	7.6	-.051	0.55
3.0	0.234	0.0295	7.9	-.068	0.47
4.0	0.281	0.0359	7.8	-.086	0.42
5.0	0.328	0.0439	7.5	-.104	0.39
6.0	0.376	0.0537	7.0	-.122	0.37
8.0	0.472	0.0788	6.0	-.161	0.34
10.0	0.569	0.1117	5.1	-.201	0.32
12.0	0.660	0.1842	3.6	-.175	0.24
15.0	0.768	0.2582	3.0	-.220	0.22

Slope Factors

ClAlpha	0.0512
Cdl^.5Alpha	0.0326

For a variable sweep wing

c/4 sweep	60.05
yawed aspect ratio	3.488
mean aero chord	16.58
t/c	0.0868
span	52.63

1995 Fighter Propulsion

PHYSICAL ATTRIBUTES

ESF =	1.070
WEIGHT =	2768.881
LENGTH =	15.309
DIAM =	3.486

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	46818.	1.714	80245.8	337.
100.00	0.000	0.0	30930.	0.803	24836.3	337.
87.50	0.000	0.0	27064.	0.778	21060.2	310.
75.00	0.000	0.0	23198.	0.745	17283.3	286.
62.50	0.000	0.0	19332.	0.702	13565.0	263.
50.00	0.000	0.0	15465.	0.695	10755.7	222.
37.50	0.000	0.0	11599.	0.685	7946.4	189.
25.00	0.000	0.0	7733.	0.664	5137.1	164.
12.50	0.000	0.0	3866.	0.723	2795.7	106.
100.00	0.600	30000.0	17568.	1.875	32940.6	337.
100.00	0.600	30000.0	9799.	0.868	8505.6	337.
87.50	0.600	30000.0	8574.	0.847	7266.2	314.
75.00	0.600	30000.0	7349.	0.820	6026.7	294.
62.50	0.600	30000.0	6124.	0.808	4950.7	262.
50.00	0.600	30000.0	4899.	0.809	3964.4	231.
37.50	0.600	30000.0	3675.	0.810	2978.0	204.
25.00	0.600	30000.0	2450.	0.843	2064.0	167.
12.50	0.600	30000.0	1225.	0.965	1182.1	135.
100.00	0.900	30000.0	22238.	1.893	42101.2	337.
100.00	0.900	30000.0	12205.	0.981	11977.4	337.
87.50	0.900	30000.0	10679.	0.968	10342.3	316.
75.00	0.900	30000.0	9154.	0.951	8707.2	297.
62.50	0.900	30000.0	7628.	0.953	7271.4	270.
50.00	0.900	30000.0	6102.	0.979	5973.5	241.
37.50	0.900	30000.0	4577.	1.022	4675.6	216.
25.00	0.900	30000.0	3051.	1.127	3438.9	185.
12.50	0.900	30000.0	1526.	1.490	2272.6	152.
100.00	1.500	50000.0	16150.	1.934	31238.7	337.
100.00	1.500	50000.0	8728.	1.143	9977.1	337.
87.50	1.500	50000.0	7637.	1.123	8579.6	317.
75.00	1.500	50000.0	6546.	1.112	7277.1	294.
62.50	1.500	50000.0	5455.	1.095	5974.5	274.
50.00	1.500	50000.0	4364.	1.112	4853.8	244.
37.50	1.500	50000.0	3273.	1.164	3811.2	215.
25.00	1.500	50000.0	2182.	1.269	2768.5	191.
12.50	1.500	50000.0	1091.	1.671	1823.5	154.

1995 Fighter Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	18718.	8491.	35.08
WING	10590.	4804.	19.85
FUSELAGE	3818.	1732.	7.16
HORIZONTAL TAIL	1221.	554.	2.29
VERTICAL TAIL	672.	305.	1.26
REACTION CONTROL SYSTEM	0.	0.	0.00
WING FOLD	0.	0.	0.00
INTERNAL BAY STRUCTURE	0.	0.	0.00
ALIGHTING GEAR	2417.	1096.	4.53
PROPULSION	4382.	1988.	8.21
ENGINES (1)	3212.	1457.	6.02
FUEL SYSTEM	1170.	531.	2.19
FIXED EQUIPMENT	6926.	3142.	12.98
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	775.	352.	1.45
ELECTRICAL	784.	356.	1.47
AVIONICS	3006.	1364.	5.63
INSTRUMENTATION	169.	77.	0.32
DE-ICE/AIR CONDITION	995.	451.	1.86
AUXILIARY GEAR	200.	91.	0.37
FURNISH. + EQPT.	534.	242.	1.00
FLIGHT CONTROLS	1685.	765.	3.16
FUEL	14746.	6689.	27.64
PAYLOAD	8583.	3893.	16.09
FLIGHT CREW (2)	360.	163.	0.67
ARMAMENT	612.	278.	1.15
AMMUNITION	287.	130.	0.54
LONG RANGE MISSILES	3948.	1791.	7.40
LRM PYLONS & LAUNCHERS	1880.	853.	3.52
SHORT RANGE MISSILES	796.	361.	1.49
SRM LAUNCHERS	700.	318.	1.31
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	53356.	24202.	100.00

1995 Light Attack Summary

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	21046.	LENGTH	35.0	AREA	285.9	75.5	42.5
W/S	73.6	DIAMETER	4.5	WETTED AREA	468.2	96.5	85.2
T/W	0.51	VOLUME	464.1	SPAN	35.9	16.4	6.6
CREW	1	WETTED AREA	444.3	L.E. SWEEP	22.5	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	7.8	C/4 SWEEP	16.6	30.0	30.0
				ASPECT RATIO	4.51	3.57	1.02
				TAPER RATIO	0.31	0.39	0.30
				T/C ROOT	0.09	0.09	0.08
				T/C TIP	0.06	0.07	0.06
				ROOT CHORD	12.1	6.6	9.9
				TIP CHORD	3.8	2.6	3.0
				M.A. CHORD	8.7	4.9	7.1
				LOC. OF L.E.	7.0	25.0	25.1

ENGINE		WEIGHTS	W	%
NUMBER	1			
LENGTH	8.7	STRUCT.	5980.	28.4
DIAM.	2.9	PROPUL.	1765.	8.4
WEIGHT	1144.9	FIX. EQ.	3802.	18.1
TSLS	10826.	FUEL	4940.	23.5
SFCSLS	0.45	PAYLOAD	4559.	21.7

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	120.	10.5					
CLIMB	0.82	36500.	431.	10.1	75.0	11.59	2316.4	0.665	220.5
CRUISE	0.80	36500.	1230.	65.4	500.0	11.66	1677.8	0.664	208.3
CRUISE	0.80	100.	411.	5.7	50.0	3.37	5647.9	0.769	944.6
COMBAT	0.85	100.	173.	2.0	18.7	5.72	6569.9	0.791	1066.4
CRUISE	0.80	100.	410.	5.7	50.0	3.27	5642.2	0.769	944.6
CLIMB	0.82	39500.	400.	10.3	76.1	11.65	2006.9	0.663	189.9
CRUISE	0.80	39500.	1064.	65.4	500.0	11.70	1458.8	0.660	180.4
LOITER	0.30	100.	321.	20.0	66.1	12.37	1358.2	0.710	132.8

BLOCK TIME = 3.077 HR
BLOCK RANGE = 1336.1 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	60.	4.0	0.123	0.0215	0.9	6.5	-105.	0.396	0.0315	2.9	7195.
0.20	100.	107.	1.5	1.324	0.1572	15.0	1.5	88.	1.324	0.1572	15.0	640.

1995 Light Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	285.9	75.5	42.5	0.0	(SQ.FT.)
SURFACE AREA.......	468.2	96.5	85.2	0.0	(SQ.FT.)
VOLUME.............	118.1	21.4	15.6	0.0	(CU.FT.)
SPAN...............	35.916	16.428	6.582	0.000	(FT.)
L.E. SWEEP.........	22.483	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	16.576	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-2.917	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	4.513	3.574	1.020	0.000	
ROOT CHORD.........	12.133	6.633	9.912	0.000	(FT.)
ROOT THICKNESS.....	13.103	7.163	9.396	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	3.785	2.560	2.993	0.000	(FT.)
TIP THICKNESS......	2.726	2.151	2.335	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	8.689	4.897	7.071	0.000	(FT.)
LE ROOT AT.........	6.982	24.988	25.105	0.000	(FT.)
C/4 ROOT AT........	10.015	26.646	27.583	0.000	(FT.)
TE ROOT AT.........	19.114	31.620	35.017	0.000	(FT.)
LE M.A.C. AT.......	10.048	27.443	27.376	0.000	(FT.)
C/4 M.A.C. AT......	12.220	28.667	29.144	0.000	(FT.)
TE M.A.C. AT.......	18.737	32.340	34.447	0.000	(FT.)
Y M.A.C. AT........	7.410	3.500	2.703	0.000	
LE TIP AT..........	14.414	30.748	30.635	0.000	(FT.)
C/4 TIP AT.........	15.360	31.388	31.383	0.000	(FT.)
TE TIP AT..........	18.199	33.308	33.628	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.258	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 21046.086 Lbs.
AIRCRAFT VOLUME = 619.233 Cu.Ft.
AIRCRAFT DENSITY = 33.987 Lbs./Cu.Ft.

1995 Light Attack Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.82	36500.	0.3225	2.41	431.5	10.09	797.
	0.67	2316.	0.0278	1.57	20494.3	0.00	220.
	0.00	0.	0.0000	11.59	1.00	0.00	75.
CRUISE	0.80	36500.	0.3287	2.53	1230.1	65.38	774.
	0.66	1678.	0.0282	0.00	19264.2	0.00	208.
	0.00	3575.	0.0000	11.66	0.73	0.00	500.
CRUISE	0.80	100.	0.0706	0.53	410.8	5.67	893.
	0.77	5648.	0.0209	0.00	18853.4	0.00	945.
	0.00	13422.	0.0000	3.37	0.73	0.00	50.
COMBAT	0.85	100.	0.1234	0.87	173.2	2.00	949.
	0.79	6570.	0.0215	0.19	18680.2	0.00	1066.
	0.00	17106.	0.0000	5.72	0.87	0.00	19.
CRUISE	0.80	100.	0.0684	0.51	410.4	5.67	893.
	0.77	5642.	0.0209	0.00	18269.8	0.00	945.
	0.00	13414.	0.0000	3.27	0.73	0.00	50.
CLIMB	0.82	39500.	0.3263	2.44	400.4	10.30	795.
	0.66	2007.	0.0280	1.56	17869.4	0.00	190.
	0.00	0.	0.0000	11.65	1.00	0.00	76.
CRUISE	0.80	39500.	0.3310	2.55	1063.6	65.38	774.
	0.66	1459.	0.0283	0.00	16805.8	0.00	180.
	0.00	3085.	0.0000	11.70	0.73	0.00	500.
LOITER	0.30	100.	0.4426	4.52	321.3	20.00	335.
	0.71	1358.	0.0358	0.00	16484.5	0.00	133.
	0.00	2637.	0.0000	12.37	0.15	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 4562.
RESERVE FUEL = 228.
TRAPPED FUEL = 150.

TOTAL FUEL = 4940.

1995 Light Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	60.0	1.00	0.00	0.	0.43	0.062	0.0208
H= 100.	SUSTAINED	0.0	3.96	7.46	7291.	0.87	0.123	0.0215
	MAX. INST.	-104.6	6.50	12.48	4355.	2.87	0.396	0.0315
	COMBAT ENERGY = 0.719532E+04							
M= 0.20	1 G FLIGHT	106.7	1.00	0.00	0.	10.72	0.977	0.0939
H= 100.	SUSTAINED	0.0	1.50	9.28	1379.	15.00	1.324	0.1572
	MAX. INST.	87.9	1.50	9.28	1379.	15.00	1.324	0.1572
	COMBAT ENERGY = 0.640381E+03							

1995 Light Attack Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag		Induced Drag					
Friction	.0113	Alpha	Cl	Cd	L/D	Cm	e
Body	.0038	0.0	0.000	0.0292	0.0	0.000	0.00
Wing	.0053	2.0	0.305	0.0357	8.5	-.015	1.02
Strakes	.0000	3.0	0.453	0.0471	9.6	-.023	0.81
H. Tail	.0012	4.0	0.549	0.0669	8.2	-.032	0.56
V. Tail	.0010	5.0	0.638	0.0836	7.6	-.042	0.53
Canard	.0000	6.0	0.726	0.1035	7.0	-.052	0.50
Pods	.0000	8.0	0.896	0.1525	5.9	-.075	0.46
Engine	.0000	10.0	1.024	0.2389	4.3	-.078	0.35
Cowl	.0000	12.0	1.113	0.2989	3.7	-.106	0.32
Boattail	.0000	15.0	1.232	0.3993	3.1	-.154	0.29
Interference	.0015						
Wave	.0105						
External	.0059						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0059						
Camber	.0000						
Cdmin	.0292						

Slope Factors	
ClAlpha	0.0821
Cdl^.5Alpha	0.0406

Mach = 0.60 Altitude = 35000.

Parasite Drag		Induced Drag					
Friction	.0119	Alpha	Cl	Cd	L/D	Cm	e
Body	.0040	0.0	0.000	0.0182	0.0	0.000	0.00
Wing	.0056	2.0	0.224	0.0218	10.3	-.008	0.98
Strakes	.0000	3.0	0.332	0.0261	12.7	-.013	0.98
H. Tail	.0013	4.0	0.438	0.0320	13.7	-.018	0.98
V. Tail	.0010	5.0	0.543	0.0416	13.1	-.025	0.89
Canard	.0000	6.0	0.629	0.0740	8.5	-.032	0.50
Pods	.0000	8.0	0.788	0.1141	6.9	-.049	0.46
Engine	.0000	10.0	0.938	0.1649	5.7	-.069	0.42
Cowl	.0000	12.0	1.080	0.2258	4.8	-.092	0.40
Boattail	.0000	15.0	1.272	0.3347	3.8	-.131	0.36
Interference	.0022						
Wave	.0000						
External	.0041						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0041						
Camber	.0000						
Cdmin	.0182						

Slope Factors	
ClAlpha	0.0848
Cdl^.5Alpha	0.0375

Detailed Aerodynamics Output

1995 Light Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.484
WEIGHT =	1144.911
LENGTH =	8.693
DIAM =	2.914

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	10826.	0.449	4860.9	239.
87.50	0.000	0.0	9473.	0.434	4108.9	222.
75.00	0.000	0.0	8120.	0.425	3452.6	203.
62.50	0.000	0.0	6766.	0.413	2796.4	186.
50.00	0.000	0.0	5413.	0.395	2140.1	172.
37.50	0.000	0.0	4060.	0.387	1573.0	144.
25.00	0.000	0.0	2707.	0.412	1116.0	109.
12.50	0.000	0.0	1353.	0.487	659.0	86.
100.00	0.600	30000.0	2808.	0.598	1679.4	240.
87.50	0.600	30000.0	2457.	0.599	1472.1	226.
75.00	0.600	30000.0	2106.	0.601	1264.9	213.
62.50	0.600	30000.0	1755.	0.603	1057.7	201.
50.00	0.600	30000.0	1404.	0.610	856.7	188.
37.50	0.600	30000.0	1053.	0.651	685.7	168.
25.00	0.600	30000.0	702.	0.733	514.7	151.
12.50	0.600	30000.0	351.	0.979	343.7	134.
100.00	0.800	30000.0	3110.	0.668	2077.5	240.
87.50	0.800	30000.0	2721.	0.670	1822.7	226.
75.00	0.800	30000.0	2332.	0.672	1567.9	214.
62.50	0.800	30000.0	1944.	0.676	1313.0	202.
50.00	0.800	30000.0	1555.	0.687	1068.5	190.
37.50	0.800	30000.0	1166.	0.733	855.4	172.
25.00	0.800	30000.0	777.	0.826	642.3	157.
12.50	0.800	30000.0	389.	1.102	428.4	133.
100.00	0.900	30000.0	3254.	0.723	2352.7	240.
87.50	0.900	30000.0	2847.	0.728	2071.4	227.
75.00	0.900	30000.0	2440.	0.734	1790.2	215.
62.50	0.900	30000.0	2034.	0.742	1508.9	204.
50.00	0.900	30000.0	1627.	0.760	1236.3	192.
37.50	0.900	30000.0	1220.	0.820	1000.7	175.
25.00	0.900	30000.0	813.	0.941	765.1	161.
12.50	0.900	30000.0	407.	1.302	529.6	148.

1995 Light Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	5980.	2713.	28.42
WING	1900.	862.	9.03
FUSELAGE	1867.	847.	8.87
HORIZONTAL TAIL	538.	244.	2.56
VERTICAL TAIL	173.	79.	0.82
ARMOR	589.	267.	2.80
WING FOLD	150.	68.	0.71
ALIGHTING GEAR	763.	346.	3.62
PROPULSION	1765.	800.	8.38
ENGINES (1)	1341.	608.	6.37
FUEL SYSTEM	424.	192.	2.01
FIXED EQUIPMENT	3802.	1725.	18.07
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	177.	80.	0.84
ELECTRICAL	544.	247.	2.58
AVIONICS	1652.	749.	7.85
INSTRUMENTATION	94.	43.	0.45
DE-ICE/AIR CONDITION	398.	181.	1.89
AUXILIARY GEAR	200.	91.	0.95
FURNISH. + EQPT.	375.	170.	1.78
FLIGHT CONTROLS	1034.	469.	4.91
FUEL	4940.	2241.	23.47
PAYLOAD	4559.	2068.	21.66
FLIGHT CREW (1)	180.	82.	0.86
ARMAMENT	612.	278.	2.91
AMMUNITION	287.	130.	1.36
LASER GUIDED BOMBS	2182.	990.	10.37
LGB PYLONS AND EJECTOR	700.	318.	3.33
SHORT RANGE MISSILES	398.	181.	1.89
SRM LAUNCHERS	200.	91.	0.95
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	21046.	9547.	100.00

1995 Medium Attack Summary

Standard English Units

GENERAL		FUSELAGE	
TOGW	27728.	LENGTH	40.3
W/S	72.9	DIAMETER	4.5
T/W Dry	0.53	VOLUME	569.7
CREW	1	WETTED AREA	530.0
N(Z) ULT	9.8	FINENESS RATIO	8.9

	WING	HTAIL	VTAIL
AREA	380.1	103.1	56.3
WETTED AREA	638.6	141.6	113.0
SPAN	40.9	19.2	7.6
L.E. SWEEP	23.6	35.0	47.8
C/4 SWEEP	17.7	30.0	30.0
ASPECT RATIO	4.40	3.57	1.02
TAPER RATIO	0.31	0.39	0.30
T/C ROOT	0.09	0.09	0.08
T/C TIP	0.06	0.07	0.06
ROOT CHORD	14.2	7.8	11.4
TIP CHORD	4.4	3.0	3.4
M.A. CHORD	10.2	5.7	8.1
LOC. OF L.E.	8.0	28.6	28.9

ENGINE	
NUMBER	1
LENGTH	10.1
DIAM.	3.4
WEIGHT	1562.6
TSLS	14559.
SFCSLS	0.45

WEIGHTS	W	%
STRUCT.	7883.	28.4
PROPUL.	2409.	8.7
FIX. EQ.	3923.	14.1
FUEL	6672.	24.1
PAYLOAD	6841.	24.7

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	162.	10.5					
CLIMB	0.79	36500.	578.	10.3	74.4	11.70	3058.5	0.651	201.0
CRUISE	0.80	36500.	1683.	65.4	500.0	11.20	2296.5	0.663	208.3
CRUISE	0.80	100.	565.	5.7	50.0	3.21	7793.1	0.767	944.6
COMBAT	0.85	100.	243.	2.0	18.7	5.33	9256.3	0.787	1066.4
CRUISE	0.80	100.	564.	5.7	50.0	3.11	7785.1	0.767	944.6
CLIMB	0.78	39500.	533.	10.4	75.4	11.76	2650.1	0.645	171.7
CRUISE	0.80	39500.	1451.	65.4	500.0	11.21	1990.5	0.660	180.4
LOITER	0.30	100.	433.	20.0	66.1	11.96	1835.3	0.708	132.8

BLOCK TIME = 3.082 HR
BLOCK RANGE = 1334.9 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	45.	3.5	0.122	0.0228	0.9	6.5	-127.	0.390	0.0331	3.0	5421.
0.20	100.	110.	1.5	1.291	0.1544	15.0	1.5	92.	1.291	0.1544	15.0	661.

1995 Medium Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	380.1	103.1	56.3	0.0	(SQ.FT.)
SURFACE AREA.......	638.6	141.6	113.0	0.0	(SQ.FT.)
VOLUME.............	187.2	34.2	23.9	0.0	(CU.FT.)
SPAN...............	40.879	19.196	7.581	0.000	(FT.)
L.E. SWEEP.........	23.637	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	17.661	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-2.259	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	4.396	3.574	1.020	0.000	
ROOT CHORD.........	14.174	7.750	11.417	0.000	(FT.)
ROOT THICKNESS.....	15.308	8.370	10.823	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	4.422	2.992	3.448	0.000	(FT.)
TIP THICKNESS......	3.184	2.513	2.689	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	10.151	5.722	8.144	0.000	(FT.)
LE ROOT AT.........	7.974	28.616	28.856	0.000	(FT.)
C/4 ROOT AT........	11.518	30.554	31.710	0.000	(FT.)
TE ROOT AT.........	22.149	36.367	40.273	0.000	(FT.)
LE M.A.C. AT.......	11.666	31.485	31.472	0.000	(FT.)
C/4 M.A.C. AT......	14.203	32.915	33.508	0.000	(FT.)
TE M.A.C. AT.......	21.816	37.207	39.616	0.000	(FT.)
Y M.A.C. AT........	8.433	4.090	3.113	0.000	
LE TIP AT..........	16.920	35.347	35.225	0.000	(FT.)
C/4 TIP AT.........	18.026	36.095	36.087	0.000	(FT.)
TE TIP AT..........	21.343	38.339	38.673	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.263	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 27726.607 Lbs.
AIRCRAFT VOLUME = 814.984 Cu.Ft.
AIRCRAFT DENSITY = 34.021 Lbs./Cu.Ft.

1995 Medium Attack Mission Performance

PHASE	M / SFC(I) / SFC(U)	H / THRUST(I) / THRUST(U)	CL / CD / CDINST	ALPHA / GAMMA / L/D	WFUEL / W / THR/THA	TIME / WA / PR	VEL / Q / X
CLIMB	0.79	36500.	0.3590	2.95	577.7	10.29	761.
	0.65	3059.	0.0307	1.51	26987.1	0.00	201.
	0.00	0.	0.0000	11.70	1.00	0.00	74.
CRUISE	0.80	36500.	0.3249	2.62	1683.0	65.38	774.
	0.66	2296.	0.0290	0.00	25304.1	0.00	208.
	0.00	4862.	0.0000	11.20	0.75	0.00	500.
CRUISE	0.80	100.	0.0697	0.55	564.8	5.67	893.
	0.77	7793.	0.0217	0.00	24739.3	0.00	945.
	0.00	18333.	0.0000	3.21	0.75	0.00	50.
COMBAT	0.85	100.	0.1217	0.91	242.7	2.00	949.
	0.79	9256.	0.0228	0.13	24496.6	0.00	1066.
	0.00	23003.	0.0000	5.33	0.92	0.00	19.
CRUISE	0.80	100.	0.0674	0.53	564.3	5.67	893.
	0.77	7785.	0.0217	0.00	23932.3	0.00	945.
	0.00	18322.	0.0000	3.11	0.74	0.00	50.
CLIMB	0.78	39500.	0.3642	3.01	533.2	10.42	756.
	0.64	2650.	0.0310	1.54	23399.1	0.00	172.
	0.00	0.	0.0000	11.76	1.00	0.00	75.
CRUISE	0.80	39500.	0.3253	2.62	1450.7	65.38	774.
	0.66	1991.	0.0290	0.00	21948.4	0.00	180.
	0.00	4189.	0.0000	11.21	0.74	0.00	500.
LOITER	0.30	100.	0.4347	4.62	433.3	20.00	335.
	0.71	1835.	0.0363	0.00	21515.0	0.00	133.
	0.00	3557.	0.0000	11.96	0.15	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 6212.
RESERVE FUEL = 311.
TRAPPED FUEL = 150.

TOTAL FUEL = 6672.

1995 Medium Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	45.2	1.00	0.00	0.	0.45	0.061	0.0220
H= 100.	SUSTAINED	0.0	3.45	6.42	8462.	0.91	0.122	0.0228
	MAX. INST.	-126.7	6.50	12.48	4355.	2.97	0.390	0.0331
	COMBAT ENERGY = 0.542117E+04							
M= 0.20	1 G FLIGHT	110.2	1.00	0.00	0.	10.85	0.959	0.0938
H= 100.	SUSTAINED	0.0	1.50	9.23	1386.	15.00	1.291	0.1544
	MAX. INST.	91.6	1.50	9.23	1386.	15.00	1.291	0.1544
	COMBAT ENERGY = 0.661418E+03							

1995 Medium Attack Aerodynamics

Mach = 0.90   Altitude = 100.

Parasite Drag	
Friction	.0109
Body	.0033
Wing	.0053
Strakes	.0000
H. Tail	.0013
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0014
Wave	.0085
External	.0121
Tanks	.0000
Bombs	.0061
Stores	.0000
Extra	.0060
Camber	.0000
Cdmin	.0329

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0329	0.0	0.000	0.00
2.0	0.289	0.0388	7.4	-.015	1.01
3.0	0.430	0.0494	8.7	-.023	0.81
4.0	0.524	0.0684	7.7	-.032	0.56
5.0	0.612	0.0845	7.2	-.042	0.52
6.0	0.698	0.1037	6.7	-.053	0.50
8.0	0.864	0.1512	5.7	-.076	0.46
10.0	1.005	0.2404	4.2	-.079	0.35
12.0	1.093	0.2996	3.6	-.108	0.32
15.0	1.211	0.3990	3.0	-.156	0.29

Slope Factors	
ClAlpha	0.0808
Cdl^.5Alpha	0.0403

Mach = 0.60   Altitude = 35000.

Parasite Drag	
Friction	.0114
Body	.0035
Wing	.0056
Strakes	.0000
H. Tail	.0013
V. Tail	.0010
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0021
Wave	.0000
External	.0082
Tanks	.0000
Bombs	.0041
Stores	.0000
Extra	.0041
Camber	.0000
Cdmin	.0216

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0216	0.0	0.000	0.00
2.0	0.214	0.0250	8.6	-.008	0.98
3.0	0.319	0.0291	10.9	-.013	0.98
4.0	0.421	0.0348	12.1	-.019	0.98
5.0	0.522	0.0433	12.0	-.026	0.91
6.0	0.606	0.0752	8.1	-.033	0.50
8.0	0.762	0.1142	6.7	-.051	0.45
10.0	0.911	0.1638	5.6	-.071	0.42
12.0	1.050	0.2235	4.7	-.094	0.40
15.0	1.242	0.3306	3.8	-.135	0.36

Slope Factors	
ClAlpha	0.0828
Cdl^.5Alpha	0.0371

1995 Medium Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.650
WEIGHT =	1562.604
LENGTH =	10.080
DIAM =	3.379

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	14559.	0.449	6536.8	322.
87.50	0.000	0.0	12739.	0.434	5525.5	298.
75.00	0.000	0.0	10919.	0.425	4643.0	273.
62.50	0.000	0.0	9099.	0.413	3760.5	251.
50.00	0.000	0.0	7279.	0.395	2878.0	231.
37.50	0.000	0.0	5459.	0.387	2115.3	193.
25.00	0.000	0.0	3640.	0.412	1500.7	147.
12.50	0.000	0.0	1820.	0.487	886.2	115.
100.00	0.600	30000.0	3776.	0.598	2258.4	323.
87.50	0.600	30000.0	3304.	0.599	1979.7	304.
75.00	0.600	30000.0	2832.	0.601	1701.0	286.
62.50	0.600	30000.0	2360.	0.603	1422.3	270.
50.00	0.600	30000.0	1888.	0.610	1152.0	253.
37.50	0.600	30000.0	1416.	0.651	922.1	226.
25.00	0.600	30000.0	944.	0.733	692.2	202.
12.50	0.600	30000.0	472.	0.979	462.1	181.
100.00	0.800	30000.0	4182.	0.668	2793.8	323.
87.50	0.800	30000.0	3659.	0.670	2451.1	304.
75.00	0.800	30000.0	3137.	0.672	2108.4	288.
62.50	0.800	30000.0	2614.	0.676	1765.7	272.
50.00	0.800	30000.0	2091.	0.687	1436.8	255.
37.50	0.800	30000.0	1568.	0.733	1150.3	232.
25.00	0.800	30000.0	1046.	0.826	863.7	212.
12.50	0.800	30000.0	523.	1.102	576.1	179.
100.00	0.900	30000.0	4375.	0.723	3163.8	323.
87.50	0.900	30000.0	3828.	0.728	2785.6	305.
75.00	0.900	30000.0	3282.	0.734	2407.4	289.
62.50	0.900	30000.0	2735.	0.742	2029.2	274.
50.00	0.900	30000.0	2188.	0.760	1662.5	258.
37.50	0.900	30000.0	1641.	0.820	1345.7	236.
25.00	0.900	30000.0	1094.	0.941	1028.9	216.
12.50	0.900	30000.0	547.	1.302	712.1	199.

1995 Medium Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	7883.	3576.	28.43
WING	2667.	1210.	9.62
FUSELAGE	2410.	1093.	8.69
HORIZONTAL TAIL	819.	371.	2.95
VERTICAL TAIL	243.	110.	0.88
ARMOR	589.	267.	2.12
WING FOLD	150.	68.	0.55
ALIGHTING GEAR	1005.	456.	3.62
PROPULSION	2409.	1093.	8.69
ENGINES (1)	1830.	830.	6.60
FUEL SYSTEM	579.	262.	2.09
FIXED EQUIPMENT	3923.	1780.	14.15
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.85)			
HYD. + PNEU.	233.	106.	0.84
ELECTRICAL	544.	247.	1.96
AVIONICS	1652.	749.	5.96
INSTRUMENTATION	94.	43.	0.34
DE-ICE/AIR CONDITION	398.	181.	1.44
AUXILIARY GEAR	200.	91.	0.72
FURNISH. + EQPT.	375.	170.	1.35
FLIGHT CONTROLS	1120.	508.	4.04
FUEL	6672.	3027.	24.06
PAYLOAD	6841.	3103.	24.67
FLIGHT CREW (1)	180.	82.	0.65
ARMAMENT	612.	278.	2.21
AMMUNITION	287.	130.	1.04
SHORT RANGE MISSILES	398.	181.	1.44
SRM LAUNCHERS	200.	91.	0.72
LASER GUIDED BOMBS	4364.	1980.	15.74
LGB PYLONS AND EJECTORS	800.	363.	2.89
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	27728.	12577.	100.00

1995 Medium All Weather Attack Summary

Standard English Units

GENERAL		FUSELAGE	
TOGW	31072.	LENGTH	44.3
W/S	73.8	DIAMETER	4.6
T/W	0.50	VOLUME	650.7
CREW	2	WETTED AREA	594.7
N(Z) ULT	9.8	FINENESS RATIO	9.7

	WING	HTAIL	VTAIL
AREA	420.8	97.2	61.2
WETTED AREA	720.5	131.1	122.7
SPAN	46.1	18.6	7.9
L.E. SWEEP	19.5	35.0	47.8
C/4 SWEEP	14.1	30.0	30.0
ASPECT RATIO	5.05	3.57	1.02
TAPER RATIO	0.31	0.39	0.30
T/C ROOT	0.09	0.09	0.08
T/C TIP	0.06	0.07	0.06
ROOT CHORD	13.9	7.5	11.9
TIP CHORD	4.3	2.9	3.6
M.A. CHORD	10.0	5.6	8.5
LOC. OF L.E.	9.2	32.5	32.4

ENGINE		WEIGHTS	W	%
NUMBER	1			
LENGTH	10.4	STRUCT.	8906.	28.7
DIAM.	3.5	PROPUL.	2588.	8.3
WEIGHT	1679.2	FIX. EQ.	5521.	17.8
TSLS	15591.	FUEL	7036.	22.6
SFCSLS	0.45	PAYLOAD	7021.	22.6

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	173.	10.5					
CLIMB	0.79	36500.	627.	10.2	75.1	12.58	3284.5	0.653	203.8
CRUISE	0.80	36500.	1750.	65.4	500.0	12.12	2389.0	0.664	208.3
CRUISE	0.80	100.	595.	5.7	50.0	3.44	8195.9	0.769	944.6
COMBAT	0.85	100.	257.	2.0	18.7	5.69	9795.7	0.787	1066.4
CRUISE	0.80	100.	595.	5.7	50.0	3.34	8188.3	0.769	944.6
CLIMB	0.79	39500.	586.	10.5	76.7	12.61	2855.5	0.650	177.4
CRUISE	0.80	39500.	1516.	65.4	500.0	12.18	2080.6	0.660	180.4
LOITER	0.30	100.	457.	20.0	66.1	13.01	1919.3	0.715	132.8

BLOCK TIME = 3.083 HR
BLOCK RANGE = 1336.9 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	46.	3.7	0.124	0.0218	0.9	6.5	-104.	0.398	0.0309	2.9	5542.
0.20	100.	104.	1.5	1.341	0.1471	15.0	1.5	87.	1.341	0.1471	15.0	625.

1995 Medium All Weather Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	420.8	97.2	61.2	0.0	(SQ.FT.)
SURFACE AREA.......	720.5	131.1	122.7	0.0	(SQ.FT.)
VOLUME.............	206.6	31.3	27.0	0.0	(CU.FT.)
SPAN...............	46.074	18.635	7.899	0.000	(FT.)
L.E. SWEEP.........	19.532	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	14.080	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-3.491	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	5.045	3.574	1.020	0.000	
ROOT CHORD.........	13.921	7.524	11.896	0.000	(FT.)
ROOT THICKNESS.....	15.035	8.126	11.278	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	4.343	2.904	3.593	0.000	(FT.)
TIP THICKNESS......	3.127	2.440	2.802	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	9.969	5.555	8.486	0.000	(FT.)
LE ROOT AT.........	9.183	32.459	32.382	0.000	(FT.)
C/4 ROOT AT........	12.664	34.340	35.356	0.000	(FT.)
TE ROOT AT.........	23.104	39.983	44.278	0.000	(FT.)
LE M.A.C. AT.......	12.555	35.244	35.107	0.000	(FT.)
C/4 M.A.C. AT......	15.047	36.633	37.229	0.000	(FT.)
TE M.A.C. AT.......	22.524	40.799	43.593	0.000	(FT.)
Y M.A.C. AT........	9.505	3.971	3.244	0.000	
LE TIP AT..........	17.356	38.994	39.018	0.000	(FT.)
C/4 TIP AT.........	18.441	39.720	39.916	0.000	(FT.)
TE TIP AT..........	21.699	41.898	42.611	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.288	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 31072.084 Lbs.
AIRCRAFT VOLUME = 915.601 Cu.Ft.
AIRCRAFT DENSITY = 33.936 Lbs./Cu.Ft.

1995 Medium All Weather Attack Mission Performance

PHASE	M SFC(I) SFC(U)	H THRUST(I) THRUST(U)	CL CD CDINST	ALPHA GAMMA L/D	WFUEL W THR/THA	TIME WA PR	VEL Q X
CLIMB	0.79	36500.	0.3585	2.77	627.5	10.25	766.
	0.65	3284.	0.0285	1.59	30271.3	0.00	204.
	0.00	0.	0.0000	12.58	1.00	0.00	75.
CRUISE	0.80	36500.	0.3304	2.52	1750.5	65.38	774.
	0.66	2389.	0.0273	0.00	28520.8	0.00	208.
	0.00	5111.	0.0000	12.12	0.72	0.00	500.
CRUISE	0.80	100.	0.0710	0.53	595.5	5.67	893.
	0.77	8196.	0.0206	0.00	27925.3	0.00	945.
	0.00	19419.	0.0000	3.44	0.73	0.00	50.
COMBAT	0.85	100.	0.1241	0.87	257.1	2.00	949.
	0.79	9796.	0.0218	0.14	27668.3	0.00	1066.
	0.00	24635.	0.0000	5.69	0.90	0.00	19.
CRUISE	0.80	100.	0.0689	0.52	595.0	5.67	893.
	0.77	8188.	0.0206	0.00	27073.3	0.00	945.
	0.00	19408.	0.0000	3.34	0.73	0.00	50.
CLIMB	0.79	39500.	0.3603	2.78	585.7	10.52	768.
	0.65	2855.	0.0286	1.56	26487.6	0.00	177.
	0.00	0.	0.0000	12.61	1.00	0.00	77.
CRUISE	0.80	39500.	0.3340	2.55	1515.9	65.38	774.
	0.66	2081.	0.0274	0.00	24971.6	0.00	180.
	0.00	4416.	0.0000	12.18	0.73	0.00	500.
LOITER	0.30	100.	0.4468	4.57	457.5	20.00	335.
	0.72	1919.	0.0343	0.00	24514.2	0.00	133.
	0.00	3751.	0.0000	13.01	0.15	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 6558.
RESERVE FUEL = 328.
TRAPPED FUEL = 150.

TOTAL FUEL = 7036.

1995 Medium All Weather Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	46.2	1.00	0.00	0.	0.43	0.062	0.0211
H= 100.	SUSTAINED	0.0	3.67	6.86	7923.	0.87	0.124	0.0218
	MAX. INST.	-103.7	6.50	12.48	4355.	2.85	0.398	0.0309
	COMBAT ENERGY = 0.554223E+04							
M= 0.20	1 G FLIGHT	104.2	1.00	0.00	0.	10.74	0.987	0.0882
H= 100.	SUSTAINED	0.0	1.50	9.27	1380.	15.00	1.341	0.1471
	MAX. INST.	86.6	1.50	9.27	1380.	15.00	1.341	0.1471
	COMBAT ENERGY = 0.625223E+03							

1995 Medium All Weather Attack Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag		Induced Drag					
Friction	.0107	Alpha	Cl	Cd	L/D	Cm	e
Body	.0033	0.0	0.000	0.0291	0.0	0.000	0.00
Wing	.0054	2.0	0.310	0.0351	8.8	-.018	1.01
Strakes	.0000	3.0	0.462	0.0465	9.9	-.028	0.77
H. Tail	.0011	4.0	0.558	0.0659	8.5	-.039	0.53
V. Tail	.0009	5.0	0.650	0.0826	7.9	-.051	0.50
Canard	.0000	6.0	0.741	0.1025	7.2	-.063	0.47
Pods	.0000	8.0	0.915	0.1517	6.0	-.089	0.43
Engine	.0000	10.0	1.020	0.2336	4.4	-.095	0.32
Cowl	.0000	12.0	1.111	0.2933	3.8	-.126	0.29
Boattail	.0000	15.0	1.232	0.3936	3.1	-.177	0.26
Interference	.0012						
Wave	.0117						
External	.0054						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0054						
Camber	.0000						
Cdmin	.0291						

Slope Factors

ClAlpha	0.0821
Cdl^.5Alpha	0.0403

Mach = 0.60 Altitude = 35000.

Parasite Drag		Induced Drag					
Friction	.0113	Alpha	Cl	Cd	L/D	Cm	e
Body	.0035	0.0	0.000	0.0169	0.0	0.000	0.00
Wing	.0057	2.0	0.224	0.0201	11.1	-.011	0.97
Strakes	.0000	3.0	0.332	0.0241	13.8	-.018	0.97
H. Tail	.0011	4.0	0.439	0.0295	14.9	-.025	0.96
V. Tail	.0010	5.0	0.546	0.0396	13.8	-.033	0.82
Canard	.0000	6.0	0.632	0.0708	8.9	-.042	0.47
Pods	.0000	8.0	0.795	0.1106	7.2	-.062	0.43
Engine	.0000	10.0	0.951	0.1613	5.9	-.084	0.39
Cowl	.0000	12.0	1.096	0.2224	4.9	-.109	0.37
Boattail	.0000	15.0	1.294	0.3322	3.9	-.152	0.34
Interference	.0019						
Wave	.0000						
External	.0037						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0037						
Camber	.0000						
Cdmin	.0169						

Slope Factors

ClAlpha	0.0863
Cdl^.5Alpha	0.0374

1995 Medium All Weather Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.696
WEIGHT =	1679.187
LENGTH =	10.432
DIAM =	3.497

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	15591.	0.449	7000.4	345.
87.50	0.000	0.0	13642.	0.434	5917.4	319.
75.00	0.000	0.0	11693.	0.425	4972.3	292.
62.50	0.000	0.0	9744.	0.413	4027.2	268.
50.00	0.000	0.0	7796.	0.395	3082.1	247.
37.50	0.000	0.0	5847.	0.387	2265.3	207.
25.00	0.000	0.0	3898.	0.412	1607.2	157.
12.50	0.000	0.0	1949.	0.487	949.0	123.
100.00	0.600	30000.0	4044.	0.598	2418.6	345.
87.50	0.600	30000.0	3539.	0.599	2120.1	325.
75.00	0.600	30000.0	3033.	0.601	1821.6	307.
62.50	0.600	30000.0	2528.	0.603	1523.2	290.
50.00	0.600	30000.0	2022.	0.610	1233.8	271.
37.50	0.600	30000.0	1517.	0.651	987.5	242.
25.00	0.600	30000.0	1011.	0.733	741.3	217.
12.50	0.600	30000.0	506.	0.979	494.9	194.
100.00	0.800	30000.0	4479.	0.668	2992.0	345.
87.50	0.800	30000.0	3919.	0.670	2625.0	326.
75.00	0.800	30000.0	3359.	0.672	2258.0	308.
62.50	0.800	30000.0	2799.	0.676	1890.9	292.
50.00	0.800	30000.0	2239.	0.687	1538.8	273.
37.50	0.800	30000.0	1680.	0.733	1231.9	248.
25.00	0.800	30000.0	1120.	0.826	925.0	227.
12.50	0.800	30000.0	560.	1.102	616.9	191.
100.00	0.900	30000.0	4686.	0.723	3388.2	345.
87.50	0.900	30000.0	4100.	0.728	2983.2	327.
75.00	0.900	30000.0	3514.	0.734	2578.1	309.
62.50	0.900	30000.0	2929.	0.742	2173.1	293.
50.00	0.900	30000.0	2343.	0.760	1780.5	276.
37.50	0.900	30000.0	1757.	0.820	1441.2	253.
25.00	0.900	30000.0	1171.	0.941	1101.9	232.
12.50	0.900	30000.0	586.	1.302	762.7	213.

1995 Medium All Weather Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	8906.	4040.	28.66
WING	3228.	1464.	10.39
FUSELAGE	2788.	1265.	8.97
HORIZONTAL TAIL	757.	343.	2.44
VERTICAL TAIL	269.	122.	0.86
ARMOR	589.	267.	1.89
WING FOLD	150.	68.	0.48
ALIGHTING GEAR	1126.	511.	3.62
PROPULSION	2588.	1174.	8.33
ENGINES (1)	1966.	892.	6.33
FUEL SYSTEM	622.	282.	2.00
FIXED EQUIPMENT	5521.	2504.	17.77
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	261.	118.	0.84
ELECTRICAL	817.	370.	2.63
AVIONICS	2790.	1266.	8.98
INSTRUMENTATION	219.	99.	0.70
DE-ICE/AIR CONDITION	398.	181.	1.28
AUXILIARY GEAR	200.	91.	0.64
FURNISH. + EQPT.	613.	278.	1.97
FLIGHT CONTROLS	1197.	543.	3.85
FUEL	7036.	3191.	22.64
PAYLOAD	7021.	3185.	22.60
FLIGHT CREW (2)	360.	163.	1.16
ARMAMENT	612.	278.	1.97
AMMUNITION	287.	130.	0.92
LASER GUIDED BOMBS	4364.	1980.	14.04
LGB PYLONS AND EJECTORS	800.	363.	2.57
SHORT RANGE MISSILES	398.	181.	1.28
SRM LAUNCHERS	200.	91.	0.64
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	31072.	14094.	100.00

1995 Medium Flying Wing Attack Summary

Standard English Units

GENERAL		FUSELAGE				WING	HTAIL	VTAIL
TOGW	25078.	LENGTH	22.5		AREA	751.6	0.0	0.0
W/S	33.4	DIAMETER	4.5		WETTED AREA	1259.6	0.0	0.0
T/W Dry	0.36	VOLUME	289.1		SPAN	51.3	0.2	0.1
CREW	2	WETTED AREA	282.4		L.E. SWEEP	47.7	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	5.0		C/4 SWEEP	39.1	30.0	30.0
					ASPECT RATIO	3.50	3.57	1.02
					TAPER RATIO	0.00	0.39	0.30
ENGINE		WEIGHTS			T/C ROOT	0.15	0.09	0.08
					T/C TIP	0.00	0.07	0.06
NUMBER	1		W	%	ROOT CHORD	29.3	0.1	0.1
LENGTH	7.9	STRUCT.	7720.	30.8	TIP CHORD	0.0	0.0	0.0
DIAM.	2.7	PROPUL.	1450.	5.8	M.A. CHORD	19.5	0.0	0.1
WEIGHT	940.7	FIX. EQ.	5359.	21.4	LOC. OF L.E.	0.1	20.2	22.3
TSLS	8978.	FUEL	4127.	16.5				
SFCSLS	0.45	PAYLOAD	6421.	25.6				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	100.	10.5					
CLIMB	0.84	33112.	409.	9.6	74.9	16.92	2271.9	0.683	271.5
CRUISE	0.80	33112.	991.	64.5	500.0	17.55	1357.3	0.675	244.5
CRUISE	0.80	100.	312.	5.7	50.0	5.55	4221.6	0.781	944.6
COMBAT	0.85	100.	133.	2.0	18.7	9.35	4973.1	0.802	1066.4
CRUISE	0.80	100.	312.	5.7	50.0	5.45	4219.0	0.781	944.6
CLIMB	0.84	39425.	465.	13.3	104.9	18.98	1685.9	0.674	200.4
CRUISE	0.80	39425.	812.	65.4	500.0	19.52	1114.0	0.663	181.0
LOITER	0.30	100.	255.	20.0	66.1	20.54	1048.8	0.730	132.8

BLOCK TIME = 3.103 HR
BLOCK RANGE = 1364.9 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	59.	4.9	0.058	0.0062	0.7	6.5	-43.	0.187	0.0091	2.4	7080.
0.20	100.	70.	1.9	0.885	0.0786	15.0	1.9	43.	0.885	0.0786	15.0	417.

1995 Medium Flying Wing Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	751.6	0.0	0.0	0.0	(SQ.FT.)
SURFACE AREA.......	1259.6	0.0	0.0	0.0	(SQ.FT.)
VOLUME.............	967.1	0.0	0.0	0.0	(CU.FT.)
SPAN...............	51.288	0.164	0.088	0.000	(FT.)
L.E. SWEEP.........	47.667	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	39.096	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-2.454	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	3.500	3.574	1.020	0.000	
ROOT CHORD.........	29.278	0.066	0.132	0.000	(FT.)
ROOT THICKNESS.....	52.701	0.071	0.125	0.000	(IN.)
ROOT T/C	0.150	0.090	0.079	0.000	
TIP CHORD..........	0.029	0.026	0.040	0.000	(FT.)
TIP THICKNESS......	0.000	0.021	0.031	0.000	(IN.)
TIP T/C	0.001	0.070	0.065	0.000	
TAPER RATIO	0.001	0.386	0.302	0.000	
MEAN AERO CHORD....	19.519	0.049	0.094	0.000	(FT.)
LE ROOT AT.........	0.093	20.218	22.331	0.000	(FT.)
C/4 ROOT AT........	7.413	20.234	22.364	0.000	(FT.)
TE ROOT AT.........	29.371	20.284	22.463	0.000	(FT.)
LE M.A.C. AT.......	9.486	20.242	22.361	0.000	(FT.)
C/4 M.A.C. AT......	14.366	20.255	22.385	0.000	(FT.)
TE M.A.C. AT.......	29.005	20.291	22.455	0.000	(FT.)
Y M.A.C. AT........	8.557	0.035	0.036	0.000	
LE TIP AT..........	28.243	20.275	22.405	0.000	(FT.)
C/4 TIP AT.........	28.250	20.282	22.415	0.000	(FT.)
TE TIP AT..........	28.272	20.301	22.445	0.000	(FT.)
ELEVATION..........	-0.450	0.000	2.250	0.000	(FT.)
VOLUME COEFF.		0.000	0.000	0.000	

AIRCRAFT WEIGHT = 25078.863 Lbs.
AIRCRAFT VOLUME = 1256.204 Cu.Ft.
AIRCRAFT DENSITY = 19.964 Lbs./Cu.Ft.

1995 Medium Flying Wing Mission Performance

PHASE	M	H	CL	ALPHA	WFUEL	TIME	VEL
	SFC(I)	THRUST(I)	CD	GAMMA	W	WA	Q
	SFC(U)	THRUST(U)	CDINST	L/D	THR/THA	PR	X
CLIMB	0.84	33112.	0.1207	1.56	409.0	9.59	827.
	0.68	2272.	0.0071	1.90	24570.1	0.00	272.
	0.00	0.	0.0000	16.92	1.00	0.00	75.
CRUISE	0.80	33112.	0.1297	1.72	991.1	64.49	785.
	0.67	1357.	0.0074	0.00	23579.0	0.00	244.
	0.00	3103.	0.0000	17.55	0.61	0.00	500.
CRUISE	0.80	100.	0.0330	0.43	311.7	5.67	893.
	0.78	4222.	0.0059	0.00	23267.3	0.00	945.
	0.00	10469.	0.0000	5.55	0.65	0.00	50.
COMBAT	0.85	100.	0.0580	0.74	132.9	2.00	949.
	0.80	4973.	0.0062	0.30	23134.4	0.00	1066.
	0.00	14186.	0.0000	9.35	0.80	0.00	19.
CRUISE	0.80	100.	0.0324	0.42	311.5	5.67	893.
	0.78	4219.	0.0059	0.00	22822.9	0.00	945.
	0.00	10465.	0.0000	5.45	0.65	0.00	50.
CLIMB	0.84	39425.	0.1483	1.93	465.1	13.29	815.
	0.67	1686.	0.0078	1.30	22357.8	0.00	200.
	0.00	0.	0.0000	18.98	1.00	0.00	105.
CRUISE	0.80	39425.	0.1598	2.13	811.6	65.38	774.
	0.66	1114.	0.0082	0.00	21546.2	0.00	181.
	0.00	2432.	0.0000	19.52	0.67	0.00	500.
LOITER	0.30	100.	0.2158	3.36	255.4	20.00	335.
	0.73	1049.	0.0105	0.00	21290.9	0.00	133.
	0.00	2088.	0.0000	20.54	0.14	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 3788.
RESERVE FUEL = 189.
TRAPPED FUEL = 150.

TOTAL FUEL = 4127.

1995 Medium Flying Wing Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	59.0	1.00	0.00	0.	0.37	0.029	0.0060
H= 100.	SUSTAINED	0.0	4.95	9.42	5770.	0.74	0.058	0.0062
	MAX. INST.	-43.0	6.50	12.48	4355.	2.43	0.187	0.0091
	COMBAT ENERGY = 0.708009E+04							
M= 0.20	1 G FLIGHT	69.5	1.00	0.00	0.	7.81	0.480	0.0275
H= 100.	SUSTAINED	0.0	1.94	13.74	931.	15.00	0.885	0.0786
	MAX. INST.	42.9	1.94	13.74	931.	15.00	0.885	0.0786
	COMBAT ENERGY = 0.417195E+03							

1995 Medium Flying Wing Aerodynamics

Mach = 0.90 Altitude = 100.

Parasite Drag		Induced Drag					
Friction	.0057	Alpha	Cl	Cd	L/D	Cm	e
Body	.0011	0.0	0.000	0.0124	0.0	0.000	0.00
Wing	.0046	2.0	0.159	0.0147	10.8	0.003	1.00
Strakes	.0000	3.0	0.237	0.0175	13.5	0.004	1.00
H. Tail	.0000	4.0	0.313	0.0213	14.7	0.006	1.00
V. Tail	.0000	5.0	0.388	0.0261	14.8	0.007	1.00
Canard	.0000	6.0	0.462	0.0330	14.0	0.009	0.94
Pods	.0000	8.0	0.573	0.0828	6.9	0.011	0.42
Engine	.0000	10.0	0.674	0.1187	5.7	0.013	0.39
Cowl	.0000	12.0	0.755	0.2086	3.6	0.034	0.26
Boattail	.0000	15.0	0.821	0.2762	3.0	0.037	0.23
Interference	.0000						
Wave	.0066						
External	.0000						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0124						

Slope Factors	
ClAlpha	0.0547
Cdl^.5Alpha	0.0342

Mach = 0.60 Altitude = 35000.

Parasite Drag		Induced Drag					
Friction	.0060	Alpha	Cl	Cd	L/D	Cm	e
Body	.0011	0.0	0.000	0.0060	0.0	0.000	0.00
Wing	.0049	2.0	0.139	0.0078	17.8	0.007	0.99
Strakes	.0000	3.0	0.206	0.0099	20.8	0.010	0.99
H. Tail	.0000	4.0	0.272	0.0128	21.2	0.013	0.99
V. Tail	.0000	5.0	0.338	0.0165	20.5	0.017	0.99
Canard	.0000	6.0	0.402	0.0209	19.3	0.020	0.99
Pods	.0000	8.0	0.528	0.0317	16.7	0.027	0.99
Engine	.0000	10.0	0.651	0.0450	14.5	0.033	0.99
Cowl	.0000	12.0	0.746	0.1422	5.2	0.037	0.37
Boattail	.0000	15.0	0.861	0.2100	4.1	0.044	0.33
Interference	.0000						
Wave	.0000						
External	.0000						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0060						

Slope Factors	
ClAlpha	0.0574
Cdl^.5Alpha	0.0301

1995 Medium Flying Wing Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.401
WEIGHT =	940.660
LENGTH =	7.916

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	8978.	0.449	4031.3	199.
87.50	0.000	0.0	7856.	0.434	3407.6	184.
75.00	0.000	0.0	6734.	0.425	2863.4	168.
62.50	0.000	0.0	5611.	0.413	2319.1	155.
50.00	0.000	0.0	4489.	0.395	1774.9	142.
37.50	0.000	0.0	3367.	0.387	1304.5	119.
25.00	0.000	0.0	2245.	0.412	925.5	90.
12.50	0.000	0.0	1122.	0.487	546.5	71.
100.00	0.600	30000.0	2329.	0.598	1392.8	199.
87.50	0.600	30000.0	2038.	0.599	1220.9	187.
75.00	0.600	30000.0	1747.	0.601	1049.0	177.
62.50	0.600	30000.0	1456.	0.603	877.2	167.
50.00	0.600	30000.0	1164.	0.610	710.5	156.
37.50	0.600	30000.0	873.	0.651	568.7	139.
25.00	0.600	30000.0	582.	0.733	426.9	125.
12.50	0.600	30000.0	291.	0.979	285.0	111.
100.00	0.800	30000.0	2579.	0.668	1723.0	199.
87.50	0.800	30000.0	2257.	0.670	1511.6	188.
75.00	0.800	30000.0	1934.	0.672	1300.3	177.
62.50	0.800	30000.0	1612.	0.676	1088.9	168.
50.00	0.800	30000.0	1290.	0.687	886.1	157.
37.50	0.800	30000.0	967.	0.733	709.4	143.
25.00	0.800	30000.0	645.	0.826	532.7	131.
12.50	0.800	30000.0	322.	1.102	355.3	110.
100.00	0.900	30000.0	2698.	0.723	1951.1	199.
87.50	0.900	30000.0	2361.	0.728	1717.9	188.
75.00	0.900	30000.0	2024.	0.734	1484.6	178.
62.50	0.900	30000.0	1686.	0.742	1251.4	169.
50.00	0.900	30000.0	1349.	0.760	1025.3	159.
37.50	0.900	30000.0	1012.	0.820	829.9	145.
25.00	0.900	30000.0	675.	0.941	634.6	133.
12.50	0.900	30000.0	337.	1.302	439.2	123.

1995 Medium Flying Wing Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	7720.	3502.	30.78
WING	3504.	1589.	13.97
FUSELAGE	1369.	621.	5.46
HORIZONTAL TAIL	0.	0.	0.00
VERTICAL TAIL	0.	0.	0.00
ARMOR	589.	267.	2.35
WING FOLD	150.	68.	0.60
INTERNAL BAY STRUCTURE	1200.	544.	4.78
ALIGHTING GEAR	909.	412.	3.62
PROPULSION	1450.	658.	5.78
ENGINES (1)	1102.	500.	4.39
FUEL SYSTEM	348.	158.	1.39
FIXED EQUIPMENT	5359.	2431.	21.37
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.85)			
HYD. + PNEU.	210.	95.	0.84
ELECTRICAL	817.	370.	3.26
AVIONICS	2790.	1266.	11.13
INSTRUMENTATION	219.	99.	0.87
DE-ICE/AIR CONDITION	398.	181.	1.59
AUXILIARY GEAR	200.	91.	0.80
FURNISH. + EQPT.	613.	278.	2.44
FLIGHT CONTROLS	1058.	480.	4.22
FUEL	4127.	1872.	16.46
PAYLOAD	6421.	2912.	25.60
FLIGHT CREW (2)	360.	163.	1.44
ARMAMENT	612.	278.	2.44
AMMUNITION	287.	130.	1.14
SHORT RANGE MISSILES	398.	181.	1.59
SRM LAUNCHERS	200.	91.	0.80
LASER GUIDED BOMBS	4364.	1980.	17.40
LGB PYLONS AND EJECTORS	200.	91.	0.80
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	25078.	11375.	100.00

1995 Medium Internal Attack Summary

Standard English Units

GENERAL		FUSELAGE				WING	HTAIL	VTAIL
TOGW	29095.	LENGTH	45.4		AREA	432.4	102.9	58.5
W/S	67.3	DIAMETER	4.6		WETTED AREA	736.3	140.3	117.3
T/W Dry	0.43	VOLUME	658.2		SPAN	44.7	19.2	7.7
CREW	2	WETTED AREA	604.9		L.E. SWEEP	20.4	35.0	47.8
N(Z) ULT	9.8	FINENESS RATIO	9.9		C/4 SWEEP	14.5	30.0	30.0
					ASPECT RATIO	4.63	3.57	1.02
					TAPER RATIO	0.31	0.39	0.30
ENGINE		WEIGHTS			T/C ROOT	0.09	0.09	0.08
					T/C TIP	0.06	0.07	0.06
NUMBER	1		W	%	ROOT CHORD	14.7	7.7	11.6
LENGTH	9.4	STRUCT.	9801.	33.7	TIP CHORD	4.6	3.0	3.5
DIAM.	3.1	PROPUL.	2077.	7.1	M.A. CHORD	10.6	5.7	8.3
WEIGHT	1347.8	FIX. EQ.	5505.	18.9	LOC. OF L.E.	9.3	33.3	33.8
TSLS	12646.	FUEL	5290.	18.2				
SFCSLS	0.45	PAYLOAD	6421.	22.1				

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	141.	10.5					
CLIMB	0.84	36500.	512.	9.4	75.1	15.59	2729.3	0.673	230.1
CRUISE	0.80	36500.	1272.	65.4	500.0	15.92	1726.9	0.668	208.3
CRUISE	0.80	100.	401.	5.7	50.0	5.05	5337.7	0.795	944.6
COMBAT	0.85	100.	171.	2.0	18.7	8.52	6275.4	0.816	1066.4
CRUISE	0.80	100.	401.	5.7	50.0	4.95	5332.6	0.795	944.6
CLIMB	0.85	39500.	502.	10.1	80.7	15.72	2377.2	0.679	204.5
CRUISE	0.80	39500.	1129.	65.4	500.0	16.11	1542.6	0.663	180.4
LOITER	0.30	100.	368.	20.0	66.1	16.03	1532.3	0.720	132.8

BLOCK TIME = 3.061 HR
BLOCK RANGE = 1340.9 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
0.85	100.	100.	5.3	0.116	0.0136	0.8	6.5	-52.	0.372	0.0222	2.7	12013.
0.20	100.	83.	1.5	1.311	0.1431	15.0	1.5	65.	1.311	0.1431	15.0	499.

1995 Medium Internal Attack Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	432.4	102.9	58.5	0.0	(SQ.FT.)
SURFACE AREA.......	736.3	140.3	117.3	0.0	(SQ.FT.)
VOLUME.............	223.8	34.1	25.3	0.0	(CU.FT.)
SPAN...............	44.724	19.177	7.726	0.000	(FT.)
L.E. SWEEP.........	20.421	35.042	40.035	0.000	(DEG.)
C/4 SWEEP..........	14.518	30.000	30.000	0.000	(DEG.)
T.E. SWEEP.........	-4.637	11.612	-11.916	0.000	(DEG.)
ASPECT RATIO	4.626	3.574	1.020	0.000	
ROOT CHORD.........	14.738	7.743	11.635	0.000	(FT.)
ROOT THICKNESS.....	15.917	8.362	11.030	0.000	(IN.)
ROOT T/C	0.090	0.090	0.079	0.000	
TIP CHORD..........	4.598	2.989	3.514	0.000	(FT.)
TIP THICKNESS......	3.311	2.510	2.741	0.000	(IN.)
TIP T/C	0.060	0.070	0.065	0.000	
TAPER RATIO	0.312	0.386	0.302	0.000	
MEAN AERO CHORD....	10.554	5.717	8.300	0.000	(FT.)
LE ROOT AT.........	9.300	33.255	33.766	0.000	(FT.)
C/4 ROOT AT........	12.985	35.190	36.675	0.000	(FT.)
TE ROOT AT.........	24.038	40.997	45.401	0.000	(FT.)
LE M.A.C. AT.......	12.735	36.120	36.431	0.000	(FT.)
C/4 M.A.C. AT......	15.374	37.549	38.506	0.000	(FT.)
TE M.A.C. AT.......	23.289	41.837	44.731	0.000	(FT.)
Y M.A.C. AT........	9.227	4.086	3.173	0.000	
LE TIP AT..........	17.626	39.979	40.257	0.000	(FT.)
C/4 TIP AT.........	18.775	40.726	41.135	0.000	(FT.)
TE TIP AT..........	22.224	42.967	43.771	0.000	(FT.)
ELEVATION..........	0.000	0.000	2.296	0.000	(FT.)
VOLUME COEFF.		0.500	0.070	0.000	

AIRCRAFT WEIGHT = 29094.568 Lbs.
AIRCRAFT VOLUME = 941.282 Cu.Ft.
AIRCRAFT DENSITY = 30.910 Lbs./Cu.Ft.

1995 Medium Internal Attack Mission Performance

PHASE	M / SFC(I) / SFC(U)	H / THRUST(I) / THRUST(U)	CL / CD / CDINST	ALPHA / GAMMA / L/D	WFUEL / W / THR/THA	TIME / WA / PR	VEL / Q / X
CLIMB	0.84	36500.	0.2847	2.10	512.4	9.37	814.
	0.67	2729.	0.0183	1.84	28441.6	0.00	230.
	0.00	0.	0.0000	15.59	1.00	0.00	75.
CRUISE	0.80	36500.	0.3052	2.38	1272.0	65.38	774.
	0.67	1727.	0.0192	0.00	27169.6	0.00	208.
	0.00	3856.	0.0000	15.92	0.65	0.00	500.
CRUISE	0.80	100.	0.0660	0.51	400.9	5.67	893.
	0.79	5338.	0.0131	0.00	26768.7	0.00	945.
	0.00	13874.	0.0000	5.05	0.59	0.00	50.
COMBAT	0.85	100.	0.1159	0.83	170.7	2.00	949.
	0.82	6275.	0.0136	0.47	26598.0	0.00	1066.
	0.00	19981.	0.0000	8.52	0.71	0.00	19.
CRUISE	0.80	100.	0.0646	0.50	400.6	5.67	893.
	0.79	5333.	0.0131	0.00	26197.4	0.00	945.
	0.00	13867.	0.0000	4.95	0.59	0.00	50.
CLIMB	0.85	39500.	0.2896	2.10	502.3	10.08	825.
	0.68	2377.	0.0184	1.67	25695.1	0.00	204.
	0.00	0.	0.0000	15.72	1.00	0.00	81.
CRUISE	0.80	39500.	0.3185	2.49	1128.6	65.38	774.
	0.66	1543.	0.0198	0.00	24566.5	0.00	180.
	0.00	3383.	0.0000	16.11	0.66	0.00	500.
LOITER	0.30	100.	0.4277	4.47	367.5	20.00	335.
	0.72	1532.	0.0267	0.00	24199.0	0.00	133.
	0.00	3011.	0.0000	16.03	0.14	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 4896.
RESERVE FUEL = 245.
TRAPPED FUEL = 150.

TOTAL FUEL = 5290.

1995 Medium Internal Attack Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 0.85	1 G FLIGHT	100.1	1.00	0.00	0.	0.42	0.058	0.0129
H= 100.	SUSTAINED	0.0	5.25	10.02	5426.	0.83	0.116	0.0136
	MAX. INST.	-51.9	6.50	12.48	4355.	2.73	0.372	0.0222
	COMBAT ENERGY = 0.120127E+05							
M= 0.20	1 G FLIGHT	83.1	1.00	0.00	0.	10.55	0.948	0.0801
H= 100.	SUSTAINED	0.0	1.50	9.24	1384.	15.00	1.311	0.1431
	MAX. INST.	64.8	1.50	9.24	1384.	15.00	1.311	0.1431
	COMBAT ENERGY = 0.498788E+03							

1995 Medium Internal Attack Aerodynamics

Mach = 0.90   Altitude = 100.

Parasite Drag		Induced Drag					
Friction	.0106	Alpha	Cl	Cd	L/D	Cm	e
Body	.0032	0.0	0.000	0.0216	0.0	0.000	0.00
Wing	.0054	2.0	0.302	0.0278	10.9	-.017	1.01
Strakes	.0000	3.0	0.450	0.0392	11.5	-.026	0.79
H. Tail	.0011	4.0	0.544	0.0585	9.3	-.036	0.55
V. Tail	.0009	5.0	0.634	0.0751	8.4	-.047	0.52
Canard	.0000	6.0	0.721	0.0949	7.6	-.059	0.49
Pods	.0000	8.0	0.891	0.1437	6.2	-.084	0.45
Engine	.0000	10.0	1.006	0.2276	4.4	-.090	0.34
Cowl	.0000	12.0	1.095	0.2869	3.8	-.120	0.31
Boattail	.0000	15.0	1.213	0.3865	3.1	-.171	0.28
Interference	.0013						
Wave	.0097						
External	.0000						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0216						

Slope Factors	
ClAlpha	0.0809
Cdl^.5Alpha	0.0403

Mach = 0.60   Altitude = 35000.

Parasite Drag		Induced Drag					
Friction	.0111	Alpha	Cl	Cd	L/D	Cm	e
Body	.0034	0.0	0.000	0.0131	0.0	0.000	0.00
Wing	.0056	2.0	0.218	0.0164	13.3	-.010	0.98
Strakes	.0000	3.0	0.325	0.0205	15.8	-.016	0.98
H. Tail	.0012	4.0	0.429	0.0261	16.4	-.023	0.97
V. Tail	.0009	5.0	0.533	0.0362	14.7	-.030	0.85
Canard	.0000	6.0	0.617	0.0671	9.2	-.038	0.48
Pods	.0000	8.0	0.776	0.1066	7.3	-.058	0.44
Engine	.0000	10.0	0.928	0.1569	5.9	-.080	0.41
Cowl	.0000	12.0	1.070	0.2175	4.9	-.105	0.39
Boattail	.0000	15.0	1.264	0.3261	3.9	-.147	0.35
Interference	.0020						
Wave	.0000						
External	.0000						
Tanks	.0000						
Bombs	.0000						
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0131						

Slope Factors	
ClAlpha	0.0843
Cdl^.5Alpha	0.0373

1995 Medium Internal Attack Propulsion

PHYSICAL ATTRIBUTES

ESF =	0.565
WEIGHT =	1347.763
LENGTH =	9.395
DIAM =	3.149

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	12646.	0.449	5677.9	280.
87.50	0.000	0.0	11065.	0.434	4799.5	259.
75.00	0.000	0.0	9484.	0.425	4032.9	237.
62.50	0.000	0.0	7904.	0.413	3266.4	218.
50.00	0.000	0.0	6323.	0.395	2499.8	201.
37.50	0.000	0.0	4742.	0.387	1837.3	168.
25.00	0.000	0.0	3161.	0.412	1303.5	127.
12.50	0.000	0.0	1581.	0.487	769.7	100.
100.00	0.600	30000.0	3280.	0.598	1961.6	280.
87.50	0.600	30000.0	2870.	0.599	1719.6	264.
75.00	0.600	30000.0	2460.	0.601	1477.5	249.
62.50	0.600	30000.0	2050.	0.603	1235.4	235.
50.00	0.600	30000.0	1640.	0.610	1000.7	220.
37.50	0.600	30000.0	1230.	0.651	801.0	196.
25.00	0.600	30000.0	820.	0.733	601.2	176.
12.50	0.600	30000.0	410.	0.979	401.4	157.
100.00	0.800	30000.0	3633.	0.668	2426.7	280.
87.50	0.800	30000.0	3179.	0.670	2129.0	264.
75.00	0.800	30000.0	2724.	0.672	1831.4	250.
62.50	0.800	30000.0	2270.	0.676	1533.7	236.
50.00	0.800	30000.0	1816.	0.687	1248.1	222.
37.50	0.800	30000.0	1362.	0.733	999.2	201.
25.00	0.800	30000.0	908.	0.826	750.2	184.
12.50	0.800	30000.0	454.	1.102	500.4	155.
100.00	0.900	30000.0	3801.	0.723	2748.1	280.
87.50	0.900	30000.0	3325.	0.728	2419.6	265.
75.00	0.900	30000.0	2850.	0.734	2091.1	251.
62.50	0.900	30000.0	2375.	0.742	1762.5	238.
50.00	0.900	30000.0	1900.	0.760	1444.1	224.
37.50	0.900	30000.0	1425.	0.820	1168.9	205.
25.00	0.900	30000.0	950.	0.941	893.7	188.
12.50	0.900	30000.0	475.	1.302	618.6	173.

1995 Medium Internal Attack Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	9801.	4446.	33.69
WING	3003.	1362.	10.32
FUSELAGE	2774.	1258.	9.53
HORIZONTAL TAIL	776.	352.	2.67
VERTICAL TAIL	255.	116.	0.88
ARMOR	589.	267.	2.02
WING FOLD	150.	68.	0.52
INTERNAL BAY STRUCTURE	1200.	544.	4.12
ALIGHTING GEAR	1055.	478.	3.62
PROPULSION	2077.	942.	7.14
ENGINES (1)	1578.	716.	5.42
FUEL SYSTEM	499.	226.	1.72
FIXED EQUIPMENT	5505.	2497.	18.92
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR = 0.85)			
HYD. + PNEU.	244.	111.	0.84
ELECTRICAL	817.	370.	2.81
AVIONICS	2790.	1266.	9.59
INSTRUMENTATION	219.	99.	0.75
DE-ICE/AIR CONDITION	398.	181.	1.37
AUXILIARY GEAR	200.	91.	0.69
FURNISH. + EQPT.	613.	278.	2.11
FLIGHT CONTROLS	1195.	542.	4.11
FUEL	5290.	2400.	18.18
PAYLOAD	6421.	2912.	22.07
FLIGHT CREW (2)	360.	163.	1.24
ARMAMENT	612.	278.	2.10
AMMUNITION	287.	130.	0.99
SHORT RANGE MISSILES	398.	181.	1.37
SRM LAUNCHERS	200.	91.	0.69
LASER GUIDED BOMBS	4364.	1980.	15.00
LGB PYLONS AND EJECTORS	200.	91.	0.69
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	29095.	13197.	100.00

1995 MRF Summary

Standard English Units

GENERAL

TOGW	41604.
W/S	67.6
T/W DRY	0.78
T/W WET	1.24
CREW	1
N(Z) ULT	13.5

FUSELAGE

LENGTH	51.5
DIAMETER	5.1
VOLUME	817.5
WETTED AREA	701.4
FINENESS RATIO	10.0

	WING	HTAIL	VTAIL
AREA	615.4	234.9	93.4
WETTED AREA	913.1	282.3	186.9
SPAN	35.1	21.7	9.7
L.E. SWEEP	42.1	42.1	53.6
C/4 SWEEP	24.3	24.3	24.3
ASPECT RATIO	2.00	2.00	1.00
TAPER RATIO	0.05	0.05	0.05
T/C ROOT	0.05	0.05	0.05
T/C TIP	0.04	0.04	0.04
ROOT CHORD	33.4	20.6	18.4
TIP CHORD	1.7	1.0	0.9
M.A. CHORD	22.3	13.8	12.3
LOC. OF L.E.	14.8	37.5	33.1

ENGINE

NUMBER	1
LENGTH	16.1
DIAM.	3.7
WEIGHT	3118.8
TSLS	32474.
SFCSLS	0.75

WEIGHTS

	W	%
STRUCT.	10402.	25.0
PROPUL.	4935.	11.9
FIX. EQ.	4585.	11.0
FUEL	17330.	41.7
PAYLOAD	4351.	10.4

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	635.	10.5					
CRUISE	0.85	100.	5088.	26.7	250.0	4.78	7858.1	1.449	1066.4
CLIMB	0.92	36296.	544.	1.9	16.4	8.74	9623.1	0.922	275.3
LOITER	0.80	37482.	3492.	60.0	458.9	8.41	3989.9	0.848	199.6
CLIMB	0.89	50000.	519.	1.4	9.7	7.39	9705.0	1.933	135.7
ACCEL	1.50	50000.	599.	1.4	16.4	3.56	17565.6	2.019	383.7
CRUISE	1.50	50000.	1669.	10.5	150.0	3.47	8535.6	1.113	383.7
COMBAT	1.50	50000.	642.	2.0	28.7	4.79	11967.8	1.610	383.7
CRUISE	0.91	42000.	2150.	46.0	400.0	8.87	3018.2	0.900	207.1
LOITER	0.30	100.	1023.	20.0	66.1	7.91	3320.2	0.924	132.8

BLOCK TIME = 2.840 HR
BLOCK RANGE = 1401.0 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	0.	1.0	0.130	0.0366	2.6	6.2	-2338.	0.799	0.2448	15.0	0.
1.50	50000.	454.	3.0	0.242	0.0505	4.7	6.6	-2041.	0.799	0.2448	15.0	54432.
0.20	100.	397.	1.6	0.781	0.1888	15.0	1.6	369.	0.781	0.1888	15.0	2380.
0.90	30000.	530.	3.8	0.580	0.1093	10.7	5.3	-554.	0.811	0.2056	15.0	11130.

1995 MRF Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	615.4	234.9	93.4	0.0	(SQ.FT.)
SURFACE AREA.......	913.1	282.3	186.9	0.0	(SQ.FT.)
VOLUME.............	340.2	107.4	38.1	0.0	(CU.FT.)
SPAN...............	35.084	21.673	9.662	0.000	(FT.)
L.E. SWEEP.........	42.138	42.138	42.138	0.000	(DEG.)
C/4 SWEEP..........	24.341	24.341	24.341	0.000	(DEG.)
T.E. SWEEP.........	-42.138	-42.138	-42.138	0.000	(DEG.)
ASPECT RATIO	2.000	2.000	1.000	0.000	
ROOT CHORD.........	33.413	20.641	18.405	0.000	(FT.)
ROOT THICKNESS.....	20.048	12.384	11.043	0.000	(IN.)
ROOT T/C	0.050	0.050	0.050	0.000	
TIP CHORD..........	1.671	1.032	0.920	0.000	(FT.)
TIP THICKNESS......	0.802	0.495	0.442	0.000	(IN.)
TIP T/C	0.040	0.040	0.040	0.000	
TAPER RATIO	0.050	0.050	0.050	0.000	
MEAN AERO CHORD....	22.329	13.793	12.299	0.000	(FT.)
LE ROOT AT.........	14.804	37.509	33.055	0.000	(FT.)
C/4 ROOT AT........	23.157	42.669	37.657	0.000	(FT.)
TE ROOT AT.........	48.217	58.150	51.460	0.000	(FT.)
LE M.A.C. AT.......	20.346	40.933	36.108	0.000	(FT.)
C/4 M.A.C. AT......	25.928	44.381	39.183	0.000	(FT.)
TE M.A.C. AT.......	42.675	54.726	48.407	0.000	(FT.)
Y M.A.C. AT........	6.126	3.784	3.374	0.000	
LE TIP AT..........	30.675	47.313	41.798	0.000	(FT.)
C/4 TIP AT.........	31.093	47.571	42.028	0.000	(FT.)
TE TIP AT..........	32.346	48.346	42.718	0.000	(FT.)
ELEVATION..........	0.232	-0.257	2.573	0.000	(FT.)
VOLUME COEFF.		0.315	0.057	0.000	

AIRCRAFT WEIGHT = 41603.836 Lbs.
AIRCRAFT VOLUME = 1341.306 Cu.Ft.
AIRCRAFT DENSITY = 31.017 Lbs./Cu.Ft.

1995 MRF Mission Performance

PHASE	M / SFC(I) / SFC(U)	H / THRUST(I) / THRUST(U)	CL / CD / CDINST	ALPHA / GAMMA / L/D	WFUEL / W / THR/THA	TIME / WA / PR	VEL / Q / X
CRUISE	0.85	100.	0.0572	0.99	5088.1	26.69	949.
	1.45	7858.	0.0120	0.00	35881.1	0.00	1066.
	0.00	22720.	0.0000	4.78	0.30	0.00	250.
CLIMB	0.92	36296.	0.2183	3.90	544.2	1.94	886.
	0.92	9623.	0.0250	8.77	35336.8	0.00	275.
	0.00	0.	0.0000	8.74	1.00	0.00	16.
LOITER	0.80	37482.	0.2730	5.07	3491.9	60.00	774.
	0.85	3990.	0.0325	0.00	31845.0	0.00	200.
	0.00	6357.	0.0000	8.41	0.48	0.00	459.
CLIMB	0.89	50000.	0.3624	6.66	519.2	1.35	863.
	1.93	9705.	0.0490	10.31	31325.7	0.00	136.
	0.00	0.	0.0000	7.39	1.97	0.00	10.
ACCEL	1.50	50000.	0.1304	2.56	599.0	1.42	1452.
	2.02	17566.	0.0366	0.00	30726.7	0.00	384.
	0.00	24661.	0.0000	3.56	2.03	0.00	16.
COMBAT	1.50	50000.	0.1301	2.56	0.3	0.10	1452.
	1.12	8632.	0.0366	0.00	30726.4	0.00	384.
	0.00	15727.	0.0000	3.56	1.00	0.00	1.
CRUISE	1.50	50000.	0.1254	2.47	1669.3	10.46	1452.
	1.11	8536.	0.0361	0.00	29057.1	0.00	384.
	0.00	15605.	0.0000	3.47	0.99	0.00	150.
COMBAT	1.50	50000.	0.2420	4.67	642.4	2.00	1452.
	1.61	11968.	0.0505	1.07	28414.6	0.00	384.
	0.00	24661.	0.0000	4.79	1.39	0.00	29.
CRUISE	0.91	42000.	0.2102	3.75	2149.9	45.98	881.
	0.90	3018.	0.0237	0.00	26264.7	0.00	207.
	0.00	5297.	0.0000	8.87	0.41	0.00	400.
LOITER	0.30	100.	0.3213	6.16	1023.0	20.00	335.
	0.92	3320.	0.0406	0.00	25241.7	0.00	133.
	0.00	4867.	0.0000	7.91	0.11	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 16362.
RESERVE FUEL = 818.
TRAPPED FUEL = 150.

TOTAL FUEL = 17330.

1995 MRF Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	0.0	1.00	0.00	0.	2.56	0.130	0.0366
H=50000.	SUSTAINED	0.0	1.00	0.061	465095.	2.55	0.130	0.0365
	MAX. INST.	-2337.9	6.21	7.78	10689.	15.00	0.799	0.2448
	COMBAT ENERGY =-0.719961E-01							
M= 1.50	1 G FLIGHT	453.6	1.00	0.00	0.	2.42	0.123	0.0359
H=50000.	SUSTAINED	0.0	2.99	3.58	23234.	4.67	0.242	0.0505
	MAX. INST.	-2041.0	6.65	8.34	9971.	15.00	0.799	0.2448
	COMBAT ENERGY = 0.544325E+05							
M= 0.20	1 G FLIGHT	396.6	1.00	0.00	0.	13.28	0.695	0.1504
H= 100.	SUSTAINED	0.0	1.64	10.74	1191.	15.00	0.781	0.1888
	MAX. INST.	369.1	1.64	10.74	1191.	15.00	0.781	0.1888
	COMBAT ENERGY = 0.237951E+04							
M= 0.90	1 G FLIGHT	530.0	1.00	0.00	0.	2.75	0.158	0.0181
H=30000.	SUSTAINED	0.0	3.81	7.58	6769.	10.69	0.580	0.1093
	MAX. INST.	-553.8	5.31	10.74	4777.	15.00	0.811	0.2056
	COMBAT ENERGY = 0.111297E+05							

1995 MRF Propulsion

PHYSICAL ATTRIBUTES

ESF =	1.214
WEIGHT =	3118.777
LENGTH =	16.087
DIAM =	3.713

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	51449.	1.770	91064.2	382.
100.00	0.000	0.0	32474.	0.754	24485.0	382.
87.50	0.000	0.0	28414.	0.731	20775.9	351.
75.00	0.000	0.0	24355.	0.701	17066.7	324.
62.50	0.000	0.0	20296.	0.661	13410.8	298.
50.00	0.000	0.0	16237.	0.655	10641.6	253.
37.50	0.000	0.0	12178.	0.646	7872.5	218.
25.00	0.000	0.0	8118.	0.629	5103.3	190.
12.50	0.000	0.0	4059.	0.690	2801.3	123.
100.00	0.600	30000.0	19311.	1.936	37387.0	382.
100.00	0.600	30000.0	10128.	0.829	8396.1	382.
87.50	0.600	30000.0	8862.	0.811	7188.3	357.
75.00	0.600	30000.0	7596.	0.787	5980.5	334.
62.50	0.600	30000.0	6330.	0.777	4918.1	300.
50.00	0.600	30000.0	5064.	0.779	3945.2	265.
37.50	0.600	30000.0	3798.	0.783	2972.4	235.
25.00	0.600	30000.0	2532.	0.821	2078.0	195.
12.50	0.600	30000.0	1266.	0.958	1212.7	160.
100.00	0.800	30000.0	22558.	1.931	43559.5	382.
100.00	0.800	30000.0	11675.	0.889	10378.9	382.
87.50	0.800	30000.0	10215.	0.878	8971.4	359.
75.00	0.800	30000.0	8756.	0.864	7564.0	338.
62.50	0.800	30000.0	7297.	0.866	6315.7	308.
50.00	0.800	30000.0	5837.	0.889	5186.5	275.
37.50	0.800	30000.0	4378.	0.927	4057.2	247.
25.00	0.800	30000.0	2919.	1.025	2992.8	212.
12.50	0.800	30000.0	1459.	1.361	1986.7	177.
100.00	0.900	30000.0	24529.	1.948	47784.6	382.
100.00	0.900	30000.0	12519.	0.944	11813.8	382.
87.50	0.900	30000.0	10954.	0.934	10235.2	359.
75.00	0.900	30000.0	9389.	0.922	8656.7	338.
62.50	0.900	30000.0	7824.	0.926	7245.5	309.
50.00	0.900	30000.0	6259.	0.955	5974.8	277.
37.50	0.900	30000.0	4695.	1.002	4704.1	249.
25.00	0.900	30000.0	3130.	1.116	3494.2	216.
12.50	0.900	30000.0	1565.	1.503	2352.3	180.

1995 MRF Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	10402.	4718.	25.00
WING	3136.	1422.	7.54
FUSELAGE	3265.	1481.	7.85
HORIZONTAL TAIL	988.	448.	2.38
VERTICAL TAIL	814.	369.	1.96
REACTION CONTROL SYSTEM	0.	0.	0.00
WING FOLD	150.	68.	0.36
INTERNAL BAY STRUCTURE	600.	272.	1.44
ALIGHTING GEAR	1450.	658.	3.49
PROPULSION	4936.	2239.	11.86
ENGINES (1)	3618.	1641.	8.70
FUEL SYSTEM	1318.	598.	3.17
FIXED EQUIPMENT	4585.	2080.	11.02
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	605.	274.	1.45
ELECTRICAL	544.	247.	1.31
AVIONICS	1652.	749.	3.97
INSTRUMENTATION	94.	43.	0.23
DE-ICE/AIR CONDITION	610.	277.	1.47
AUXILIARY GEAR	200.	91.	0.48
FURNISH. + EQPT.	375.	170.	0.90
FLIGHT CONTROLS	1314.	596.	3.16
FUEL	17330.	7861.	41.66
PAYLOAD	4351.	1974.	10.46
FLIGHT CREW (1)	180.	82.	0.43
ARMAMENT	612.	278.	1.47
AMMUNITION	287.	130.	0.69
LONG RANGE MISSILES	1974.	895.	4.74
LRM PYLONS & LAUNCHERS	700.	318.	1.68
SHORT RANGE MISSILES	398.	181.	0.96
SRM LAUNCHERS	200.	91.	0.48
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	41604.	18871.	100.00

1995 NFA Summary

Standard English Units

GENERAL

TOGW	49471.
W/S	66.1
T/W DRY	0.77
T/W WET	1.22
CREW	1
N(Z) ULT	13.5

FUSELAGE

LENGTH	52.7
DIAMETER	5.3
VOLUME	885.8
WETTED AREA	739.0
FINENESS RATIO	10.0

	WING	HTAIL	VTAIL
AREA	748.4	285.6	113.5
WETTED AREA	1136.1	357.7	227.3
SPAN	38.7	23.9	10.7
L.E. SWEEP	42.1	42.1	53.6
C/4 SWEEP	24.3	24.3	24.3
ASPECT RATIO	2.00	2.00	1.00
TAPER RATIO	0.05	0.05	0.05
T/C ROOT	0.05	0.05	0.05
T/C TIP	0.04	0.04	0.04
ROOT CHORD	36.8	22.8	20.3
TIP CHORD	1.8	1.1	1.0
M.A. CHORD	24.6	15.2	13.6
LOC. OF L.E.	14.5	36.8	32.4

ENGINE

NUMBER	1
LENGTH	17.5
DIAM.	4.0
WEIGHT	3703.6
TSLS	38248.
SFCSLS	0.75

WEIGHTS

	W	%
STRUCT.	13995.	28.3
PROPUL.	5861.	11.8
FIX. EQ.	4893.	9.9
FUEL	20371.	41.2
PAYLOAD	4351.	8.8

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	748.	10.5					
CRUISE	0.85	100.	5979.	26.7	250.0	4.85	9221.3	1.451	1066.4
CLIMB	0.92	36296.	648.	2.0	16.6	8.87	11341.1	0.922	275.7
LOITER	0.80	37464.	4100.	60.0	458.9	8.54	4684.6	0.848	199.7
CLIMB	0.89	50000.	620.	1.4	9.8	7.53	11430.8	1.933	135.7
ACCEL	1.50	50000.	713.	1.4	16.6	3.62	20689.3	2.019	383.7
CRUISE	1.50	50000.	1962.	10.5	150.0	3.52	10036.3	1.113	383.7
COMBAT	1.50	50000.	753.	2.0	28.7	4.87	14062.4	1.607	383.7
CRUISE	0.91	42000.	2530.	46.0	400.0	9.01	3553.7	0.900	207.1
LOITER	0.30	100.	1205.	20.0	66.1	8.03	3911.8	0.924	132.8

BLOCK TIME = 2.841 HR
BLOCK RANGE = 1401.4 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	1.	1.0	0.128	0.0354	2.5	6.3	-2383.	0.799	0.2438	15.0	5.
1.50	50000.	448.	3.0	0.238	0.0488	4.6	6.8	-2093.	0.799	0.2438	15.0	53762.
0.20	100.	390.	1.6	0.778	0.1869	15.0	1.6	362.	0.778	0.1869	15.0	2342.
0.90	30000.	524.	3.8	0.569	0.1054	10.6	5.4	-573.	0.807	0.2036	15.0	11007.

1995 NFA Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	748.4	285.6	113.5	0.0	(SQ.FT.)
SURFACE AREA.......	1136.1	357.7	227.3	0.0	(SQ.FT.)
VOLUME.............	466.6	144.0	51.1	0.0	(CU.FT.)
SPAN...............	38.689	23.900	10.655	0.000	(FT.)
L.E. SWEEP.........	42.138	42.138	42.138	0.000	(DEG.)
C/4 SWEEP..........	24.341	24.341	24.341	0.000	(DEG.)
T.E. SWEEP.........	-42.138	-42.138	-42.138	0.000	(DEG.)
ASPECT RATIO	2.000	2.000	1.000	0.000	
ROOT CHORD.........	36.847	22.762	20.296	0.000	(FT.)
ROOT THICKNESS.....	22.108	13.657	12.178	0.000	(IN.)
ROOT T/C	0.050	0.050	0.050	0.000	
TIP CHORD..........	1.842	1.138	1.015	0.000	(FT.)
TIP THICKNESS......	0.884	0.546	0.487	0.000	(IN.)
TIP T/C	0.040	0.040	0.040	0.000	
TAPER RATIO	0.050	0.050	0.050	0.000	
MEAN AERO CHORD....	24.623	15.211	13.563	0.000	(FT.)
LE ROOT AT.........	14.503	36.789	32.404	0.000	(FT.)
C/4 ROOT AT........	23.715	42.480	37.478	0.000	(FT.)
TE ROOT AT.........	51.350	59.551	52.700	0.000	(FT.)
LE M.A.C. AT.......	20.615	40.565	35.771	0.000	(FT.)
C/4 M.A.C. AT......	26.771	44.367	39.161	0.000	(FT.)
TE M.A.C. AT.......	45.238	55.775	49.333	0.000	(FT.)
Y M.A.C. AT........	6.755	4.173	3.721	0.000	
LE TIP AT..........	32.006	47.601	42.045	0.000	(FT.)
C/4 TIP AT.........	32.466	47.886	42.298	0.000	(FT.)
TE TIP AT..........	33.848	48.739	43.059	0.000	(FT.)
ELEVATION..........	0.237	-0.264	2.635	0.000	(FT.)
VOLUME COEFF.		0.273	0.049	0.000	

AIRCRAFT WEIGHT = 49471.258 Lbs.
AIRCRAFT VOLUME = 1598.504 Cu.Ft.
AIRCRAFT DENSITY = 30.948 Lbs./Cu.Ft.

1995 NFA Mission Performance

PHASE	M / SFC(I) / SFC(U)	H / THRUST(I) / THRUST(U)	CL / CD / CDINST	ALPHA / GAMMA / L/D	WFUEL / W / THR/THA	TIME / WA / PR	VEL / Q / X
CRUISE	0.85	100.	0.0560	0.99	5979.0	26.69	949.
	1.45	9221.	0.0116	0.00	42744.7	0.00	1066.
	0.00	26716.	0.0000	4.85	0.30	0.00	250.
CLIMB	0.92	36296.	0.2130	3.85	647.6	1.96	887.
	0.92	11341.	0.0240	8.72	42097.1	0.00	276.
	0.00	0.	0.0000	8.87	1.00	0.00	17.
LOITER	0.80	37464.	0.2675	5.02	4099.7	60.00	774.
	0.85	4685.	0.0313	0.00	37997.4	0.00	200.
	0.00	7471.	0.0000	8.54	0.48	0.00	459.
CLIMB	0.89	50000.	0.3544	6.58	619.6	1.37	863.
	1.93	11431.	0.0471	10.23	37377.8	0.00	136.
	0.00	0.	0.0000	7.53	1.97	0.00	10.
ACCEL	1.50	50000.	0.1280	2.51	713.1	1.43	1452.
	2.02	20689.	0.0354	0.00	36664.8	0.00	384.
	0.00	29046.	0.0000	3.62	2.03	0.00	17.
CRUISE	1.50	50000.	0.1231	2.42	1961.8	10.46	1452.
	1.11	10036.	0.0349	0.00	34702.6	0.00	384.
	0.00	18358.	0.0000	3.52	0.99	0.00	150.
COMBAT	1.50	50000.	0.2378	4.58	753.4	2.00	1452.
	1.61	14062.	0.0488	1.07	33949.2	0.00	384.
	0.00	29046.	0.0000	4.87	1.38	0.00	29.
CRUISE	0.91	42000.	0.2067	3.73	2530.4	45.98	881.
	0.90	3554.	0.0229	0.00	31418.8	0.00	207.
	0.00	6238.	0.0000	9.01	0.41	0.00	400.
LOITER	0.30	100.	0.3160	6.12	1205.2	20.00	335.
	0.92	3912.	0.0393	0.00	30213.6	0.00	133.
	0.00	5734.	0.0000	8.03	0.11	0.00	66.

FUEL SUMMARIES

MISSION FUEL = 19258.
RESERVE FUEL = 963.
TRAPPED FUEL = 150.

TOTAL FUEL = 20371.

1995 NFA Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	0.8	1.00	0.00	0.	2.51	0.128	0.0353
H=50000.	SUSTAINED	0.0	1.02	0.23	366342.	2.51	0.128	0.0354
	MAX. INST.	-2383.5	6.33	7.93	10489.	15.00	0.799	0.2438
	COMBAT ENERGY = 0.460688E+01							
M= 1.50	1 G FLIGHT	448.0	1.00	0.00	0.	2.37	0.121	0.0348
H=50000.	SUSTAINED	0.0	3.00	3.59	23172.	4.58	0.238	0.0488
	MAX. INST.	-2093.0	6.76	8.49	9797.	15.00	0.799	0.2438
	COMBAT ENERGY = 0.537623E+05							
M= 0.20	1 G FLIGHT	390.3	1.00	0.00	0.	13.13	0.684	0.1455
H= 100.	SUSTAINED	0.0	1.65	10.80	1184.	15.00	0.778	0.1869
	MAX. INST.	361.8	1.65	10.80	1184.	15.00	0.778	0.1869
	COMBAT ENERGY = 0.234173E+04							
M= 0.90	1 G FLIGHT	524.2	1.00	0.00	0.	2.73	0.155	0.0174
H=30000.	SUSTAINED	0.0	3.83	7.60	6747.	10.55	0.569	0.1054
	MAX. INST.	-573.1	5.39	10.91	4702.	15.00	0.807	0.2036
	COMBAT ENERGY = 0.110074E+05							

1995 NFA Aerodynamics

Mach = 0.80 Altitude = 40000.

Parasite Drag	
Friction	.0094
Body	.0023
Wing	.0040
Strakes	.0000
H. Tail	.0014
V. Tail	.0018
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0013
Wave	.0000
External	.0000
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0000
Camber	.0000
Cdmin	.0108

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0108	0.0	0.000	0.00
2.0	0.112	0.0143	7.8	-.005	0.57
3.0	0.164	0.0184	8.9	-.008	0.56
4.0	0.215	0.0239	9.0	-.011	0.56
5.0	0.266	0.0311	8.5	-.015	0.55
6.0	0.319	0.0400	8.0	-.019	0.55
8.0	0.425	0.0630	6.7	-.029	0.55
10.0	0.532	0.0931	5.7	-.040	0.55
12.0	0.639	0.1302	4.9	-.053	0.54
15.0	0.798	0.1990	4.0	-.075	0.54

Slope Factors	
ClAlpha	0.0532
Cdl^.5Alpha	0.0289

Mach = 1.50 Altitude = 50000.

Parasite Drag	
Friction	.0080
Body	.0019
Wing	.0034
Strakes	.0000
H. Tail	.0012
V. Tail	.0015
Canard	.0000
Pods	.0000
Engine	.0000
Cowl	.0000
Boattail	.0000
Interference	.0003
Wave	.0214
External	.0000
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0000
Camber	.0000
Cdmin	.0298

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e
0.0	0.000	0.0298	0.0	0.000	0.00
2.0	0.101	0.0333	3.0	-.015	0.46
3.0	0.154	0.0378	4.1	-.023	0.47
4.0	0.207	0.0442	4.7	-.031	0.47
5.0	0.260	0.0525	5.0	-.039	0.47
6.0	0.314	0.0628	5.0	-.047	0.48
8.0	0.423	0.0892	4.7	-.064	0.48
10.0	0.533	0.1237	4.3	-.082	0.48
12.0	0.641	0.1660	3.9	-.100	0.48
15.0	0.799	0.2438	3.3	-.126	0.47

Slope Factors	
ClAlpha	0.0532
Cdl^.5Alpha	0.0308

1995 NFA Propulsion

PHYSICAL ATTRIBUTES

ESF =	1.430
WEIGHT =	3703.564
LENGTH =	17.459
DIAM =	4.030

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	60598.	1.770	107257.9	450.
100.00	0.000	0.0	38248.	0.754	28839.2	450.
87.50	0.000	0.0	33467.	0.731	24470.4	414.
75.00	0.000	0.0	28686.	0.701	20101.7	382.
62.50	0.000	0.0	23905.	0.661	15795.6	351.
50.00	0.000	0.0	19124.	0.655	12534.0	299.
37.50	0.000	0.0	14343.	0.646	9272.4	257.
25.00	0.000	0.0	9562.	0.629	6010.9	223.
12.50	0.000	0.0	4781.	0.690	3299.5	145.
100.00	0.600	30000.0	22745.	1.936	44035.4	450.
100.00	0.600	30000.0	11929.	0.829	9889.2	450.
87.50	0.600	30000.0	10438.	0.811	8466.6	420.
75.00	0.600	30000.0	8947.	0.787	7044.0	393.
62.50	0.600	30000.0	7456.	0.777	5792.6	353.
50.00	0.600	30000.0	5964.	0.779	4646.8	312.
37.50	0.600	30000.0	4473.	0.783	3501.0	277.
25.00	0.600	30000.0	2982.	0.821	2447.6	230.
12.50	0.600	30000.0	1491.	0.958	1428.4	188.
100.00	0.900	30000.0	28891.	1.948	56282.0	450.
100.00	0.900	30000.0	14745.	0.944	13914.6	450.
87.50	0.900	30000.0	12902.	0.934	12055.3	423.
75.00	0.900	30000.0	11059.	0.922	10196.1	398.
62.50	0.900	30000.0	9216.	0.926	8533.9	364.
50.00	0.900	30000.0	7372.	0.955	7037.2	326.
37.50	0.900	30000.0	5529.	1.002	5540.6	294.
25.00	0.900	30000.0	3686.	1.116	4115.5	254.
12.50	0.900	30000.0	1843.	1.503	2770.6	212.
100.00	1.500	50000.0	20689.	2.019	41761.9	450.
100.00	1.500	50000.0	10167.	1.116	11342.4	450.
87.50	1.500	50000.0	8896.	1.099	9773.7	425.
75.00	1.500	50000.0	7625.	1.090	8309.8	397.
62.50	1.500	50000.0	6355.	1.077	6845.8	371.
50.00	1.500	50000.0	5084.	1.098	5583.8	335.
37.50	1.500	50000.0	3813.	1.153	4396.9	300.
25.00	1.500	50000.0	2542.	1.267	3220.7	268.
12.50	1.500	50000.0	1271.	1.715	2179.7	222.

1995 NFA Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	13995.	6350.	28.29
WING	3994.	1812.	8.07
FUSELAGE	4648.	2108.	9.40
HORIZONTAL TAIL	1333.	604.	2.69
VERTICAL TAIL	1029.	467.	2.08
REACTION CONTROL SYSTEM	0.	0.	0.00
WING FOLD	150.	68.	0.30
INTERNAL BAY STRUCTURE	600.	272.	1.21
ALIGHTING GEAR	2241.	1017.	4.53
PROPULSION	5861.	2659.	11.85
ENGINES (1)	4296.	1949.	8.68
FUEL SYSTEM	1565.	710.	3.16
FIXED EQUIPMENT	4893.	2220.	9.89
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	719.	326.	1.45
ELECTRICAL	544.	247.	1.10
AVIONICS	1652.	749.	3.34
INSTRUMENTATION	94.	43.	0.19
DE-ICE/AIR CONDITION	610.	277.	1.23
AUXILIARY GEAR	200.	91.	0.40
FURNISH. + EQPT.	375.	170.	0.76
FLIGHT CONTROLS	1563.	709.	3.16
FUEL	20371.	9240.	41.18
PAYLOAD	4351.	1974.	8.79
FLIGHT CREW (1)	180.	82.	0.36
ARMAMENT	612.	278.	1.24
AMMUNITION	287.	130.	0.58
LONG RANGE MISSILES	1974.	895.	3.99
LRM PYLONS & LAUNCHERS	700.	318.	1.41
SHORT RANGE MISSILES	398.	181.	0.80
SRM LAUNCHERS	200.	91.	0.40
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	49471.	22440.	100.00

1995 STOVL SUMMARY

Standard English Units

GENERAL		FUSELAGE			WING	HTAIL	VTAIL
TOGW	46276.	LENGTH	56.1	AREA	724.1	221.1	87.9
W/S	63.9	DIAMETER	5.6	WETTED AREA	1072.9	247.2	176.0
T/W DRY	0.77	VOLUME	1051.1	SPAN	38.1	21.0	9.4
T/W A/B	1.22	WETTED AREA	830.0	L.E. SWEEP	42.1	42.1	53.6
CREW	1	FINENESS RATIO	10.0	C/4 SWEEP	24.3	24.3	24.3
N(Z) ULT	13.5			ASPECT RATIO	2.00	2.00	1.00
				TAPER RATIO	0.05	0.05	0.05
				T/C ROOT	0.05	0.05	0.05
				T/C TIP	0.04	0.04	0.04
				ROOT CHORD	36.2	20.0	17.9
				TIP CHORD	1.8	1.0	0.9
				M.A. CHORD	24.2	13.4	11.9
				LOC. OF L.E.	16.2	43.3	38.2

ENGINE		WEIGHTS	W	%
NUMBER	1			
LENGTH	16.9	STRUCT.	11722.	25.3
DIAM.	3.9	PROPUL.	7040.	15.2
WEIGHT	5069.1	FIX. EQ.	4768.	10.3
TSLS	35731.	FUEL	18395.	39.8
SFCSLS	0.75	PAYLOAD	4351.	9.40

MISSION SUMMARY

PHASE	MACH	ALT	FUEL	TIME	DIST	L/D	THRUST	SFC	Q
TAKEOFF	0.00	0.	748.	10.5					
CRUISE	0.85	100.	5579.	26.7	250.0	4.87	8598.0	1.452	1066.4
CLIMB	0.92	35000.	578.	1.8	15.2	8.97	11287.2	0.924	293.4
LOITER	0.79	36321.	3794.	60.0	454.3	8.71	4298.6	0.855	207.3
CLIMB	0.89	50000.	582.	1.4	9.9	7.52	10678.6	1.933	135.7
ACCEL	1.50	50000.	670.	1.4	16.7	3.62	19327.8	2.019	383.7
CRUISE	1.50	50000.	1837.	10.5	150.0	3.53	9395.0	1.113	383.7
COMBAT	1.50	50000.	709.	2.0	28.7	4.87	13186.1	1.612	383.7
CRUISE	0.91	41000.	2368.	46.0	400.0	9.12	3294.7	0.910	217.2
LOITER	0.30	100.	560.	10.0	33.1	8.11	3630.6	0.926	132.8

BLOCK TIME = 2.666 HR
BLOCK RANGE = 1360.2 NM

COMBAT PHASES

MACH	ALT	PS1G	NZS	CLS	CDS	ALS	NZI	PSI	CLI	CDI	ALI	CBE
1.50	50000.	0.	1.0	0.124	0.0342	2.5	6.3	-2373.	0.770	0.2352	15.0	0.
0.90	30000.	521.	3.8	0.553	0.1024	10.5	5.4	-569.	0.779	0.1965	15.0	3125.
1.50	50000.	446.	3.0	0.230	0.0473	4.6	6.7	-2083.	0.770	0.2352	15.0	53473.

1995 STOVL Geometry

	WING	H.TAIL	V.TAIL	CANARD	UNITS
PLAN AREA..........	724.1	221.1	87.9	0.0	(SQ.FT.)
SURFACE AREA.......	1072.9	247.2	176.0	0.0	(SQ.FT.)
VOLUME.............	433.7	98.1	34.8	0.0	(CU.FT.)
SPAN...............	38.056	21.028	9.376	0.000	(FT.)
L.E. SWEEP.........	42.138	42.138	42.138	0.000	(DEG.)
C/4 SWEEP..........	24.341	24.341	24.341	0.000	(DEG.)
T.E. SWEEP.........	-42.138	-42.138	-42.138	0.000	(DEG.)
ASPECT RATIO	2.000	2.000	1.000	0.000	
ROOT CHORD.........	36.244	20.026	17.859	0.000	(FT.)
ROOT THICKNESS.....	21.746	12.016	10.716	0.000	(IN.)
ROOT T/C	0.050	0.050	0.050	0.000	
TIP CHORD..........	1.812	1.001	0.893	0.000	(FT.)
TIP THICKNESS......	0.870	0.481	0.429	0.000	(IN.)
TIP T/C	0.040	0.040	0.040	0.000	
TAPER RATIO	0.050	0.050	0.050	0.000	
MEAN AERO CHORD....	24.220	13.383	11.934	0.000	(FT.)
LE ROOT AT.........	16.165	43.318	38.198	0.000	(FT.)
C/4 ROOT AT........	25.226	48.325	42.663	0.000	(FT.)
TE ROOT AT.........	52.409	63.344	56.057	0.000	(FT.)
LE M.A.C. AT.......	22.177	46.640	41.160	0.000	(FT.)
C/4 M.A.C. AT......	28.232	49.986	44.144	0.000	(FT.)
TE M.A.C. AT.......	46.397	60.023	53.095	0.000	(FT.)
Y M.A.C. AT........	6.645	3.671	3.274	0.000	
LE TIP AT..........	33.381	52.831	46.681	0.000	(FT.)
C/4 TIP AT.........	33.834	53.081	46.904	0.000	(FT.)
TE TIP AT..........	35.193	53.832	47.574	0.000	(FT.)
ELEVATION..........	0.252	-0.280	2.803	0.000	(FT.)
VOLUME COEFF.		0.274	0.051	0.000	

AIRCRAFT WEIGHT = 46272.629 Lbs.
AIRCRAFT VOLUME = 1652.424 Cu.Ft.
AIRCRAFT DENSITY = 28.003 Lbs./Cu.Ft.

1995 STOVL Mission Performance

PHASE	M	H	CL	ALPHA	WFUEL	TIME	VEL
	SFC(I)	THRUST(I)	CD	GAMMA	W	WA	Q
	SFC(U)	THRUST(U)	CDINST	L/D	THR/THA	PR	X
CRUISE	0.85	100.	0.0542	0.96	5578.6	26.69	949.
	1.45	8598.	0.0111	0.00	39995.7	0.00	1066.
	0.00	24936.	0.0000	4.87	0.30	0.00	250.
CLIMB	0.92	35000.	0.1972	3.59	578.4	1.80	892.
	0.92	11287.	0.0220	9.65	39417.3	0.00	293.
	0.00	0.	0.0000	8.97	1.00	0.00	15.
LOITER	0.79	36321.	0.2495	4.77	3794.3	60.00	765.
	0.85	4299.	0.0286	0.00	35623.0	0.00	207.
	0.00	6951.	0.0000	8.71	0.45	0.00	454.
CLIMB	0.89	50000.	0.3483	6.60	582.3	1.38	863.
	1.93	10679.	0.0463	10.06	35040.7	0.00	136.
	0.00	0.	0.0000	7.52	1.97	0.00	10.
ACCEL	1.50	50000.	0.1240	2.52	670.0	1.44	1452.
	2.02	19328.	0.0342	0.00	34370.8	0.00	384.
	0.00	27135.	0.0000	3.62	2.03	0.00	17.
CRUISE	1.50	50000.	0.1193	2.43	1837.4	10.46	1452.
	1.11	9395.	0.0338	0.00	32533.0	0.00	384.
	0.00	17174.	0.0000	3.53	0.99	0.00	150.
COMBAT	1.50	50000.	0.2304	4.60	708.6	2.00	1452.
	1.61	13186.	0.0473	1.07	31824.4	0.00	384.
	0.00	27135.	0.0000	4.87	1.39	0.00	29.
CRUISE	0.91	41000.	0.1909	3.48	2367.6	45.98	881.
	0.91	3295.	0.0209	0.00	29456.8	0.00	217.
	0.00	5918.	0.0000	9.12	0.39	0.00	400.
LOITER	0.30	100.	0.3062	6.04	560.3	10.00	335.
	0.93	3631.	0.0377	0.00	28896.4	0.00	133.
	0.00	5329.	0.0000	8.11	0.11	0.00	33.

FUEL SUMMARIES

MISSION FUEL = 17376.
RESERVE FUEL = 869.
TRAPPED FUEL = 150.

TOTAL FUEL = 18395.

1995 STOVL Maneuver Performance

	CONDITIONS	PS	NZ	TDOT	RADIUS	ALPHA	CL	CD
M= 1.50	1 G FLIGHT	-0.1	1.00	0.00	0.	2.52	0.124	0.0342
H=50000.	SUSTAINED	0.0	1.00	0.06	1465095.	3.33	0.165	0.0395
	MAX. INST.	-2372.9	6.30	7.89	10539.	15.00	0.770	0.2352
	COMBAT ENERGY =-0.455245E+00							
M= 0.90	1 G FLIGHT	520.8	1.00	0.00	0.	2.68	0.151	0.0168
H=30000.	SUSTAINED	0.0	3.81	7.57	6775.	10.55	0.553	0.1024
	MAX. INST.	-568.9	5.36	10.83	4736.	15.00	0.779	0.1965
	COMBAT ENERGY = 0.312491E+04							
M= 1.50	1 G FLIGHT	445.6	1.00	0.00	0.	2.39	0.117	0.0336
H=50000.	SUSTAINED	0.0	2.99	3.57	23288.	4.60	0.230	0.0473
	MAX. INST.	-2083.1	6.73	8.45	9843.	15.00	0.770	0.2352
	COMBAT ENERGY = 0.534733E+05							

1995 STOVL Aerodynamics

Mach = 0.80 Altitude = 40000.

Parasite Drag		Induced Drag					
Friction	.0090	Alpha	Cl	Cd	L/D	Cm	e
Body	.0026	0.0	0.000	0.0104	0.0	0.000	0.00
Wing	.0039	2.0	0.111	0.0139	8.0	-.005	0.56
Strakes	.0000	3.0	0.162	0.0179	9.0	-.009	0.55
H. Tail	.0010	4.0	0.211	0.0234	9.0	-.013	0.55
V. Tail	.0014	5.0	0.262	0.0305	8.6	-.017	0.54
Canard	.0000	6.0	0.312	0.0392	8.0	-.022	0.54
Pods	.0000	8.0	0.415	0.0615	6.7	-.032	0.54
Engine	.0000	10.0	0.518	0.0906	5.7	-.044	0.53
Cowl	.0000	12.0	0.620	0.1263	4.9	-.058	0.53
Boattail	.0000	15.0	0.770	0.1920	4.0	-.082	0.52
Interference	.0014						
Wave	.0000						
External	.0000			Slope Factors			
Tanks	.0000			ClAlpha			0.0513
Bombs	.0000			Cdl^.5Alpha			0.0284
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0104						

Mach = 1.50 Altitude = 50000.

Parasite Drag		Induced Drag					
Friction	.0077	Alpha	Cl	Cd	L/D	Cm	e
Body	.0022	0.0	0.000	0.0288	0.0	0.000	0.00
Wing	.0034	2.0	0.098	0.0322	3.0	-.016	0.45
Strakes	.0000	3.0	0.148	0.0365	4.1	-.024	0.45
H. Tail	.0008	4.0	0.199	0.0427	4.7	-.032	0.45
V. Tail	.0012	5.0	0.251	0.0507	4.9	-.040	0.46
Canard	.0000	6.0	0.303	0.0606	5.0	-.049	0.46
Pods	.0000	8.0	0.408	0.0861	4.7	-.067	0.46
Engine	.0000	10.0	0.514	0.1193	4.3	-.086	0.46
Cowl	.0000	12.0	0.618	0.1601	3.9	-.104	0.46
Boattail	.0000	15.0	0.770	0.2352	3.3	-.132	0.46
Interference	.0003						
Wave	.0208						
External	.0000			Slope Factors			
Tanks	.0000			ClAlpha			0.0514
Bombs	.0000			Cdl^.5Alpha			0.0303
Stores	.0000						
Extra	.0000						
Camber	.0000						
Cdmin	.0288						

1995 STOVL Propulsion

PHYSICAL ATTRIBUTES		HOVER PERFORMANCE	DRY	WET	
ESF =	1.336	T =	35650.	35650.	lb
WEIGHT =	5069.139	T/W =	7.033	7.033	
LENGTH =	16.875	FFLOW =	462.	462.	lb/hr
DIAM =	3.895	SFC =	0.778	0.778	lb/(lb-hr)
		TF/T =	0.000	0.000	

POWER	MACH	ALT (ft)	THRUST (lb)	SFC	FFLOW (lb/hr)	WAF (lb/sec)
100.00	0.000	0.0	56610.	1.770	100199.9	421.
100.00	0.000	0.0	35731.	0.754	26941.4	421.
87.50	0.000	0.0	31265.	0.731	22860.2	387.
75.00	0.000	0.0	26798.	0.701	18778.9	357.
62.50	0.000	0.0	22332.	0.661	14756.1	328.
50.00	0.000	0.0	17866.	0.655	11709.2	279.
37.50	0.000	0.0	13399.	0.646	8662.3	240.
25.00	0.000	0.0	8933.	0.629	5615.3	209.
12.50	0.000	0.0	4466.	0.690	3082.4	136.
100.00	0.600	30000.0	21249.	1.936	41137.7	421.
100.00	0.600	30000.0	11144.	0.829	9238.4	421.
87.50	0.600	30000.0	9751.	0.811	7909.4	393.
75.00	0.600	30000.0	8358.	0.787	6580.4	367.
62.50	0.600	30000.0	6965.	0.777	5411.4	330.
50.00	0.600	30000.0	5572.	0.779	4341.0	291.
37.50	0.600	30000.0	4179.	0.783	3270.6	259.
25.00	0.600	30000.0	2786.	0.821	2286.5	215.
12.50	0.600	30000.0	1393.	0.958	1334.4	176.
100.00	0.900	30000.0	26989.	1.948	52578.4	421.
100.00	0.900	30000.0	13775.	0.944	12998.9	421.
87.50	0.900	30000.0	12053.	0.934	11262.0	395.
75.00	0.900	30000.0	10331.	0.922	9525.1	372.
62.50	0.900	30000.0	8609.	0.926	7972.4	340.
50.00	0.900	30000.0	6887.	0.955	6574.2	304.
37.50	0.900	30000.0	5165.	1.002	5176.0	274.
25.00	0.900	30000.0	3444.	1.116	3844.7	237.
12.50	0.900	30000.0	1722.	1.503	2588.3	198.
100.00	1.500	50000.0	19328.	2.019	39013.8	421.
100.00	1.500	50000.0	9498.	1.116	10596.0	421.
87.50	1.500	50000.0	8311.	1.099	9130.6	397.
75.00	1.500	50000.0	7124.	1.090	7762.9	371.
62.50	1.500	50000.0	5936.	1.077	6395.3	347.
50.00	1.500	50000.0	4749.	1.098	5216.4	313.
37.50	1.500	50000.0	3562.	1.153	4107.5	280.
25.00	1.500	50000.0	2375.	1.267	3008.8	250.
12.50	1.500	50000.0	1187.	1.715	2036.2	207.

1995 STOVL Weights

COMPONENT	POUNDS	KILOGRAMS	PERCENT
AIRFRAME STRUCTURE	11722.	5318.	25.33
WING	3741.	1697.	8.08
FUSELAGE	3881.	1760.	8.39
HORIZONTAL TAIL	868.	394.	1.87
VERTICAL TAIL	757.	343.	1.64
REACTION CONTROL SYSTEM	112.	51.	0.24
WING FOLD	150.	68.	0.32
INTERNAL BAY STRUCTURE	600.	272.	1.30
ALIGHTING GEAR	1613.	731.	3.48
PROPULSION	7040.	3194.	15.21
ENGINES (1)	5586.	2534.	12.07
FUEL SYSTEM	1454.	659.	3.14
FIXED EQUIPMENT	4768.	2163.	10.30
(COMPONENTS BELOW DO NOT INCLUDE TECH FACTOR=0.85)			
HYD. + PNEU.	672.	305.	1.45
ELECTRICAL	544.	247.	1.18
AVIONICS	1652.	749.	3.57
INSTRUMENTATION	94.	43.	0.20
DE-ICE/AIR CONDITION	610.	277.	1.32
AUXILIARY GEAR	200.	91.	0.43
FURNISH. + EQPT.	375.	170.	0.81
FLIGHT CONTROLS	1462.	663.	3.16
FUEL	18395.	8344.	39.75
PAYLOAD	4351.	1974.	9.40
FLIGHT CREW (1)	180.	82.	0.39
ARMAMENT	612.	278.	1.32
AMMUNITION	287.	130.	0.62
LONG RANGE MISSILES	1974.	895.	4.27
LRM PYLONS & LAUNCHERS	700.	318.	1.51
SHORT RANGE MISSILES	398.	181.	0.86
SRM LAUNCHERS	200.	91.	0.43
EXTERNAL TANKS	0.	0.	0.00
TOTAL WEIGHT	46276.	20991.	100.00

Appendix B – SSF DOC Mission Definitions

<u>Payload</u>
2 Long-Range, Air-to-Air Missiles
2 Short-Range, Air-to-Air Missiles
Gun and Ammunition

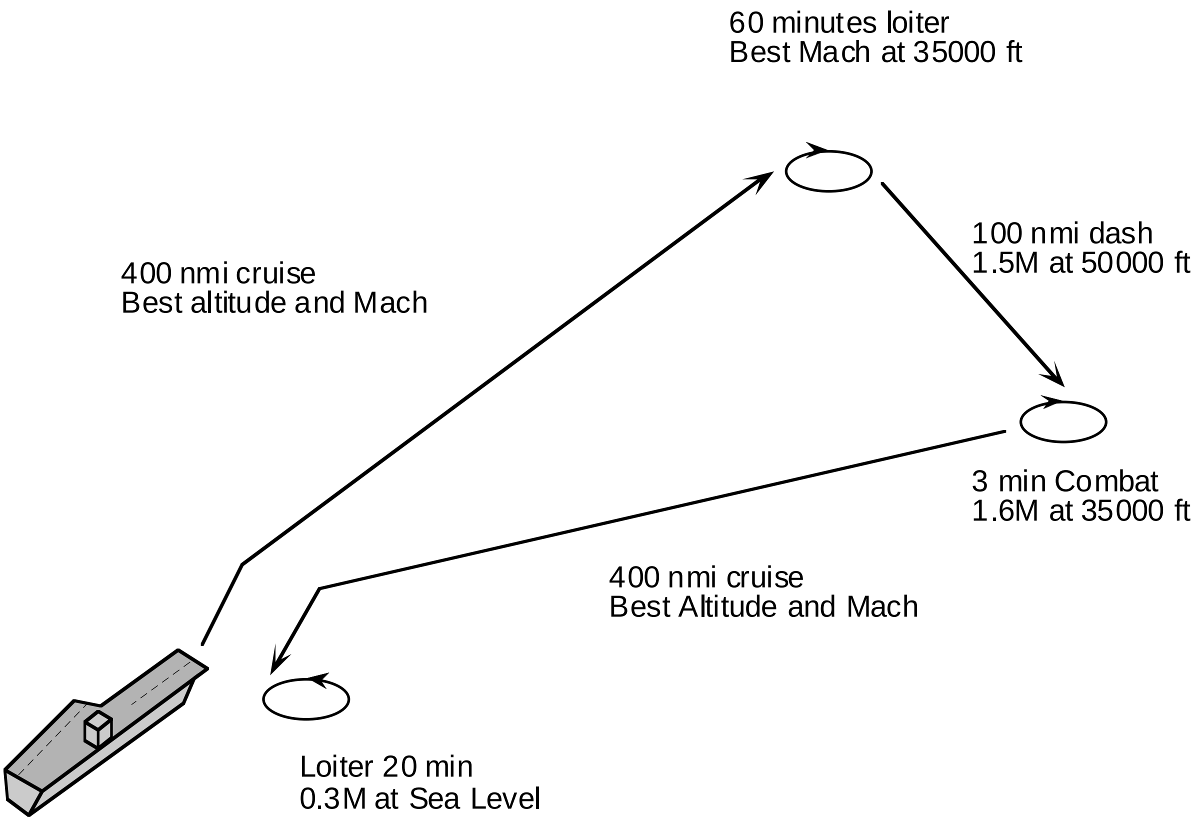

Figure B1. Combat Air Patrol fallout mission.

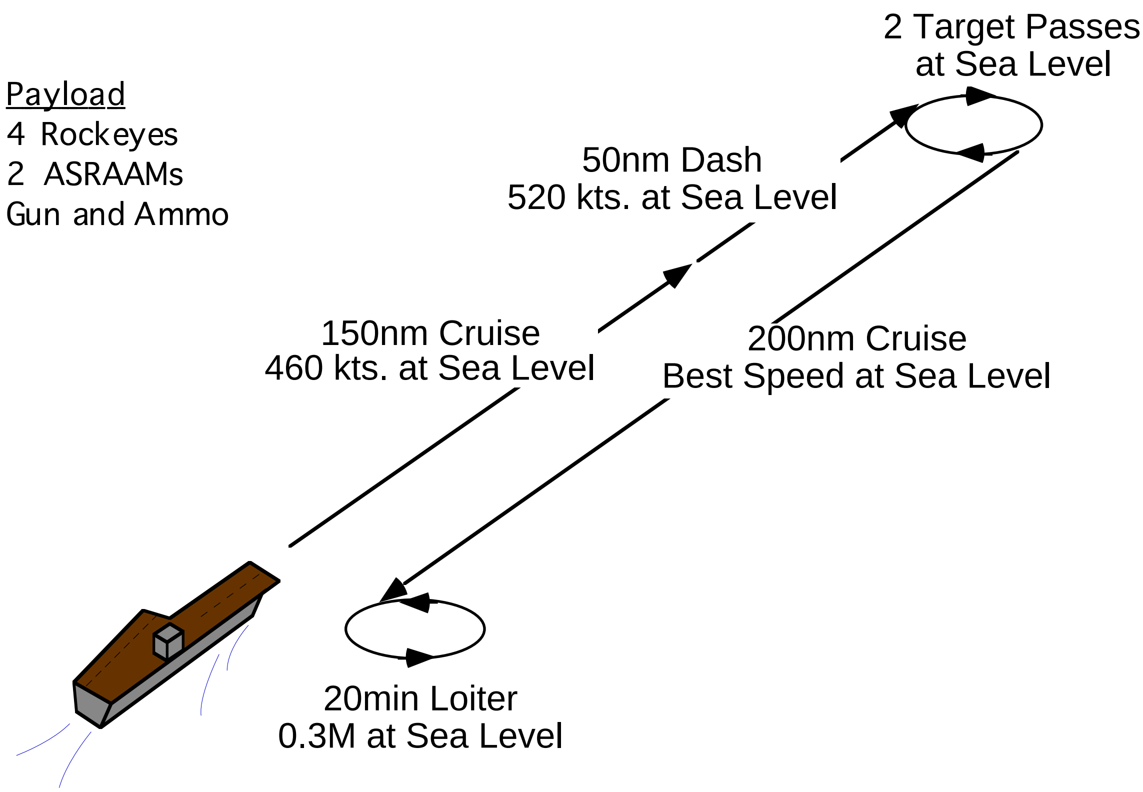

Figure B2. CAS fallout mission.

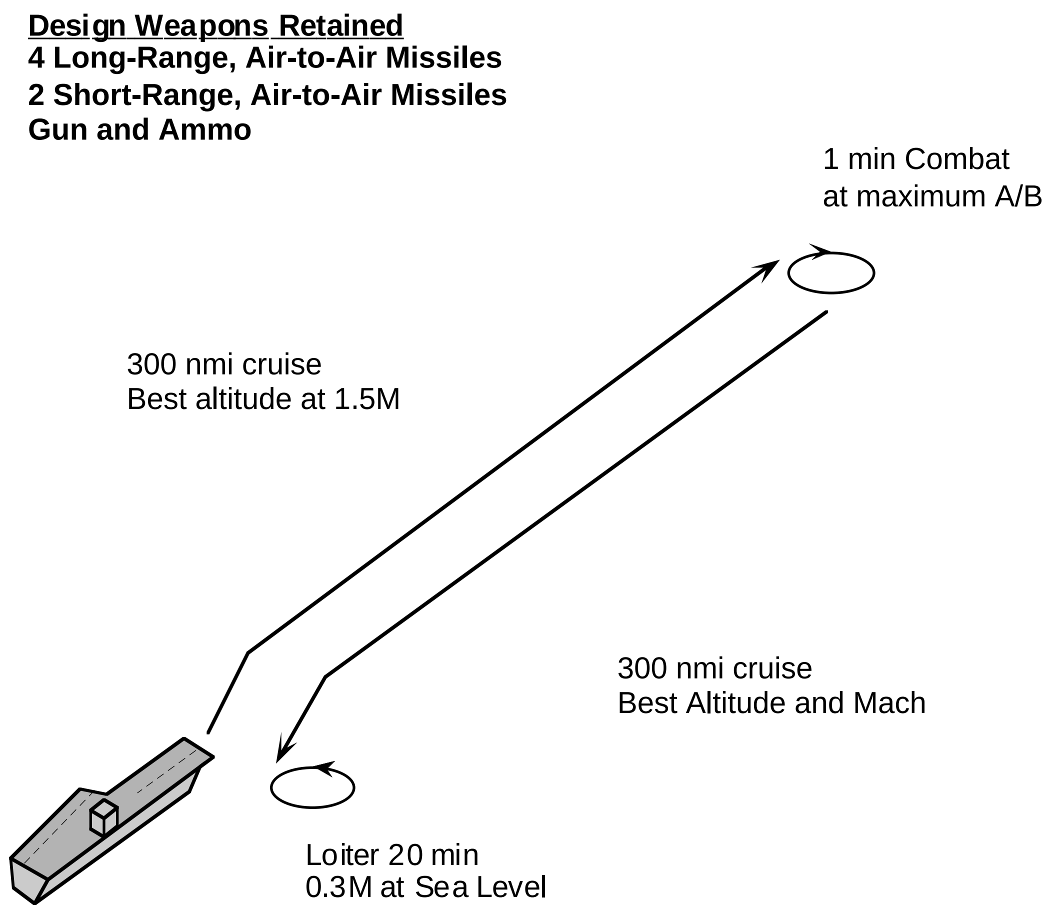

Figure B3. Deck Launched Intercept fallout mission.

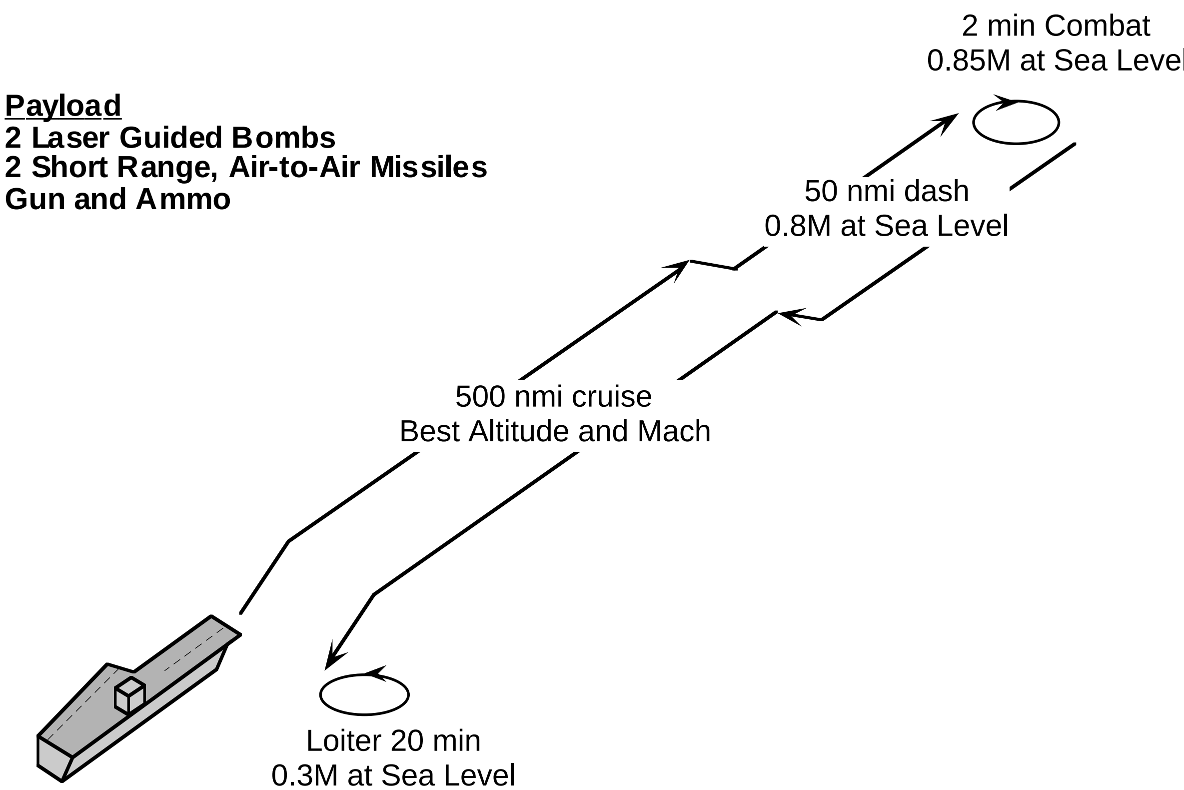

Figure B4. Interdiction fallout mission.

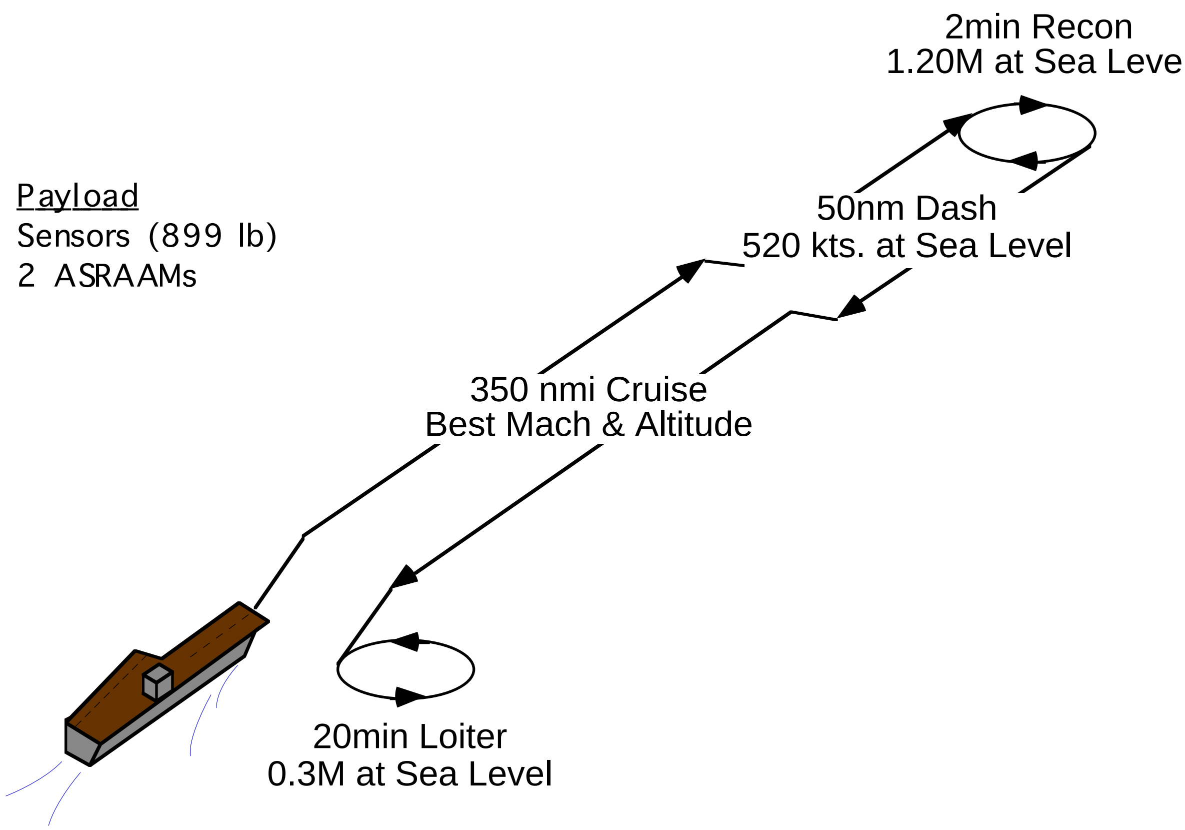

Figure B5. Reconnaissance fallout mission.

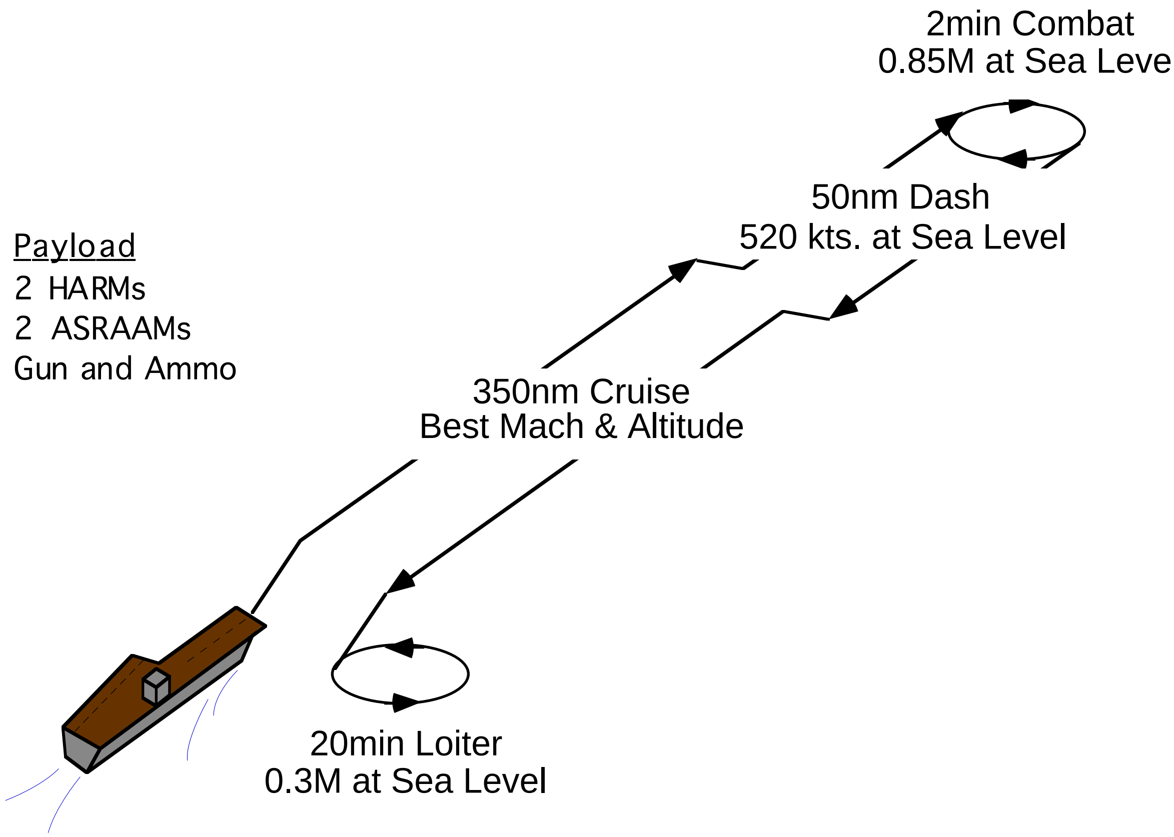

Figure B6. SEAD fallout mission.

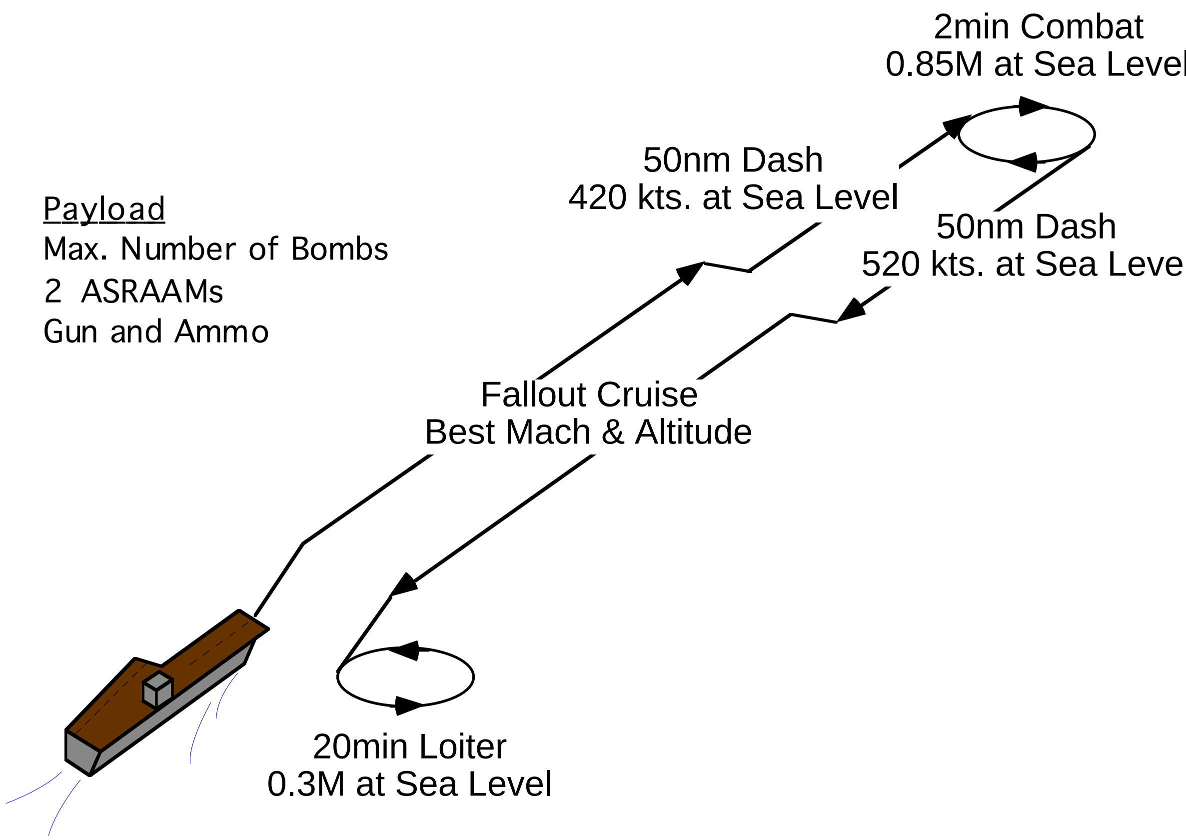

Figure B7. Strike fallout mission.

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13. ABSTRACT ***(Maximum 200 words)***

This report describes an aircraft database which was developed to identify technology trends for several classes of tactical naval aircraft, including subsonic attack, supersonic fighter, and supersonic multimission aircraft classes. This study used an approach that was internally consistent among designs, whereas most comparative studies require "normalizing" aircraft that are developed by different design groups using different methods and databases. All aircraft were evaluated in two technology timeframes and were sized with consistent methods which allow the aircraft to be directly compared in operational utility or cost analysis trends. The multimission aircraft were compared to evaluate the effect of technology and mission requirements. This comparison highlights the effect of changing technology and mission requirements on the Short Takeoff and Vertical Landing (STOVL) aircraft and addresses the impact of aircraft navalization. The subsonic attack aircraft evaluation compared flying wing to conventional designs, one- versus two-place crew, two versus four bombs, and internal versus external weapon carriage.

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