

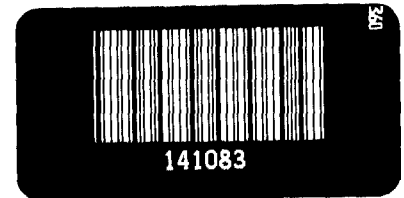
GAO

Report to the Chairman, Committee on
Armed Services, House of
Representatives

March 1990

AIRCRAFT DEVELOPMENT

Navy's Participation in Air Force's Advanced Tactical Fighter Program



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Washington, D.C. 20548

**National Security and
International Affairs Division**

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March 7, 1990

The Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report, which was prepared at your request, examines the Navy's involvement and financial participation in the Air Force's Advanced Tactical Fighter program and the aircraft design considerations to accommodate the Navy's requirements.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after its issue date. At that time we will send copies to appropriate congressional committees; the Secretaries of Defense, the Air Force, and the Navy; the Director, Office of Management and Budget; and other interested parties.

Please contact me at (202) 275-4268 if you or your staff have any questions concerning this report. Other major contributors to this report are listed in appendix II.

Sincerely yours,

A handwritten signature in black ink that reads 'Nancy R. Kingsbury'.

Nancy R. Kingsbury
Director
Air Force Issues

Executive Summary

Purpose

The Air Force is developing the Advanced Tactical Fighter (ATF) to replace its land-based F-15 air superiority fighter, and the Navy is evaluating a variant of the ATF as a possible replacement for its carrier-based F-14. Since World War II no U.S. fighter aircraft developed to operate from land has been successfully adapted to operate from carriers and procured by both the Air Force and the Navy.

The House Committees on Armed Services and on Appropriations are concerned about the Navy's commitment to the aircraft. The Chairman, House Committee on Armed Services, asked GAO to examine the Navy's involvement and financial participation in the program and the design considerations for meeting the Navy's requirements.

Background

The ATF and the Navy variant are to be twin-engine, all-weather aircraft capable of day or night operations over land or sea. Both are expected to have many new or expanded capabilities, such as maintenance of supersonic speeds over long distances and lower detectability through the use of stealth technologies.

Two airframe contractor teams and two engine contractors are involved in the demonstration and validation of the ATF and the Navy variant. Each airframe contractor team is building two prototype ATF aircraft, a ground-based avionics prototype, and an avionics test bed to be flown in a commercial-type aircraft. The engines are to be demonstrated in each of the airframe contractor's prototype aircraft.

The Air Force estimates that its acquisition costs will be \$67.2 billion for 750 aircraft; the Navy estimates that its acquisition costs will be \$66.1 billion for 618 aircraft.

In March 1986 the Secretaries of the Air Force and the Navy agreed to evaluate the potential use of each service's advanced aircraft to meet their future aircraft requirements. This led to the Navy's participation in the ATF program. Similarly, the Navy is developing the Advanced Tactical Aircraft to replace its A-6 surface attack aircraft, and the Air Force is evaluating a variant of that aircraft to replace its F-111 surface attack aircraft.

The Congress insisted that the Air Force and the Navy coordinate their advanced aircraft development programs closely to achieve commonality and cross-service use of their aircraft. In 1988 the Navy contracted with the competing contractors to develop preliminary specifications for

its fighter and to assess the suitability of the aircraft for use on aircraft carriers.

Results in Brief

Although the Navy's involvement and financial participation in the ATF program has increased over the last few years, the Navy is uncertain if it will continue development and eventual procurement of the aircraft. The Navy's major concern is whether the airframe design derived from the ATF is suitable for carrier operations. The extent to which the contractor teams can satisfy the Navy's requirements from a derivative design is a key factor in the Navy's continued involvement in the program.

The Air Force and the Navy expect their fighters' airframes to have some commonality, even though the services have different requirements for their aircraft. The Navy's fighter must have a stronger structure and excellent low-speed flying qualities to be compatible with carrier operations. Even though achieving airframe commonality may be difficult, the Air Force and the Navy plan to select the same airframe and engine contractors and expect the engines and avionics to be highly common.

Principal Findings

Navy's Involvement

Since 1986 the Navy's participation has grown from monitoring the ATF's early development efforts to establishing a Navy ATF program office and planning for the joint selection of the airframe and engine contractors.

The Navy ATF program office, established in 1988, is colocated with the ATF program office. At the Congress' direction, the Navy signed an agreement in 1988 with the Air Force that provided for the Navy's participation in selecting the Air Force's full-scale development airframe and engine contractors. The agreement provided that the Navy's requirements will be major criteria for selecting the contractors.

Navy's Financial Participation

Although the Navy's initial financial commitment to the ATF variant was at the Congress' insistence, the Navy has budgeted a total of \$724 million for the aircraft for fiscal years 1990 through 1994. To date, the

Navy's financial commitment has been for studies on the Navy's unique requirements and designs.

The Navy does not plan to build a prototype aircraft during its demonstration and validation phase. The Navy has contracted with the competing contractor teams to develop preliminary Navy specifications and designs that are suitable for carrier operations. The Air Force plans to begin full-scale development in July 1991. At that time the Navy will have only a preliminary aircraft design and plans to continue its demonstration and validation effort. The services will have to renew their contracts because neither has contract obligations beyond December 1990.

Basing and Mission Affect Aircraft Design

The ATF is designed to operate from fixed land bases, whereas the Navy variant must operate from the pitching and rolling deck of an aircraft carrier at sea. This requires that the Navy variant be equipped with a stronger landing gear, an arresting tail hook, and a stronger and heavier structure to withstand the stress of carrier catapult takeoffs and arrested landings. However, the Navy variant must not exceed the size and weight limits imposed by a carrier's elevator, catapult, and arresting equipment. Additionally, the Navy variant must be configured and aerodynamically designed to provide the pilot with adequate visibility and the aircraft with unusually good low-speed flying qualities to make a safe carrier approach and landing.

The differences in the Air Force and Navy missions also affect the Navy variant's design. Even though both services require an air superiority fighter, the Navy's fleet air defense mission requires that its ATF be capable of attacking enemy bombers before they can launch their cruise missiles. Thus, the Navy variant must be capable of using long-range weapons while operating for extended periods at long distances from the fleet. This requires an aircraft with a larger fuel capacity and longer range sensors and weapons than envisioned for the ATF.

The exact effect the preceding accommodations will have on aircraft commonality is uncertain at this time. However, both services expect the engines, avionics, and subsystems to provide the greatest potential for commonality and the airframe to provide the least. According to the Air Force, the engines and avionics could represent 44 percent of the ATF's unit flyaway cost. Historically, the services have been able to achieve commonality for similar major components.

Executive Summary

Recommendations

GAO is not making recommendations in this report.

Agency Comments

The Department of Defense agreed with GAO's findings. (See app. I.)

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Abbreviations

ATF	Advanced Tactical Fighter
GAO	General Accounting Office
NATF	Navy Advanced Tactical Fighter

Introduction

In the early 1980s the Air Force and the Navy initiated aircraft development programs to replace existing aircraft. The Air Force is developing the Advanced Tactical Fighter (ATF) for its air superiority mission to replace the F-15. The Navy is developing the Advanced Tactical Aircraft for its surface attack mission to replace the A-6. Because the Air Force and the Navy have similar air superiority and surface attack missions, the Secretaries of the Air Force and the Navy signed agreements in early 1986 to evaluate the potential use of each service's advanced aircraft. The Congress insisted that the Air Force and the Navy coordinate their development activities closely to achieve commonality in their advanced aircraft. This report discusses the ATF and the Navy ATF (NATF). We do not discuss the Advanced Tactical Aircraft program because it is highly classified.

Aircraft Design and Mission Goals

The ATF is to be a land-based, single-seat, twin-engine fighter armed with AIM-120A Advanced Medium Range Air-to-Air Missiles, AIM-9 Sidewinder Missiles, and a 20-millimeter gun. The ATF's primary mission is to maintain air superiority, which means that it will dominate the air battle so that friendly air and surface forces can conduct operations without prohibitive interference by enemy air forces.

The NATF is to be a carrier-based, twin-engine fighter that can be armed with the ATF's complement of weapons, the Navy's Advanced Air-to-Air Missile, and certain Navy air-to-surface weapons, such as the AGM-88 High Speed Anti-Radiation Missile. The Navy has not decided whether the NATF will be a single- or two-seat aircraft. This decision will be based on contractor studies of the difference in performance and mission effectiveness. The NATF's primary missions are fleet air defense and fighter support of friendly ground and tactical airborne forces.

The ATF and NATF are expected to be able to fight in all types of weather, during the day or night, and over land or sea. The design concepts of both aircraft include use of stealth technology, advanced materials, new engines, and an advanced, highly integrated avionics system. Both aircraft are expected to have new or expanded capabilities over existing fighters, including the ability to cruise at supersonic speeds over long distances without using fuel-inefficient afterburners; increased maneuverability; longer range; lower detectability; greatly improved reliability and maintainability; and the capability to detect, identify, and engage the enemy at ranges beyond the pilot's vision.

Status of Contractors' Efforts

Two airframe contractor teams and two engine contractors are involved in the demonstration and validation of the ATF and NATF. The team of Lockheed Corporation, Boeing Advanced Systems, and General Dynamics Corporation is competing with the team of Northrop Corporation and McDonnell Aircraft Company for the development and production of the airframe and avionics. General Electric Corporation and Pratt & Whitney Division, United Technologies Corporation, are competing for the development and production of the engines.

Each airframe contractor team is building two ATF prototype aircraft, a ground-based avionics prototype, and a flying avionics test bed to be flown in a commercial-type aircraft. The engines are to be demonstrated in each of the airframe contractor's prototype aircraft. Flight demonstrations are to begin in early 1990.

Each airframe contractor team is developing preliminary NATF specifications and designs as part of the NATF demonstration and validation. The specifications and designs are to retain many of the ATF's features, yet be suitable for carrier operations, and accommodate the Navy missions. The Navy does not plan to build NATF prototype aircraft during demonstration and validation.

After the flight demonstrations of the ATF prototypes, the airframe contractor teams are to submit proposals for the full-scale development of the ATF and proposals for the continued demonstration and validation of the NATF. The proposals are also to include budgetary data for the subsequent production of the ATF and subsequent full-scale development and production of the NATF. The Air Force and the Navy plan to select the same airframe contractor team and engine contractor to continue development of the ATF and the NATF.

The Air Force and the Navy have program offices colocated at Wright-Patterson Air Force Base, Ohio.

Cost of Aircraft Programs

The Air Force estimates that the ATF's acquisition costs will total \$67.2 billion in escalated dollars. This estimate includes \$13.5 billion for research, development, test, and evaluation and \$53.7 billion for procurement of 750 aircraft. The Navy estimates that the NATF's acquisition costs will total \$66.1 billion in escalated dollars. This estimate includes \$8.5 billion for research, development, test, and evaluation and \$57.6 billion for procurement of an estimated 618 aircraft. The Navy plans to

revise its cost estimate as the NATF designs are refined by the contractors.

Congressional Direction and Concerns

The Senate Committee on Armed Services report on the National Defense Authorization Act for fiscal year 1987 stated that

“Since the Navy must eventually replace the F-14 as well as the A-6, and the Air Force must eventually replace its F-111s along with its F-15s, the committee believes it is essential that the designs selected for the ATF and ATA [Advanced Tactical Aircraft] anticipate these additional cross-service requirements.”

Further, the National Defense Authorization Act for fiscal years 1988 and 1989 made the Air Force’s use of fiscal year 1988 funds conditional on its certification that the ATF designs

“are capable of accepting physical and structural modifications necessary to satisfy fully the requirements of the Navy concerning catapults and arresting gear, and ... that a major source selection criteria for full scale development and production will be the extent to which the contractor’s proposals for the Navy-variant of the advanced tactical fighter meets fully the requirements of the Navy.”

Similar congressional direction on common and fully integrated avionics for the ATF, Advanced Tactical Aircraft, and Army’s LHX helicopter is included in other legislative materials.

The House Committees on Armed Services and on Appropriations are concerned about the Navy’s commitment to the NATF. The Committee on Appropriations also questioned whether the relative funding levels in fiscal year 1990 between the Navy and Air Force for the ATF indicate a serious commitment to joint use.

Objectives, Scope, and Methodology

The Chairman, House Committee on Armed Services, requested that we examine the Navy’s involvement and financial participation in the ATF program and the design considerations for meeting the Navy’s requirements.

To determine the Navy’s involvement and financial participation in the ATF program, we reviewed and compared legislation and congressional testimony with the Navy’s agreements, contracts, cost estimates, and other documents. To determine the Navy’s design considerations, we obtained data, studies, and analyses from officials of the Departments of Defense, the Air Force, and the Navy in Washington, D.C.; the Air

Force and the Navy System Program Offices at Wright-Patterson Air Force Base, Ohio; and the two competing ATF contractor teams of Lockheed/General Dynamics/Boeing and Northrop/McDonnell Douglas.

We conducted our work from March to November 1989 in accordance with generally accepted government auditing standards. The Department of Defense provided written comments on a draft of this report and concurred with our findings.

Navy's Involvement and Financial Participation

Over the last few years, the Navy has increased its involvement in the ATF program. In 1988 it established a program office that is colocated with the ATF program office. It plans to participate in the next major decision in the ATF program, which is to select the airframe and engine contractors for the ATF's full-scale development phase. The selection decision is scheduled for April 1991, and the decision to begin full-scale development of the ATF is scheduled to follow in June 1991.

The Navy's major concern for the selection decision is whether a NATF airframe derived from the ATF design is suitable for carrier operations. The Navy will have only preliminary specifications and designs based on analysis and wind tunnel testing at the time of the selection. Provided a carrier-suitable design is selected in April 1991, the Navy plans to continue its demonstration and validation of the NATF at the same time the ATF begins full-scale development. The Air Force and the Navy will have to commit to new contracts because the present contracts obligate neither service beyond December 1990. However, the Air Force and the Navy are in the process of negotiating extensions of the present contracts through June 1991. Further, the Navy needs to make key milestone decisions before it ultimately commits to produce the NATF.

The Navy's financial commitment to date has been for contractor studies of unique requirements for the NATF airframe and modifications required to the ATF engines, avionics, and subsystems. Although the Navy's initial financial commitment to the NATF was at the Congress' insistence, it has budgeted a total of \$724 million for the program for fiscal years 1990 through 1994.

Navy's Agreements and Management Structure

In March 1986 the Secretary of the Navy committed the Navy to an evaluation of the ATF candidates. From 1986 until 1988, direct Navy involvement consisted of monitoring the Air Force's early demonstration and validation efforts. One Navy official was assigned to the ATF program office to monitor the efforts.

In March 1987 the Navy signed an agreement with the Air Force and the Army to identify and develop common avionics for the Navy's Advanced Tactical Aircraft, the Air Force's ATF, and the Army's LHX helicopter. This agreement established a committee composed of program management officials and avionics specialists from the three programs. The committee provides a forum to coordinate the avionics development activities and develop common avionics specifications and

standards for the three weapon systems and their derivatives. The committee's decisions require tri-service consensus.

At the Congress' direction, the Air Force and the Navy signed an agreement in January 1988 that provides for the Navy's participation in the Air Force's selection of the airframe and engine contractors for the ATF full-scale development phase. Also, at the Congress' direction, the agreement was written to specify that the Navy's requirements will be major criteria in selecting the aircraft design. Navy officials said that the aircraft's carrier suitability will be the major Navy issue during the selection process. The Navy will have representation at all levels in the selection process, and the NATF program manager does not expect any disagreement with the Air Force in the selection of the same contractors.

In August 1988 the Navy established a program office at Wright-Patterson Air Force Base to manage the NATF effort. The staff consists of a program manager, a deputy, and an assistant. An additional seven personnel located at the Naval Air Systems Command are dedicated to coordinating the efforts of functional specialists supporting the NATF program. Unlike the Air Force, which has functional specialists such as engineers assigned to the program office, the Navy requires the program manager to obtain support and assistance from specialists within the Naval Air Systems Command and other Navy activities. Because these specialists support a number of Navy programs, their efforts are not dedicated to the NATF and are provided as needed.

ATF and NATF Program Schedules

The ATF and NATF program schedules project key events and major milestone decisions at different points in time. Figures 2.1 and 2.2 show the schedules for the two programs.

Figure 2.1: Acquisition Schedule for the ATF

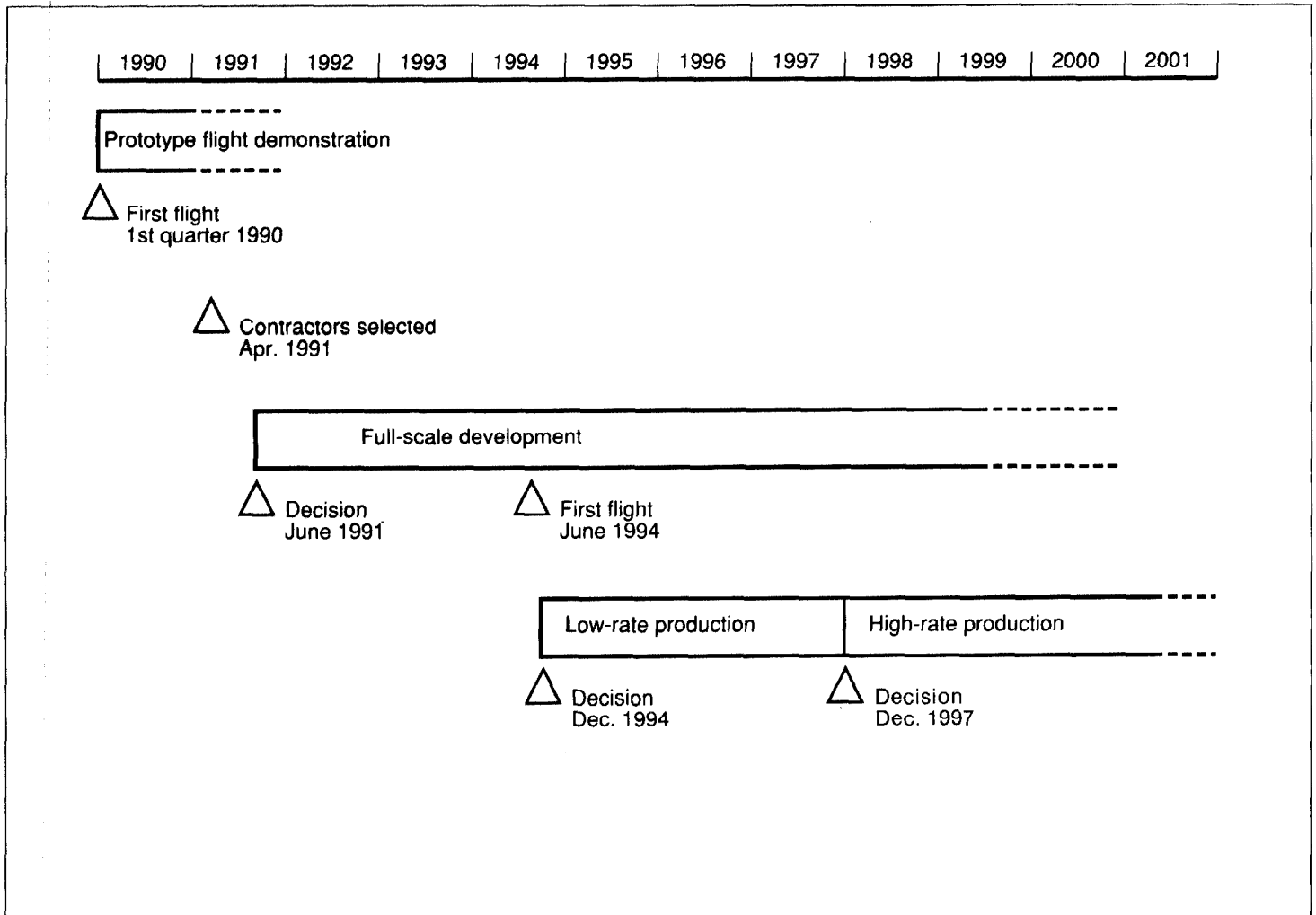
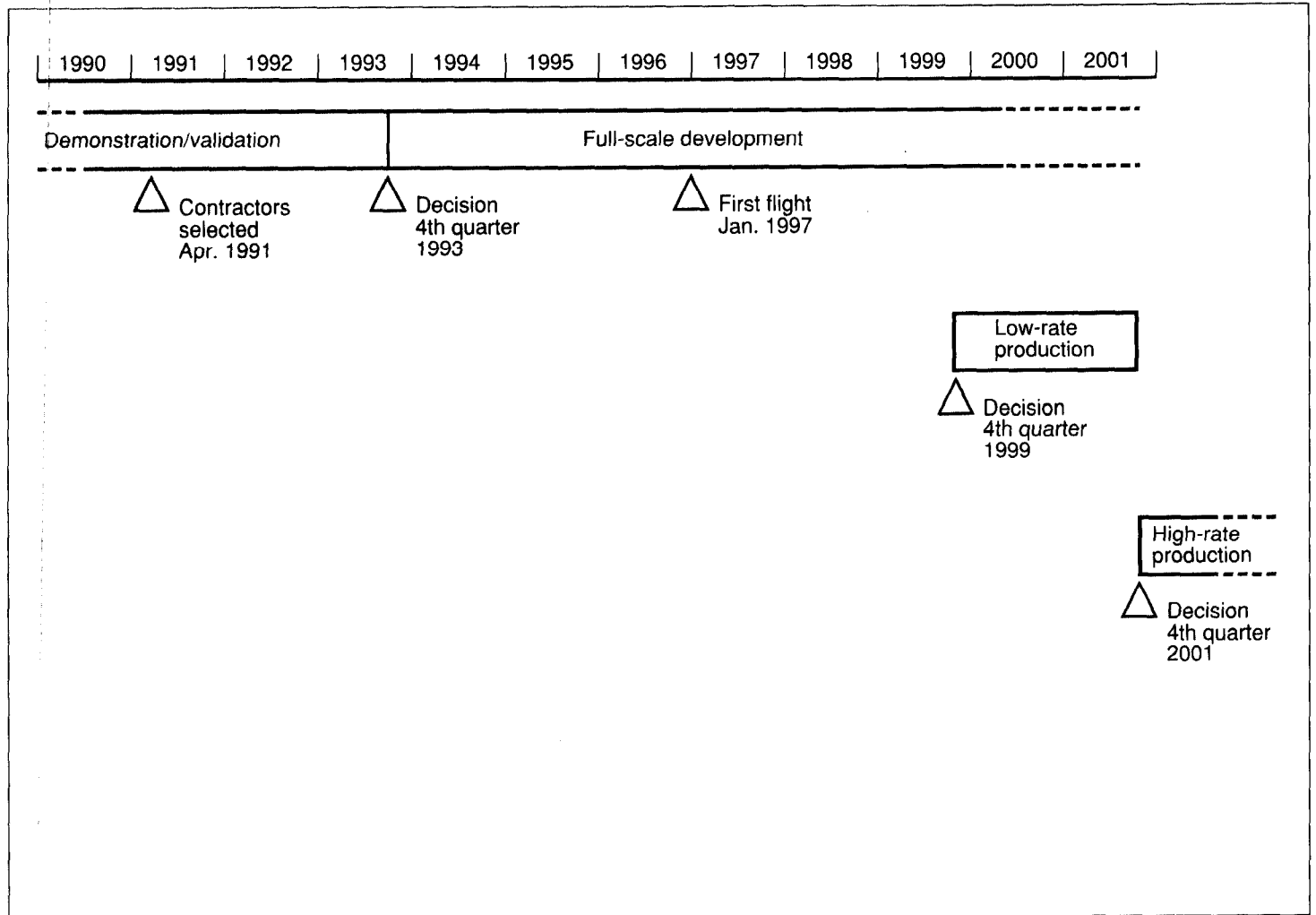


Figure 2.2: Acquisition Schedule for the NATF



The Air Force and the Navy are negotiating a 6-month extension of the current demonstration and validation contracts to reduce risks associated with full-scale development. The selection of the contractors is scheduled for April 1991, and the ATF's full-scale development milestone decision is to follow in June 1991. The Navy plans to begin the final stage of the NATF's demonstration and validation in July 1991 at the same time the Air Force is scheduled to award the ATF's full-scale development contracts. The Navy plans to begin the NATF full-scale development phase in fiscal year 1994, about 2-1/2 years after the ATF begins full-scale development.

The flights of the ATF prototypes are to demonstrate supersonic cruise, weapons launch, detectability, flight handling qualities, and other performance characteristics. The flights will not demonstrate the aircraft's carrier suitability because the prototypes are not designed for use on aircraft carriers.

Navy's Financial Participation

The Navy's initial financial commitment to the NATF was at the Congress' insistence, and the Congress continues to insist that the Navy remain committed to the program. To date, the Navy has used funds only for studies of Navy requirements unique to the NATF airframe and required modifications to the ATF engines, avionics, and subsystems.

Although the ATF program is not a joint Air Force and Navy program, the services' funding arrangement is similar to that of joint programs. For example, the Navy is providing funds to the contractors only for studies and design changes to meet their particular requirements, whereas the Air Force is providing funds for all other aspects of the program. Cost-sharing arrangements for joint programs during research, development, test, and evaluation typically provide for each service to fund its own peculiar requirements. Common requirements are funded entirely by the lead service or are shared by the services according to an agreed formula.

Funding

The first 2 years of the NATF efforts were funded with \$1.9 million of fiscal year 1988 reprogrammed funds and \$65 million of fiscal year 1989 funds appropriated by the Congress. The fiscal year 1990 budget request for \$65 million was the first Navy request for funds for the NATF. According to Navy officials, the \$131.9 million budgeted through fiscal year 1990 will fund the Navy's demonstration and validation effort through the development of a preliminary NATF design.

The National Defense Authorization Act for fiscal year 1989 required the Secretary of Defense to certify that the Navy had budgeted sufficient funds for fiscal years 1990 through 1994 to participate in the ATF demonstration and validation program. The Secretary of Defense provided the certification in January 1989, and the Navy included funds in its budget, as shown in table 2.1.

Table 2.1: Funding Plans for the NATF as of November 1989

Dollars in millions					
		Fiscal year			
1990	1991	1992	1993	1994	Total
\$65	\$65	\$100	\$99	\$395	\$724

After selection of the airframe and engine contractors for the ATF's full-scale development, the Navy will decide whether to continue demonstration and validation of the NATF with the selected design. The Navy has budgeted funds through fiscal year 1993 to continue demonstration and validation. The fiscal year 1994 funds are budgeted to initiate full-scale development.

Contractual Commitment

The first stages of the Navy's demonstration and validation efforts are provided for in two contract modifications to the ATF contracts. In September 1988 the Navy contracted with the competing ATF contractor teams to develop preliminary NATF specifications and assess carrier suitability, performance, and other mission capabilities specific to the Navy. The Navy specified the ATF subsystems that should be retained in the NATF designs. In assessing carrier suitability, the Navy specified that the NATF had to operate from the CV-63 class and subsequent classes of aircraft carriers.¹ According to the Navy, the NATF must be compatible with the size and weight capacities of the deck elevators, catapults, and arresting gear, and other carrier-imposed limits. The Navy specified that the NATF must be compatible with its Advanced Air-to-Air Missile and that the ATF's fuel, armament, avionics and sensor, propulsion, and flight control systems would be retained but modified to accommodate carrier operations.

In April 1989 the ATF contracts were again modified to continue the NATF's demonstration and validation and further define the NATF. The Navy specified a maximum take-off gross weight of 65,000 pounds and a carrier landing weight of 52,000 pounds as design goals and set limits on the NATF's length and size. The NATF is not to exceed the F-14 in length, and with its wings folded, it is to take up no greater deck space than the F-14.

¹The U.S.S. Kitty Hawk, which was commissioned in 1961, was the first CV-63 class aircraft carrier acquired. Twelve aircraft carriers are included in this and subsequent classes.

The preliminary NATF designs are expected to be completed and substantiated by wind tunnel testing at the conclusion of the Air Force demonstration and validation phase and available for use in the selection of the contractor, scheduled for April 1991.

Conclusions

The Navy has focused its efforts on developing preliminary NATF specifications and designs so that it can participate in the selection of the airframe and engine contractors. The Navy wants to ensure that the selected contractors have a NATF design that accommodates Navy requirements. The Navy's major issue in the selection process is the aircraft's suitability for carrier operations. The flight demonstrations of the ATF prototypes will be of little value to the Navy in making this evaluation because the prototypes will not be suitable for carrier operations. Therefore, in making its selection, the Navy will rely on studies and designs prepared by the contractors and substantiated by wind tunnel testing.

Although the Navy's financial participation in the ATF program has been limited, it has budgeted funds to continue NATF development through fiscal year 1994. The Navy is uncertain if it will continue development and eventual procurement of the NATF. In April 1991 the Air Force and the Navy are scheduled to select the ATF and derivative NATF designs. The extent to which the contractors can satisfy the Navy's requirements from a derivative design of the ATF is a key factor in whether the Navy remains committed to the program.

Basing and Mission Differences Affect Aircraft Design

Few attempts to make common airframes serve both Air Force and Navy purposes have been successful. Studies show that it is difficult to accommodate Navy missions and carrier basing in an airframe designed for Air Force missions and land basing. The services have had more success with common use of major components such as engines, weapons, and avionics equipment. Nevertheless, according to the Air Force and the Navy, their early involvement in the ATF's development can preserve common design features for the ATF and NATF.

Past Experience With Cross-Service Use of Aircraft

Since the mid-1940s successful cross-service use of fighter and attack aircraft has been limited. The F-4 and A-7 are among the more successful aircraft used by both the Air Force and the Navy during this period, but both were initially designed by the Navy to operate from aircraft carriers. Since World War II no U.S. fighter or attack aircraft developed to operate from land bases has been successfully adapted to operate from carriers and procured by both the Air Force and the Navy.

Although success in making common airframes that satisfy both Air Force and Navy requirements has been limited, certain major components such as engines, weapons, and avionics equipment have been used by both services. For example, the J-79 engine was used in the Air Force F-104 and Air Force and Navy F-4 aircraft, the AIM-9 Sidewinder missile is commonly used by many Air Force and Navy fighters, and the ALQ-99 tactical jamming equipment is used by the Air Force EF-111A and Navy EA-6B aircraft. Similarly, the services expect the ATF and NATF engines, avionics, and subsystems to have commonality, even though the airframe will likely have to be significantly different to make the NATF suitable for carrier operations and to meet the Navy's mission requirements. The Air Force estimates that the cost of the engines and avionics will be about 44 percent of the ATF's estimated \$37.2 million (1985 dollars) total unit flyaway cost.² By accommodating the differences early in development while the aircraft design is flexible, the Air Force and the Navy expect that many common design features can be preserved and that both services' needs will be met.

²Unit flyaway cost includes all production costs (recurring and nonrecurring) that are incurred in the manufacture of a usable end item. It includes the prime mission equipment (basic structure, propulsion, electronics) and allowances for engineering changes and warranties.

Carrier Suitability

A key factor contributing to the design differences between the ATF and NATF is their different basing requirements. The ATF is designed to operate from land bases, whereas the NATF must operate from the pitching and rolling deck of an aircraft carrier at sea. To be suitable for carrier operations, the NATF must have, among other things, a stronger structure than the ATF to withstand carrier launches and recoveries; excellent low-speed flying qualities tailored to carrier approaches and landings; and size, weight, configuration, and environmental compatibility with carrier operations.

Carrier Launch and Recovery

Carrier launch and recovery requires that an aircraft be equipped with a strong landing gear, an arresting tail hook, and a reinforced structure to withstand the high stress of catapult takeoffs and arrested landings. The acceleration, deceleration, and impact forces encountered by carrier-based aircraft are substantially greater than those experienced by land-based aircraft. For example, because land-based aircraft do not use catapults for takeoffs, they are not equipped with a nose landing gear suitable for catapulting or subjected to the substantial acceleration forces experienced during catapult takeoffs. Similarly, land-based aircraft do not routinely make arrested landings. Therefore, they are not equipped with a fully capable tail hook or normally subjected to the deceleration forces of arrested landings. The deceleration force experienced in arrested carrier landings is 24 times greater than that experienced by land-based aircraft, and the vertical impact force is over 3 times the level encountered by land-based aircraft.

Accordingly, a land-based aircraft's landing gear, wings, and fuselage must be strengthened with additional materials and/or redesigned structure to enable the aircraft to withstand the stress of catapult launches and arrested landings. Air Force and Navy program officials estimate that, to accommodate these and the other Navy requirements, the empty weight³ of the NATF will have to be about 4,000 pounds heavier than the ATF.

Low-Speed Flying Qualities

To ensure a safe carrier approach and landing, the NATF must be capable of a lower landing speed and more precise flight control during landings than required for the ATF. The low approach speed is necessary to stay within the structural load limits of the arresting gear aboard both the

³Empty weight includes the weight of an aircraft's structure, engines, hydraulic and electrical systems, and avionics. It does not include such items as fuel and armament.

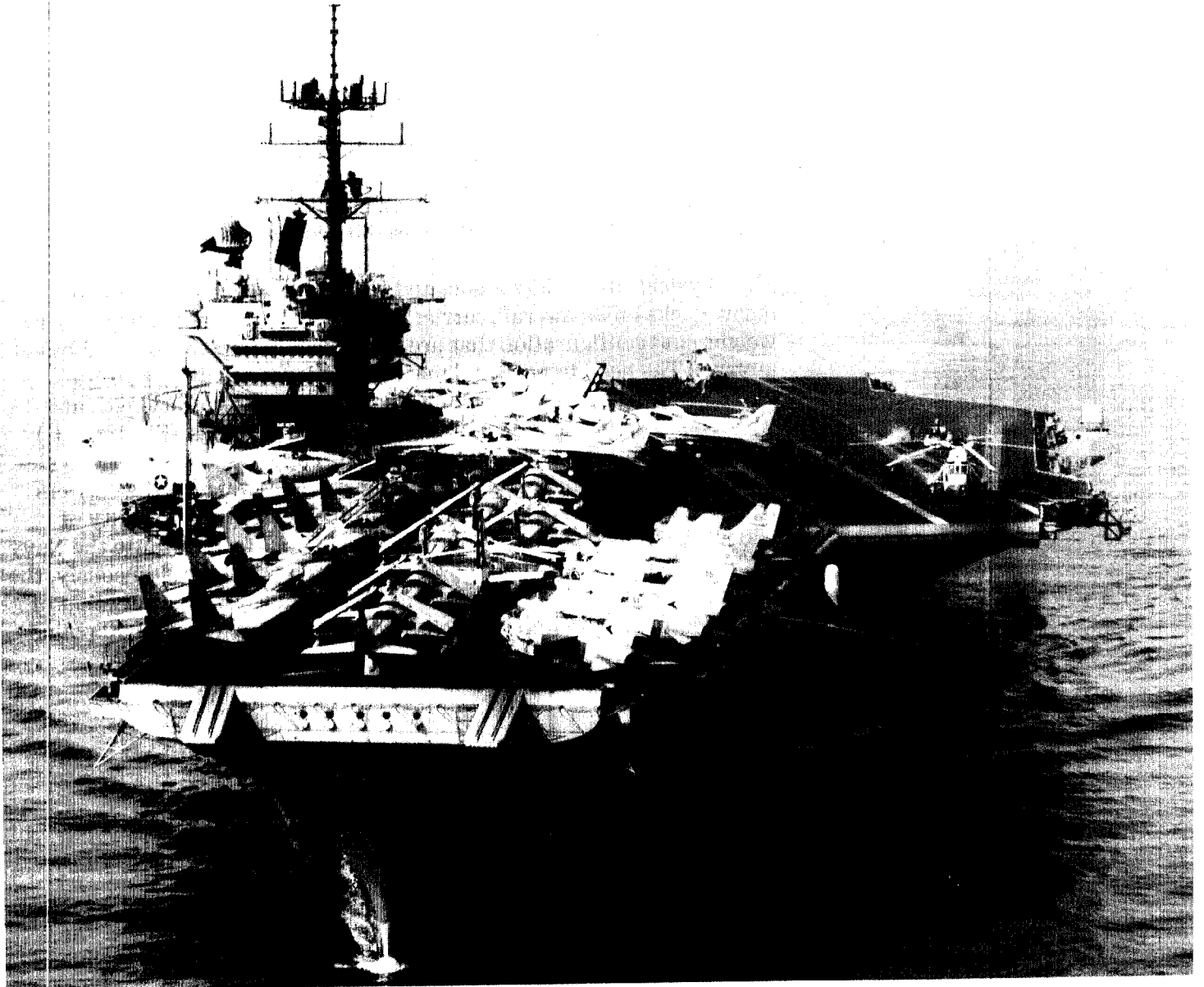
aircraft and the carrier. If approach speeds are too high, damage or failure of the aircraft's or carrier's arresting equipment is a risk. In addition, a carrier-based aircraft's design must provide unusually good aerodynamic performance at these low speeds for the precise flight control needed during carrier approach and landing.

**Size, Weight, and
Configuration
Compatibility**

Although carrier-based aircraft tend to have heavier structures to withstand catapult launches and arrested landings, they must not exceed certain size and weight limits imposed by carrier operations.

The physical constraints associated with handling an aircraft above and below decks on an aircraft carrier pose strict limits on an aircraft's size, weight, and configuration that are not normally imposed on land-based aircraft. The need to park and maneuver a large number of aircraft while avoiding obstructions, not only limits the aircraft's length and width but also necessitates folding the aircraft's wings. (See fig. 3.1.) Similarly, aircraft weight is limited by the capacity of the carrier's elevators, catapults, and arresting equipment. For example, the carriers from which the NATF will operate have an elevator load capacity of 130,000 pounds and dimensions of 70 feet by 52 feet. Because the Navy has a design goal of lifting two NATFs on an elevator simultaneously, the Navy has limited the NATF's size with wings folded to basically that of the F-14 and has limited its takeoff gross weight goal to 65,000 pounds.

Figure 3.1: Aerial View of Carrier Deck



Source: Navy

The NATF must also be configured to accommodate carrier use and safe carrier approaches and landings. The need for stability while maneuvering an aircraft on a pitching, rolling deck to prevent tipping to the side or back constrains landing gear placement. Further, main landing gear

placement is also limited to allow for adequate wheel clearance from the edge of the carrier deck during catapult launch.

The NATF must provide the pilot with adequate visibility in addition to low-speed flying qualities to make a safe carrier approach and landing. Steep approach angles, required for carrier landings, demand that the aircraft's cockpit and front fuselage design provide the pilot with an unobstructed view of the carrier deck and stern. This degree of over-the-nose visibility is unnecessary for a land-based aircraft. Consequently, the ATF cockpit, canopy, and front fuselage structure will likely be redesigned to provide the NATF pilot with an increased forward field of view.

Environment

The marine and electromagnetic environments encountered by carrier-based aircraft require special design considerations not normally required of land-based aircraft. For example, additional corrosion protection is necessary against high humidity, a salt laden environment, and corrosive carrier stack exhaust gases. Corrosion protection is normally achieved by using special materials, construction techniques, and protective coatings. The services expect few problems in satisfying this requirement for the NATF. For example, the Air Force has tentatively adopted the Navy's more stringent corrosion protection requirements for its engines.

Aircraft avionics and electronic components of the flight control system require additional protection because of the high level of electromagnetic interference encountered around the ship. According to Navy officials, this protection will likely include additional shielding, electronic filtering, and modified circuitry and software for the NATF electronic flight controls.

Mission Differences

Although the ATF and NATF are required to be air superiority fighters, the differences in their missions tend to require certain differences in the airframe designs. The ATF is to protect friendly air and surface forces by attacking high-priority airborne enemy targets such as interceptors, stand-off jammers, and large offensive attack formations. However, the Navy's fleet air defense mission requires that the NATF be capable of using long-range weapons while operating for extended periods at long distances from the fleet, which is unnecessary for the Air Force mission.

According to the Navy, the main threat to the carrier fleet are cruise missiles launched by enemy bombers at great distances. The NATF's primary role in fleet air defense is to detect and destroy enemy bombers before they can launch their missiles. Once launched, the missiles become additional targets for the air defense fighters to destroy. Consequently, according to the Navy, the NATF must be capable of remaining aloft for long periods and at extended distances from the fleet to provide early warning and protection from encroaching enemy aircraft. Also, it must be capable of carrying and firing long-range weapons. This requires the NATF to have larger wings, more fuel-carrying capacity, and longer range weapons than the ATF. The larger wing is also compatible with attaining the excellent low-speed flying qualities necessary for carrier approaches and landings. The longer range weapon capability requires integration of the Navy's Advanced Air-to-Air Missile and modification of the ATF's radar system to achieve longer detection ranges to be compatible with the Advanced Air-to-Air Missile.

The Navy also requires that the NATF be capable of using air-to-surface weapons for its mission in support of ground forces. This is not a primary Air Force requirement for the ATF. Because carriers hold a limited number of aircraft, this dual capability provides a Navy commander with the operational flexibility to attack either air or surface targets with one aircraft.

Conclusions

Few fighter aircraft in the past have successfully been used by both the Air Force and the Navy, and no U.S. fighter aircraft developed to operate from land has been successfully adapted to operate from carriers and procured by both the Air Force and the Navy. Although the ATF has been designed to operate from land bases, the Air Force and the Navy consider it an exception to past experiences because their requirements are being incorporated early while the aircraft design is flexible.

The Air Force and the Navy expect the ATF and NATF airframes to have some commonality, even though the services have different requirements for their aircraft. Although history shows that few aircraft have been commonly used by both services, it also shows that the services have used common engines, weapons, and avionics. Similarly, the Air Force and the Navy expect the ATF and NATF engines, subsystems, and avionics to be highly common. The Air Force estimates that the cost of the engines and avionics will be about 44 percent of the ATF's unit fly-away cost.

Comments From the Department of Defense



ACQUISITION

THE UNDER SECRETARY OF DEFENSE
WASHINGTON, DC 20301

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Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) Draft Report, "AIRCRAFT DEVELOPMENT: Navy's Participation in Air Force's Advanced Tactical Fighter Program" dated December 15, 1989 (GAO Code 392493/OSD Case 8207).

The DoD has reviewed the report and concurs without comment. The DoD appreciates the opportunity to review the report in draft form.

Sincerely,

A handwritten signature in cursive script that reads "Robert C. McCormack".

ROBERT C. MCCORMACK
By Direction of the Secretary of Defense

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