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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

F/A-18 Naval Strike Fighter: Progress Has Been Made But Problems And Concerns Continue

The Navy and its contractors have made progress in solving technical problems discussed in GAO's February 14,1980, report on the F/A-18, but problems remain. Future decisions should include consideration of whether

- --modifications to the wing will correct a roll-rate problem without adversely affecting other performance areas,
- --modifications in response to bulkheads cracks are adequate,
- --a high-oil temperature condition can be corrected,
- --built-in test objectives can be achieved,
- --fuel cell leakages can be corrected, and
- --causes of two crashes can be corrected.

Estimates of the cost of the F/A-18 program continue to increase. Inflation and quantity changes have been the major reasons for cost estimate increases. Furthermore, the estimates are based on escalation rates prescribed by the Office of the Secretary of Defense which are considerably lower than those projected by industry.

The Secretary of Defense should identify the risks associated with the outstanding technical problems, identify production cost estimates at various production quantities, and provide a program cost estimate based on realistic inflation rates.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report presents our views on the major technical and cost issues facing the Navy's F/A-18 strike fighter program.

For the past several years, we have reported annually to the Congress on the status of selected major weapon systems. This report is one in a series that is being furnished to the Congress for its use in reviewing fiscal year 1982 requests for funds.

We are sending copies of this report to the Director, Office of Management and Budget, and to the Secretary of Defense.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

F/A-18 NAVAL STRIKE FIGHTER: PROGRESS HAS BEEN MADE BUT PROBLEMS AND CONCERNS CONTINUE

D I G E S T

The F/A-18 strike fighter is planned to replace such aircraft as the A-7, A-4, and F-4, presently used by the Navy and Marine Corps for fighter and light attack missions. This twin-engine aircraft is to be based on aircraft carriers and is to perform such missions as strike escort, fleet air defense, interdiction, and close air support.

Both the Congress and the executive branch have expressed concern over the F/A-18's cost and performance. Many of these issues were raised in GAO's February 14, 1980, report on the program.

Program cost estimates continue to increase. Although there has been other cost growth, inflation and quantity changes have been the major reasons for cost estimate increases since the development estimate was established in 1975. Furthermore, current estimates of total program cost vary from $29.7 billion to $41 billion depending on the assumptions used, such as differing build-up rates for production. These estimates are based on escalation rates prescribed by the Office of the Secretary of Defense, which are considerably lower than those projected by industry. If actual escalation rates continue to be higher than rates used by the Department of Defense, program cost estimates will continue to be understated.

The Navy and contractors continue to work on technical problems discussed in GAO's February 1980 report. These include the computer systems' software, the air turbine starter, oil temperature, bulkhead failures, and manufacturing processes. Improvements have been made on some of the problems such as the manufacturing process for the hybrid chips used in the radar. (See p. 14.)

GAO's February 1980 report also addressed deficiencies in acceleration and range, which are still below threshold levels. However, a Department of Defense F/A-18 review group has concluded that the demonstrated acceleration and range are acceptable and that acceleration at some speeds is impressive. (See p. 14.)

During 1980, a roll-rate performance problem was identified, a fuel cell leakage problem reoccurred, and two F/A-18s crashed. The roll-rate problem was reported by the Navy in February 1980 and has required extensive engineering work to modify the aircraft's wings. Flight testing is underway to evaluate whether the problem has been corrected and to determine the effect of the correction in other performance areas. (See pp. 9 and 10.) The fuel cell leakage problem has caused delays in the flight test program and has adversely affected reliability and maintainability. (See pp. 20 and 21.)

In September 1980, a development aircraft crashed in England because of a failure in the low-pressure turbine in one of its F404 engines. The cause of the turbine failure is not yet known but is being investigated. (See pp. 11 and 12.)

Another crash occurred on November 14, 1980, during an initial operational test and evaluation exercise at Patuxent River, Maryland. An investigation is also taking place on the cause. According to Navy officials, the aircraft entered into a spin while practicing air combat maneuvers, and the pilot was unable to regain control. (See p. 12.)

Reliability and maintainability experience has continued to improve even though problems are being encountered with subsystems, such as the fuel system, mission computer, air turbine starter, and built-in test. For example, the F/A-18's maintenance concept is based on satisfactory operation of built-in test. However, built-in test is not yet capable of providing maintenance and failure information necessary to adequately support aircraft maintenance. (See pp. 22 and 23.) Nonetheless, Navy officials expect the F/A-18 to represent a major improvement in the areas of reliability and maintainability when it enters the fleet.

GAO believes that development of the F/A-18 is at the stage where the following issues should be considered in development and production decisions:

--Whether the modifications to the wing will correct the roll-rate problem without adversely affecting other performance areas. (See pp. 9 and 10.)

--Whether the modifications to the bulkheads are adequate. (See pp. 6 and 7.)

--Whether the high-oil temperature condition can be corrected. (See pp. 7 and 8.)

--Whether the built-in test objectives can be achieved. (See pp. 22 and 23.)

--Whether the fuel cell leakages can be corrected. (See pp. 20 and 21.)

--Whether the causes of the accidents can be corrected to assure safe flight conditions and operational effectiveness. (See pp. 11 and 12.)

RECOMMENDATIONS

GAO recommends that during fiscal year 1982 budget hearings, the Secretary of Defense should

--identify the development, production, and operational risks associated with the outstanding technical problems;

--identify the production cost estimates associated with higher and lower production quantities than requested for fiscal year 1982 including the most efficient and economical production rate; and

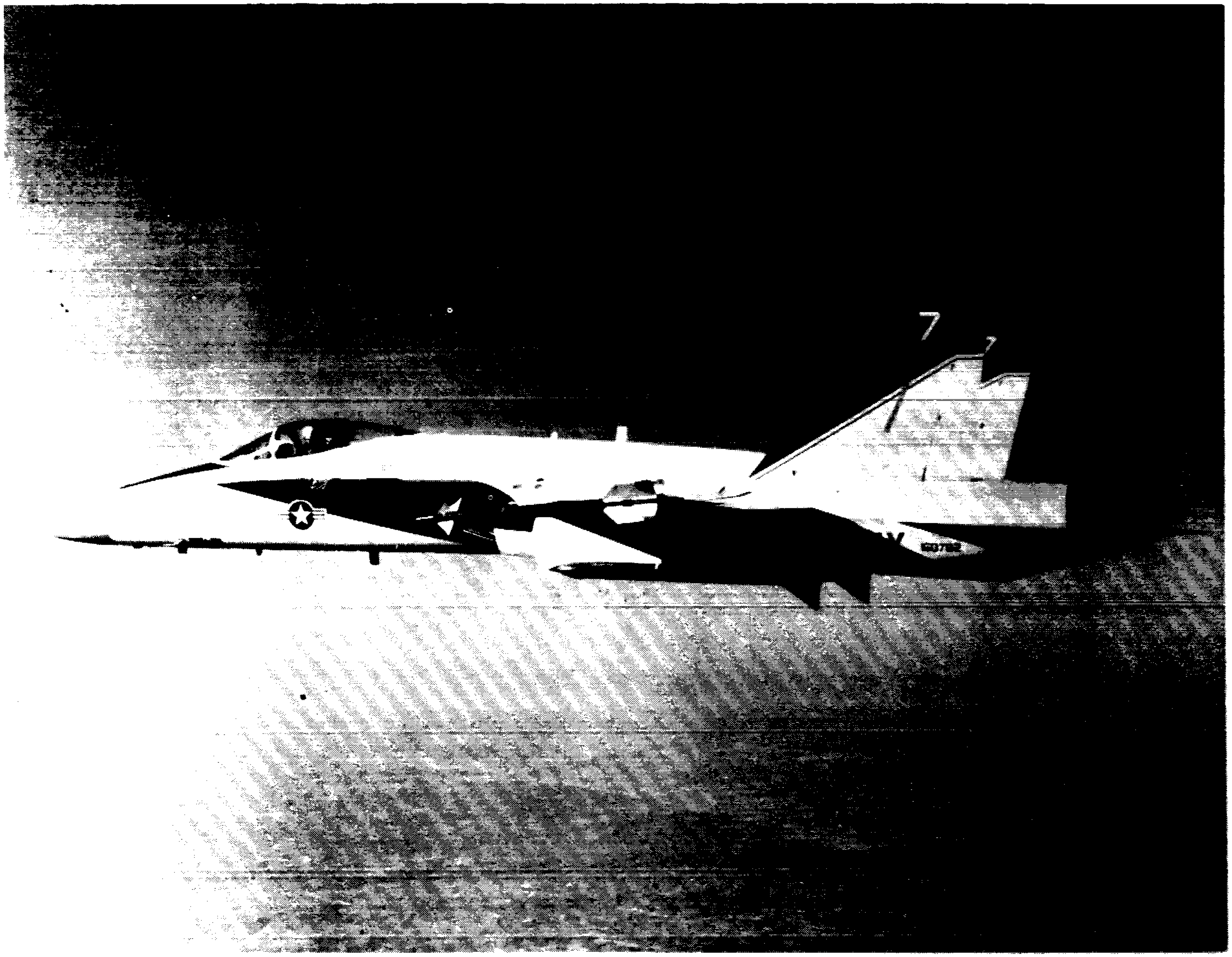
--provide a program cost estimate based on realistic inflation rates.

GAO did not request official comments on this report because of the tight reporting deadline. Instead, a draft of this report was discussed with high level officials associated with management of the program to assure that the report is accurate and complete. Their points of view are included where they differ with GAO's.

Contents

ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
MFHBF	mean-flight-hours-between-failures
OSD	Office of the Secretary of Defense



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F/A-18 NAVAL STRIKE FIGHTER

CHAPTER 1

INTRODUCTION

The F/A-18 strike fighter is a twin-engine aircraft designed to meet the Navy's and Marine Corps' fighter and light attack aircraft requirements. The aircraft is planned to replace such aircraft as the A-7, A-4, and F-4 being used for Navy and Marine Corps fighter and light attack missions, such as strike escort, fleet air defense, interdiction, and close air support. The Navy also plans to develop a reconnaissance version of the aircraft to replace the RF-4 and RF-8.

The F/A-18 fighter and attack configurations will be identical, except for different external equipment or ordnance peculiar to their respective missions. The identical features are expected to provide operational flexibility during combat and result in reduced life-cycle costs. The Sparrow air-to-air missile will be used, primarily, on the F/A-18 fighter configuration. Equipment used on the Marine Corps fighter/attack and Navy attack configured F/A-18s will include various conventional ordnance; antiradiation missiles (Shrike or Harm); guided weapons (Maverick and Walleye); forward-looking, infrared/laserspot tracker pods; and strike cameras for air-to-ground attack. An internal 20-mm. gun and wingtip Sidewinders will be on all configurations. The Navy also plans to use the Advanced Medium Range Air-to-Air Missile and Harpoon. Initial integration studies of these missiles are expected to begin during the 1981-82 timeframe.

The F/A-18 radar is described as two radars in one. It has air-to-air capability for fighter operations and air-to-ground capability for attack operations. It is capable of providing a multitude of information to the pilot on command.

The Navy has given much attention to enhancing the aircraft's survivability. The F/A-18 contract requires the contractor to conduct aircraft survivability studies and to produce and test survivability enhancement designs during the full-scale development program. Some of the survivability features designed into the aircraft include

--dual, smokeless engines;

--redundant flight control computers; and

--a backup, mechanical flight control system.

PROGRAM STATUS

The F/A-18 full-scale development program began in early 1976, and the first flight was made in November 1978. By November 1980, the Navy had received all 11 development aircraft and 4 of the 9 fiscal year 1979 (pilot production) aircraft. The Navy expects to have initial operational capability in December 1982 and carrier deployment in 1985.

The number of F/A-18s planned for procurement each fiscal year has changed frequently due to Department of Defense (DOD), Presidential, and congressional decisions affecting the program. In addition, the total number of aircraft to be procured has fluctuated and may change again depending on future action on the AV-8B aircraft program. These fluctuations have caused many program uncertainties, which have affected F/A-18 program cost and schedule. Although the latest F/A-18 Selected Acquisition Report includes a program cost estimate of about $29 billion, internal DOD cost estimates for developing and procuring 1,377 aircraft range from $36 billion to $41 billion. 1/

The full-scale development test program is about 50 percent complete and is scheduled to be completed in July 1982. By the end of November 1980, the F/A-18 had flown 2,716 hours during 2,005 flights. Flight testing was interrupted when two F/A-18 aircraft crashed; one on September 8 and the other on November 14, 1980. Milestones to be achieved before the Defense Systems Acquisition Review Council III (fighter version) have been met except for two important milestones--the completion of the initial operational test and evaluation and the completion of one lifetime of fatigue testing. Both were scheduled to be completed in January 1981.

Sparrow and Sidewinder missile separations from the aircraft and tactical firings have been conducted over most of the fighter envelope. When our fieldwork was completed in November 1980, McDonnell Douglas had executed 12 separations and 5 tactical firings for the Sparrow and 5 separations and 5 tactical firings for the Sidewinder. According to McDonnell--the prime contractor--and Navy officials, all tests were successful from an aircraft/missile interface standpoint. One Sidewinder, which was successfully launched, failed to lock onto the target because of a missile malfunction.

1/Assumptions used in preparing the $41 billion estimate differ from assumptions used in preparing the program cost estimate. (See p. 24.)

McDonnell also reported that the gun firing tests have been completed except for final accuracy tests with the production flight control system. Navy and contractor officials said that the gun firing has produced no adverse effects on radar tracking or engine operations.

PROGRAM MANAGEMENT

The F/A-18 project manager, Naval Air Systems Command, Washington, D.C., is responsible for all management and technical aspects of the program.

The McDonnell Douglas Corporation, St. Louis, Missouri, is the airframe prime contractor. McDonnell has overall weapon system performance and technical management responsibility. It designed and is building the forward fuselage, wings, and stabilator subassemblies and is responsible for the landing gear, arresting gear, crew station, and avionics integration. McDonnell is also responsible for total F/A-18 system survivability and the continuing assessment of its vulnerability against the specified threat. To help manage the F/A-18 contract, a project office representative is located at McDonnell's facilities.

Northrop Corporation, Hawthorne, California--a major McDonnell subcontractor--designed and is building the center and aft fuselage, vertical fins, environmental control system, hydraulics, secondary power, starting unit, and several other F/A-18 systems. Northrop designed the YF-17 aircraft, the prototype of the F/A-18.

The F/A-18 radar is being developed by Hughes Aircraft Company, Culver City, California, under subcontract with McDonnell. This radar incorporates technological advances in a radar smaller and lighter than those produced by Hughes for other Air Force and Navy aircraft.

The General Electric Company, Lynn, Massachusetts, is developing the F404 engine, which will be used on the F/A-18 aircraft. The development is being performed under a Navy contract. An associate contractors' agreement between McDonnell and General Electric provides the engine and airframe interface.

The F/A-18 is being flight tested at the Naval Air Test Center at Patuxent River, Maryland. For the first time, the Navy is using a single-site testing approach. Under single-site testing, the Navy expects the development program will be more efficient and will improve Navy and contractor coordination. Navy officials said that because of this approach significantly more is known about the aircraft than any previous aircraft after a similar period of testing.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objective of our review was to provide the Congress information on the cost, technical, and operational performance status of the F/A-18 program for its use in reviewing the Navy's fiscal year 1982 budget request. We issued reports on the status of the program 1/ and on operational and support costs 2/ in 1980.

Our review this year specifically addressed (1) the progress made in resolving and correcting performance and technical problems discussed in our previous report or identified during the F/A-18 test program, (2) the F/A-18's rising program costs, and (3) the progress and problems associated with the F/A-18's reliability and maintainability program.

We performed our audit work at the F/A-18 project office and other related DOD activities, particularly within the Naval Air Systems Command. We also conducted work at locations of the major contractors responsible for developing, building, and testing the F/A-18 aircraft. These included McDonnell, Northrop, Hughes, and General Electric.

To obtain as much information as possible within the timeframe of our review, we conducted interviews with DOD, Navy, and contractor officials at various organizational levels and obtained and reviewed status and test reports and briefing documents. At the Office of the Secretary of Defense (OSD), we interviewed the members of a review group established to evaluate the F/A-18 program. The review group evaluated testing, technical, cost, and performance issues. We received the group's final report in November 1980, but did not fully evaluate it because of tight reporting deadlines. We interviewed officials who examined specific technical problems facing the F/A-18 program and obtained their conclusions. We interviewed Navy officials at Navy Headquarters, the F/A-18 project office, the Naval Air Development Center, the Naval Air Test Center (including pilots with F/A-18 flight

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1/"F/A-18 Naval Strike Fighter: Its Effectiveness Is Uncertain," (PSAD-80-24, Feb. 14, 1980).

2/"Operational And Support Costs of the Navy's F/A-18 Can Be Substantially Reduced," (LCD-80-65, June 6, 1980).

experience), the Operational Test and Evaluation Force, and a Naval Plant Representative Office. We also interviewed contractor officials, including headquarters level personnel and production line supervisors.

Because of the tight reporting deadlines, we did not request official comments on this report. Instead, a draft of this report was discussed with high level officials associated with management of the program to assure that the report is accurate and complete. Their points of view are included where they differ with ours.

CHAPTER 2

TECHNICAL PROBLEMS STILL EXIST BUT PROGRESS HAS BEEN MADE

During 1980, some technical problems have continued, additional problems have surfaced, and some have been resolved. Current problems are related to

--bulkhead failures,

--high-oil temperature,

--software development delays,

--recurring fuel cell leaks,

--aircraft roll-rate performance,

--difficult vertical tail installation, and

--two F/A-18 aircraft crashes.

In addition, concerns have been raised by Navy officials about the testing and repairability of composite materials which comprise a large portion of the F/A-18's airframe.

Some of the technical problems we reported on last year have been improved or resolved. Acceleration and range are considered acceptable by the Navy and OSD, hybrid chip production rates have increased to an acceptable level, and work has begun on development of advanced systems. Technical problems and concerns, the status of the crash investigations, and descriptions of corrective actions are presented in the following sections. The fuel cell leakage problem, which was thought to have been corrected, affects reliability and maintainability and is discussed in chapter 3.

BULKHEAD FAILURES

In our report on the F/A-18 last year, we discussed a fatigue failure that occurred in a wing-carry-through bulkhead in early December 1979. That failure occurred after 328 hours of testing. Since that time additional fatigue failures have occurred on wing-carry-through bulkheads. Bulkhead failures were reported at 2,428 hours, 3,002 hours, and 4,000 hours on the fatigue test article. The failure at 4,000 hours was the most serious, but Navy officials consider all three to be minor and common in fatigue testing.

As explained in our last year's report, the F/A-18 will be tested for fatigue through two design lifetimes. The F/A-18 design life is 6,000 hours; thus, fatigue testing will be performed for a minimum of 12,000 hours. According to McDonnell officials, retrofit changes will be used to complete the test rather than incorporating redesigned bulkheads into the test article. We found that the second major failure occurred on a different bulkhead. One lifetime of fatigue testing was scheduled to be completed in January 1981.

OIL-TEMPERATURE PROBLEM STILL UNDER CONSIDERATION

Last year we reported that oil temperatures in the hydraulic systems and in the airframe mounted accessory drive approached or exceeded critical levels on several occasions. The oil in these systems is cooled by circulation through the aircraft's fuel supply so the problem is more pronounced at low fuel states. Navy officials expressed concern over the effect high-oil temperatures may have on the life and performance of parts and subsystems in the aircraft. For example, we were told that if oil temperatures rose too high the aircraft's generator could overheat resulting in a shutdown of the electrical power system.

Northrop officials informed us that the original cooling system was replaced by a continuous bypass system. After some improvements, this system has met engine fuel, oil, and hydraulic fluid temperature requirements in flight. However, we were told that testing and analysis indicates that engine fuel and oil temperatures will exceed specified limits at the end of a training mission on extremely hot days. This configuration is scheduled to be installed in all development and pilot production aircraft when they receive the wing modification.

In view of the uncertain cooling capability of this current configuration at extreme operational and temperature conditions, Northrop and McDonnell decided in August 1980 to develop another system to cool the oil and hydraulic fluid. The new design, which is similar to the system used in the Air Force's F-15 aircraft, is an active control system as compared to the current configuration in the F/A-18 which is a passive control system. The contractor stated that the new system will increase aircraft weight by 11 to 12 pounds and is expected to have an adverse impact on reliability and maintainability since it contains additional parts. Installation of the active control system is targeted for the 21st aircraft (the physical configuration audit aircraft).

The Navy, McDonnell, and Northrop are still considering improving the passive configuration, since they feel it is a less costly and more reliable system. Improvements include the addition of an air/fuel heat exchanger on each side of the center fuselage. According to Northrop officials, these improvements could be ready for installation on the 21st aircraft. A final decision on which system will be used will depend on testing due to be completed in early 1981.

SOFTWARE DEVELOPMENT STILL BEHIND SCHEDULE

Last year we reported that the development of the computer systems' software was behind schedule. Although some progress has been made, software development for the mission computer, flight control system, radar, and the built-in test is still lagging behind. Discussions regarding the mission computer and built-in test software development are included in chapter 3.

Flight control system

Software development for the flight control system is over a year behind schedule. Navy and contractor officials said that the scope of work involved in developing the flight control software has turned out to be much greater than anticipated. The schedule for developing the outer-loop modes, which include autopilot, data link, approach power compensation, and blind bombing has been slipped 11 to 13 months because of the delays in the development and demonstration of hardware and software for aircraft flying qualities. Also, changes such as the roll-rate modification have delayed the normal development work on the flight control system. According to one contractor official, delays in development increase the risk that retrofit will be required in limited production aircraft. In addition, the schedule allows only 6 months for developing a mature system for the outer-loop modes while similar efforts on other aircraft have required 1 to 1-1/2 years.

We also reported last year that almost all of the flight control computer's memory space had been used while demands for additional space continued. The contractor informed us that since then, a review was conducted to reduce memory requirements. The review resulted in a reduction in memory requirements and contractor officials expressed confidence that additional demands can be met within the computer's memory capacity with a margin for future needs.

Radar

Radar software development is scheduled to be completed by mid-1981; about 1 year after the originally scheduled completion date. The scope of work involved in the development of radar software has also turned out to be much greater than anticipated. In addition, the problem with the production of hybrid chips for the radar, mentioned in our report last year, affected the radar test schedule. Instead of using some of the radars for reliability developmental testing at the contractor's plant, program priorities dictated that as radars were produced they be installed in aircraft for the flight test program. Therefore, radar reliability developmental testing is about 30 months behind schedule. Navy officials commented that while reliability developmental testing is 30 months behind schedule, the radar is only 6 to 7 months behind the present flight test and production schedule requirements.

UNACCEPTABLE ROLL-RATE PERFORMANCE

In February 1980, the Navy reported that the F/A-18's roll performance during a Navy Preliminary Evaluation was insufficient. Flight test data showed that the aircraft failed to complete a 90-degree change in bank angle in the specified time of 1 second and failed to achieve the specified sustained roll rate of between 180 and 220 degrees per second.

The problem has been attributed to the flexibility of the outer wing panel combined with the excessive damping effect produced by the Sidewinder missile installed on the wingtip. To initiate a roll, the aileron, which is a movable control surface on the outer, trailing edge of the wing is deflected. When the F/A-18's aileron was deflected at transonic speeds, the flexibility of the outer wing panel permitted it to bend in such a way that it reduced the effect of the aileron.

The F/A-18's wing is manufactured with a large amount of composite material instead of conventional aircraft materials, such as aluminum and titanium. The composite material was used because it is stronger and lighter than the conventional materials. One Navy official explained that a stronger, lighter material was required to produce a wing that is strong enough to carry heavy ordnance in the attack mode without sacrificing the performance characteristics necessary in the fighter mode. However, Navy officials said that the general unfamiliarity with composite structures within the aerospace industry resulted in poor predictions of the flexibility of composite structures.

The contractors made the following design changes to the wing to correct the roll-rate problem

--stiffened and strengthened the wings by adding composite material and

--increased the area of the aileron by extending it to the wingtip.

Also, software changes in the flight control computer were made to increase the contribution of the horizontal stabilator and the trailing edge flaps to the aircraft's roll performance. The contractor plans to incorporate these changes beginning with the 19th production aircraft. The full-scale development aircraft and early production aircraft will be retrofitted.

Navy and contractor officials report that, based on preliminary data, it appears that the F/A-18 will meet the roll performance specifications in all but the most extreme corners of the flight envelope. In fact, the design change may have provided the aircraft with more capability than can safely be used. According to Navy officials, the excess roll capability can be corrected by a software change in the flight control computer.

DIFFICULTY HAS BEEN EXPERIENCED IN INSTALLING THE VERTICAL TAILS

Northrop has been experiencing difficulty in installing the vertical tails. As the tails are installed, shims are individually machined to fit between the vertical tail tabs and the aircraft's frame. The problem lies in the difficulty of measuring the gaps so that the shims can be machined to within acceptable tolerance.

To assure proper shimming, Northrop currently has a team that performs special measurements on each vertical tail installed. If the measurements are not within specifications, the vertical tail shimming must be corrected. Northrop officials informed us that although no tail assemblies are being shipped out with improper shimming, this is a time consuming and costly process. They said that tools are being improved to correct installation difficulties, and plans are underway to automate the shim machining process.

INVESTIGATIONS ONGOING ON TWO F/A-18 CRASHES

On September 8, 1980, one of the developmental aircraft crashed in England en route to Madrid, Spain, about 10 minutes after takeoff. Before the accident, the aircraft had flown daily in England's Farnborough Air Show. The Navy conducted an investigation of the accident and determined that a failure of the low-pressure turbine disk in the aircraft's right engine initiated the sequence of events which led to the crash.

The cause of the low-pressure turbine disk failure is unknown at this time. According to Navy and General Electric officials, information is not available to identify the specific cause of the failure because two vital pieces of the disk have not yet been recovered from the crash site. We were also informed that data obtained from the aircraft's engine monitoring and recording system gave no hint that the low-pressure turbine was going to fail. At the completion of our review in November 1980, General Electric officials did not know whether a problem related to the disk's design or the manufacturing process exists.

The engines in the test aircraft were preproduction models which contained a different type of low-pressure turbine material than is installed in production engines. The low-pressure turbine disk which failed was made of "60-mesh" material. The disk was made by a process involving the pouring of a powdered metal into a form and subjecting the metal to extreme temperature and pressure. The production engines contained 150-mesh disks which were made by the same process except the powdered metal is a finer grain than used for the 60-mesh disk. All production engines have the 150-mesh disks which Navy officials consider to be twice as reliable as the 60-mesh.

When the crash occurred, flying of all other F/A-18s was temporarily halted pending the accident investigation. Upon determining the low-pressure turbine disk to be the cause of the crash, those preproduction engines which contained the 60-mesh disks were removed and stronger disks were installed. The flight testing was resumed after a 2-week delay. As a precautionary measure, engine operating time limits have been reduced and more frequent inspections of certain sections of the engines are being made. In addition, efforts continue by the Navy and the contractor to determine why the disk failed, including attempts to recreate the failure in the test facility. Both Navy and General Electric officials believe the missing pieces of the low-pressure turbine disk hold the clue to the mystery.

The crashed aircraft had been used for the accelerated service test engines. The purpose of the accelerated service test is to obtain data on the operational characteristics of the engine through special instrumentation. This purpose is fulfilled by accumulating as many flight hours as possible to accelerate engine maturity. The engine which failed had accumulated 275-flight hours in 250 flights. The Navy does not expect the loss of the aircraft to have a great impact, since it was not as heavily instrumented as most of the developmental aircraft. One program official said there will be only minimal impact on the program if a material failure is the cause. If, however, the cause is found to be a design failure, then the crash will have a serious impact on the program.

The second F/A-18 crashed on November 14, 1980, as a result of a spin which occurred while the aircraft was practicing air combat maneuvers at the Naval Air Test Center at Patuxent River, Maryland. The manuevers were part of the initial operational test and evaluation being conducted by the Navy's Operational Test and Evaluation Force. Previously performed wind tunnel and drop model tests indicated that the F/A-18 would spin under certain conditions. During the flight test program, the contractor tried to make the aircraft enter the predicted spin, but was unsuccessful. After the crash, however, the contractor has been able to duplicate the spin and to demonstrate a spin recovery technique which will require software changes in the aircraft's flight control system. A manual override of the flight control computer was installed as an interim measure and thresholds in the flight control system's spin logic are being adjusted based on the actual spin experience. The Navy's initial operational test and evaluation proceeded with a reduced angle of attack limit imposed as a precautionary measure until the changes to the flight control system could be verified.

CONCERNS ABOUT COMPOSITE STRUCTURES

The use of composites in the manufacture of aircraft components is relatively new to the industry. Composite materials are used because they are stronger relative to their weight, than conventional aircraft materials. Composites are used on the F/A-18's wings, tail sections, and on parts of its fuselage.

Ultrasonic and X-ray techniques have been developed to perform nondestructive testing of composite materials. However, contractor officials informed us that the existing techniques test for voids in the composite laminations, but that techniques have not been developed to nondestructively test the strength of the bonds between the composite material and the metal aircraft structures. Test articles are included in the production line, which are destructively tested.

Also, according to Navy officials, techniques have not been fully developed to repair composite structures. The techniques used to repair conventional aircraft materials are not applicable to composites because relatively minor damage to part of a composite structure may affect the strength of the entire structure. Although techniques are now available for some minor repairs, mission readiness and maintainability will be affected unless effective testing and fleet repair techniques can be developed.

DOD NOW CONSIDERS ACCELERATION AND RANGE ACCEPTABLE

Currently, the F/A-18 cannot meet program thresholds or contract specifications for acceleration or range. However, performance in these two areas has improved over levels demonstrated in 1979. During a Navy Preliminary Evaluation conducted in October 1979, the acceleration threshold was breached by 35 percent and the aircraft range was deficient.

During the past year, modifications were made to the aircraft which improved acceleration and increased range, but thresholds still have not been met. Although the acceleration is 22 percent short of the threshold and range is deficient by 4 percent, OSD officials responsible for reviewing the program concluded that the F/A-18's demonstrated acceleration and range were acceptable. Navy estimates indicate that the aircraft is expected to meet the range threshold for both fighter and attack missions, but Navy officials believe that acceleration is probably the best that can be achieved without increasing engine temperatures. OSD and Navy officials said that this would not be desirable since it would adversely affect engine durability.

Improvements obtained by reducing drag

The F/A-18's airframe experienced higher drag (wind resistance) than anticipated. This along with excess weight, including additional increases since our February 1980 report, contributed to the aircraft's acceleration and range problems. The contractor made the following modifications to the aircraft to reduce drag

--filled the leading edge extension slots,

--streamlined the exhaust port of the environmental control system, and

--increased the leading edge radius of the wing.

According to contractor officials, of these modifications, filling the open slots in the F/A-18's leading edge extension was the modification which reduced drag most significantly. In addition to the drag improvements, the range was enhanced by increasing fuel capacity through use of a vent tank located in the vertical tail.

Comparison with other aircraft

Although the F/A-18's performance in acceleration and range has been deficient relative to program thresholds and contract specifications, OSD officials consider its performance to be competitive with or better than existing military aircraft. For example, its acceleration is considered exceptional over the transonic range of 0.8 to 1.2 Mach. OSD officials have said that transonic acceleration is critical for the F/A-18 to accomplish its mission. Program officials and pilots have reported that in the transonic range the aircraft has accelerated faster than the F-4, F-14, and F-15 aircraft and consider acceleration from 0.8 to 1.6 Mach to be competitive with the F-14. According to Navy officials, the range for the fighter version of the F/A-18 with its standard armaments is 100 nautical miles better than that of the F-4 it will replace and 55 nautical miles better than the F-14 with Phoenix missiles. Although the A-7E, which the attack version will replace, has a longer range by about 50 nautical miles, OSD and Navy officials consider the F/A-18's added agility, speed, and self-defense capability to be a reasonable tradeoff. According to Navy and contractor pilots, the A-7 is considered extremely vulnerable due to its lack of agility and speed. OSD officials also pointed out that the mission radius of a light attack aircraft is limited by that of its fighter escort, since interdiction strikes with light attack aircraft are flown with an escort.

HYBRID CHIPS PRODUCTION

The main problem with the radar last year was the contractor's inability to produce enough electronic hybrid chips to meet the production schedule. According to Hughes officials, this is no longer a problem because of improvements in the manufacturing process. As of early October, Hughes was ahead of the hybrid chips requirement schedule.

DEVELOPMENT OF ADVANCED SYSTEMS UNDERWAY

Last year we reported that the Navy had determined that the F/A-18's success against future threats would depend largely on its all-weather capability and advances in survivability. We noted the following conditions which, if not remedied, would impede the aircraft's success:

--All-weather requirements for the aircraft were limited to air-to-air fighter conditions.

--Software for the electronic counter-countermeasures had not been refined and tested.

--The F/A-18 contract did not call for an identification system which differentiates between enemy and friendly aircraft beyond visual range.

Although there is still no Navy requirement for the F/A-18 to have all-weather air-to-ground capability, DOD officials say the aircraft will have improved all-weather attack capability compared to the A-7 aircraft. One improvement would be the addition of the Marine Radar Beacon Forward Air Controller System. The aircraft's manufacturer commenced a study on the integration of Beacon with the radar. This system which will be incorporated into the aircraft's radar is used for close air support. Ground troops have a transponder (Beacon) which the aircraft's pilot would use as a reference point for locating enemy positions. Work continued on the electronic counter-countermeasures. Although its development is still behind schedule, the contractor estimated that software development was 65 percent complete as of October 1980. Also during 1980, the Navy exercised its contract option authorizing the contractor to start developing a noncooperative target recognition capability which would enable the pilot to identify aircraft.

CHAPTER 3

F/A-18 RELIABILITY AND MAINTAINABILITY CONTINUE TO IMPROVE DESPITE PROBLEM AREAS

The reliability and maintainability experience of the overall F/A-18 weapon system has continued to improve throughout the full-scale development phase. The Navy has closely monitored the collection of reliability and maintainability data since the beginning of the flight test program. Navy officials expressed confidence that the F/A-18 will meet its reliability and maintainability goals and will represent a major improvement in the areas of reliability and maintainability when it enters the fleet. The F/A-18 has already achieved 1/ levels of reliability and maintainability, which are significantly better than current Navy aircraft. There are, however, several subsystems of the aircraft that are experiencing technical problems resulting in much lower reliability and maintainability than expected. These subsystems include

--the fuel system, primarily the number 4 fuel cell;

--the air turbine starter; and

--the mission computer.

In addition, achievement of high-maintainability goals depends on the satisfactory operation of built-in test. However, built-in test is not yet capable of adequately supporting aircraft maintenance and therefore represents a major uncertainty in the program.

HIGH RELIABILITY AND MAINTAINABILITY IS VITAL TO THE NAVY

Improving overall reliability and maintainability of Navy fleet aircraft is vital to assuring combat readiness and is a key ingredient to minimizing life-cycle costs. The modern weapon systems currently being developed are very complex. At the same time, though, the Navy is experiencing difficulties in recruiting, training, and retaining people to

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1/Comparisons of reliability and maintainability may not be exact because data collected on fleet aircraft is not as closely monitored as data collected during the F/A-18's development program.

maintain these systems. Retention problems result, in part, because the private sector is able to offer more lucrative employment benefits.

PLANNED AND ACTUAL LEVELS EXCEED THOSE OF CURRENT NAVY AIRCRAFT

The F/A-18 is being developed with reliability and maintainability designed at the beginning of the program. The development contract contains provisions requiring specified levels of reliability and maintainability to be demonstrated at various milestones in the full-scale development program and before production. In addition, the contract contains an award payments plan which provides for up to $24 million in incentive fees for the achievement of reliability and maintainability within an established range of interim goals during the full-scale development program.

Reliability

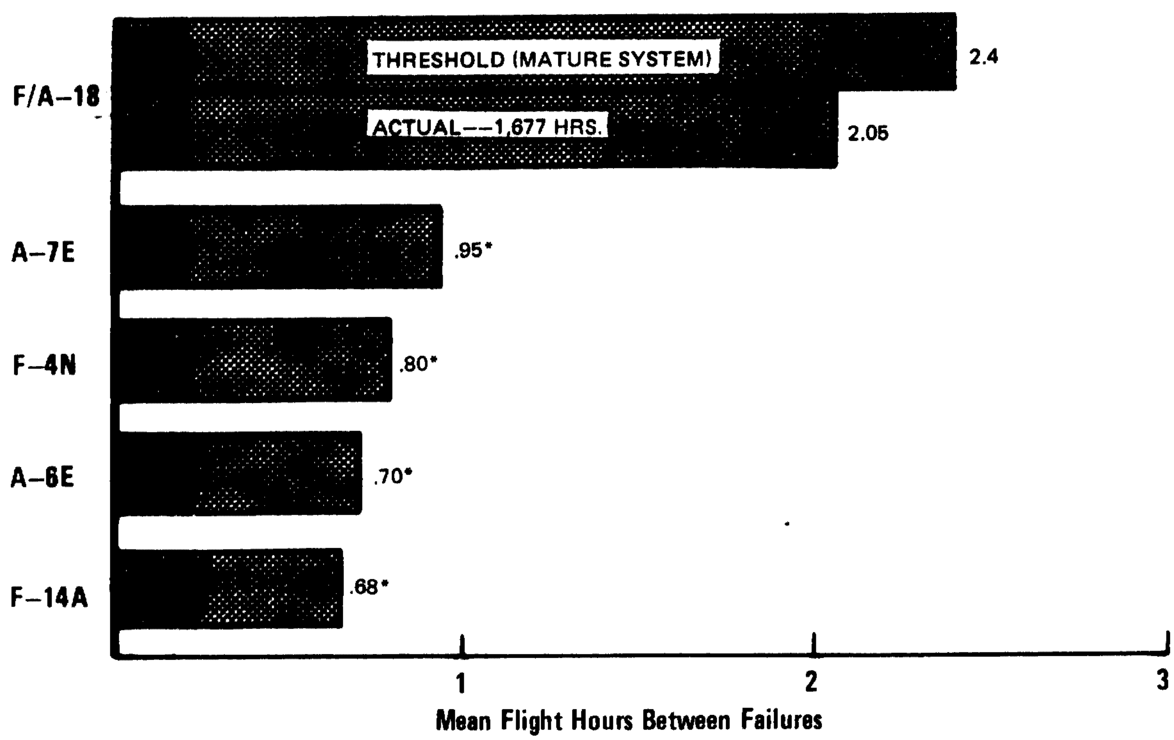
The basic reliability specification is expressed in mean-flight-hours-between-failures (MFHBF). The specification requires that the reliability of the weapon system equal or exceed 3.7 MFHBF. Compliance with the reliability specification is based on a 50-flight reliability demonstration, which was conducted during November 1980. There are also interim specifications requiring the aircraft to achieve a reliability at 1,200- and 2,500-flight hours of 2.9 and 3.7 MFHBF, respectively.

The award payments plan provides for incentive fees of up to $12 million for reliability. The contractor may receive award payments at the 1,200-flight hour milestone if the system achieves a reliability level of over 1.9 MFHBF. The potential award can be up to $4 million for the achievement of 4.0 MFHBF. An additional incentive fee may be earned on the 50-flight reliability demonstration starting at the achievement of over 2.77 MFHBF. This award can range up to $8 million for the achievement of 6.25 MFHBF. The 2.77 figure may be adjusted based on results at the 1,200-flight hour milestone. Since the award payments plan permits the contractor to receive incentive fees for performance below specification, Navy officials commented that the specifications for reliability and maintainability were intentionally set very high to encourage the contractor to strive for these levels. However, Navy officials felt that if the contractor came close to the specifications it deserved to be rewarded.

The F/A-18 weapon system had a cumulative reliability of 2.05 MFHBF after 1,677-flight hours in the full-scale development program and had demonstrated 1.93 cumulative MFHBF at the 1,200-flight hour point. Although the interim specification for 1,200 hours was not met and current reliability remains below the growth curve, the contractor demonstrated 8.5 MFHBF in the 50-flight, 100-hour reliability demonstration. Also, the F/A-18's MFHBF is above the Navy thresholds for the 1,200-, 2,500-, and 4,000-flight hour milestones and close to the mature system threshold of 2.4 MFHBF.

The F/A-18's reliability in the full-scale development program compares favorably with that of the Navy's F-4, A-6, A-7, and F-14 operational aircraft based on data from the Navy's Maintenance and Materiel Management System as shown in figure 1.

FIGURE 1
RELIABILITY COMPARISON



*BASED ON CALENDAR YEAR 1979 DATA

Maintainability

The basic maintainability specification requires that the mature F/A-18 weapon system attain a level of maintainability expressed in terms of direct maintenance man-hours per flight hour. Included in direct maintenance man-hours are direct scheduled and unscheduled maintenance man-hours and general support man-hours. The contract requires the contractor to demonstrate a level of maintainability of 11.02 1/ direct maintenance man-hours per flight hour during a 6-month fleet supportability evaluation beginning within 3 months of the activation of a fleet operational squadron designated by the Navy. Also, during the fleet supportability evaluation, the contractor is required to demonstrate maintainability in terms of turnaround time, mean-time-to-repair, mean-time-between-maintenance, fault isolate time, and removal/replacement times for the engine and radar. For example, the specified removal/replacement time for the engine, based on an average crew size of four, is 21 minutes. 2/

The award payments plan provides for incentive fees of up to $12 million for maintainability performance at 1,200-, 2,500-, and 9,000-flight hour milestones. The actual level achieved at 1,200 hours entitled the contractor to the entire $1.5 million incentive fee.

During the flight test program, the F/A-18 achieved a maintainability level which exceeds that of current Navy tactical aircraft. In terms of unscheduled maintenance man-hours, which is the measurement for maintainability used in the Navy's Maintenance and Materiel Management System, the closest Navy tactical aircraft to the F/A-18 is the A-7 with a maintainability level of 13.6 unscheduled maintenance man-hours per flight hour. The F/A-18 achieved a level of 4.9 unscheduled maintenance man-hours per flight hour after 1,677-flight hours based on the average of the preceding 6 months. This comparison, however, is rough since fleet maintainability data is not as closely monitored as data collected during the F/A-18's development program.

1/Personnel requirements are being based on the F/A-18 requiring 18 maintenance man-hours per flight hour instead of the design goal of 11 hours. (See "Operational and Support Costs of the Navy's F/A-18 Can Be Substantially Reduced" (LCD-80-65, June 6, 1980).)

2/Navy officials said that the contractor has already demonstrated an engine change in slightly over 16 minutes.

RELIABILITY AND MAINTAINABILITY PROBLEM AREAS

The Navy has reported relatively high levels of overall reliability and maintainability for the F/A-18 compared to existing Navy aircraft, but several of the F/A-18's subsystems have fallen well below expected levels of reliability and maintainability.

Fuel cell leakage

Navy and contractor officials agree that the leakage problem with fuselage fuel cell number 4 is by far the most serious problem with respect to reliability and maintainability. As of October 1980, 18 number 4 fuel cells had been replaced on 5 aircraft. The Navy reported in April 1980 that the recurring failure of the number 4 fuel cell has resulted in excessive maintenance and aircraft unavailability, which, in turn, has had a severe impact on the flight test program. The Navy reported further that continued failures of this nature will adversely affect fleet aircraft readiness, availability, spares, manpower requirements, and life-cycle costs. According to Navy officials, they cannot accept the current fuel cell situation in the fleet environment.

The F/A-18's fuel storage system is comprised of a fuel tank in each wing and four fuselage fuel cells, the largest of which is fuel cell number 4. The fuselage fuel cells are manufactured by Firestone and are made of a rubberized cloth material. The cells are installed inside cavities of the aircraft's fuselage. Fuel cell number 4 is a very large bladder, over 8-feet long, and it is designed to hold 554 gallons of fuel. The design of the fuel cell is complex in that fuel system plumbing passes through the cell requiring 105 pierce points which must be sealed. When the fuel cell is installed, it must be folded and strapped tightly to fit through a small access hole in the fuselage. Because of the limited space in the fuselage cavity, it is not possible to unfold, fit, and lace the cell in place without leaning or standing on the cell at some point during the installation process.

The difficulty of installation of the fuselage fuel cells, particularly the number 4 cell, is illustrated by the maintainability statistics compiled by the Navy. During the 6-month period ending July 12, 1980, 54 percent of the total organizational level unscheduled maintenance man-hours expended in the full-scale development program were devoted to fuselage fuel cell replacement and repair. Fuel cell number 4 required an average of 410 man-hours to repair or replace during the full-scale development program, resulting in an average downtime for the aircraft of 12 to 14 days. McDonnell predicts that a total of 153 man-hours will normally be required to remove and replace fuel cell number 4. These figures can be contrasted with a remove/replace goal for fuel tanks of 8.5 hours with a two-person crew, set forth in the original maintainability specification.

The problems with the complexity and difficulty of installation of the number 4 fuel cell have been compounded because the contractor has had difficulty producing acceptable fuel cells due to inadequate testing and quality control procedures. Even though modifications have been made and quality control procedures have been added, the DOD F/A-18 review group reported that the cell may have to be redesigned.

Leaks have also occurred in the other fuel cells and in the wing fuel tanks. These leakage problems are not viewed as being serious by Navy officials, since they are rare occurrences compared to the number 4 fuel cell problem.

Air turbine starter

The air turbine starter is a component of the secondary power system used to drive the airframe mounted accessory drive and to start the F404 engines, both on the ground and as a backup system in the air. We reported last year that contractor officials thought the air turbine starter would probably never meet its reliability requirement of 7,800 hours. The limited life of the starter continues to be a problem, and a requirement that the air turbine starter be torn down and inspected after 125 hours has been imposed on the flight test program. In addition, the questionable durability of the air turbine starter prevents its use to drive the airframe mounted accessory drive in the ground-maintenance mode. The Navy reported that the inability to use the ground-maintenance mode would adversely affect F/A-18 maintainability by increasing the need for supplementary ground support equipment for routine maintenance.

Although an improvement program was instituted, which resulted in a more durable starter, its expected life is less than 1,000 hours. Another conventional starter, designed by the same supplier has been selected for installation on production aircraft. After almost 600 hours of preflight verification testing, this latest starter has shown no signs of distress. After installation and checkout on full-scale development aircraft in January 1981, the starter is scheduled for installation on production aircraft beginning in June 1981.

Mission computer

The F/A-18's mission computer, which is a Government furnished equipment item, is achieving a lower than expected level of reliability. Each aircraft has two mission computers which control the navigation and weapons systems. The contract requires the mission computer to demonstrate a reliability of 1,500 hours mean-time-between-failures in a laboratory test to be conducted starting February 1981. However, to monitor the reliability improvement of the mission computer during the flight test program, a reliability improvement schedule was developed by converting the specification into MFHBF. After 2,400-flight hours, the mission computer had a reliability of 122 MFHBF compared to a desired reliability of 500 MFHBF as shown on the reliability improvement schedule. The Navy reported in July 1980 that an increasing difference between measured reliability and the desired reliability exists and that unless the trend is reversed, the mission computer will not meet its specification.

Built-in test

The development of built-in test, on which the F/A-18's maintenance concept is based, is behind schedule. The Navy reported in June 1980 that built-in test was not fully capable of providing the maintenance and failure information necessary to adequately support aircraft maintenance. In addition, it was reported that if the F/A-18's maintenance concept cannot be followed because of undependable built-in test, there will be an adverse impact on aircraft availability, operational readiness, and maintenance man-hours.

The built-in test is designed to present advisories and cautions to the pilot on the cockpit displays and to store test information which can be viewed on the maintenance monitor panel located in the aircraft's nose wheel well. The test information should appear on the monitor only if the aircraft equipment has failed, certain performance parameters are exceeded, or certain consumables need replenishment. The F/A-18's maintenance concept requires maintenance personnel to check the maintenance monitor panel before performing maintenance on components equipped with built-in test. If no information appears on the maintenance monitor panel, then the aircraft is supposed to be fully operationally ready and no maintenance is required. However, March 1980 Navy Preliminary Evaluations and data reported in mid-summer 1980 confirmed an extremely high built-in test false alarm rate.

Navy officials said that this data may not be representative of the true-false alarm rates. They said that during the period between July 14 and September 2, 1980, there were only 14 actual failures in equipment that had operational built-in test, while more than 350-flight hours were accumulated. The high reliability of the equipment resulted in a small data base from which to compute the false alarm rate.

Contractor officials said that the development of built-in test was behind schedule, but starting in May 1980 increased management emphasis was placed on built-in test to improve its operation before the Navy's initial operational test and evaluation, which began in October 1980. However, the results of this evaluation were not available by the completion of our review in November 1980. According to Navy officials, negotiations are underway with the contractor to provide an incentivized built-in test demonstration during the final Navy Preliminary Evaluation and Board of Inspection and Survey trials as well as during the first 3,500 hours of operations of the limited production aircraft.

CHAPTER 4

F/A-18 PROGRAM COSTS ARE STEADILY INCREASING

Dramatic increases in the estimated costs of the F/A-18 program have raised considerable interest, especially within the Congress. Congressional concern has grown because the F/A-18, which was intended to be a low-cost replacement for the Navy's and Marine Corps' F-4 and the Navy's A-7 and also as a complement to the Navy's F-14, has exceeded cost expectations and is continually increasing in cost. Currently, the F/A-18 program is the Navy's largest aircraft program in total funding requirements and production quantities.

The Navy and OSD officials cited several reasons for the increases in estimated F/A-18 program costs. Also, we identified other factors which could affect future program costs. We believe F/A-18 program costs could continue to rise to a level which could, because of budgetary constraints, lead to a reduction in F/A-18 procurement quantities, thus impairing the Navy's ability to adequately meet its tactical air requirements.

REASONS FOR F/A-18 COST INCREASES

The September 1980 F/A-18 Selected Acquisition Report shows the total program cost estimate to be $29.7 billion. Current internal DOD estimates for the program range as high as $41 billion. This estimate consists of $2 billion for research, development, test and evaluation, and the F/A-18 review group's $39 billion production cost estimate which was based on the actual cost of the first 17 F/A-18 production aircraft and includes higher adjustments for projected increases in future vendor and subcontractor costs. This estimate also assumes a slower buildup of production quantities than is assumed in developing the Selected Acquisition Report estimate. Navy officials have acknowledged that program costs will increase above the costs reported in September 1980, and they said that future F/A-18 Selected Acquisition Reports will reflect cost estimate increases but believe the $41 billion estimate is excessive.

The Navy's baseline estimate, established in fiscal year 1975, was $12.9 billion. The rise in estimated costs over the baseline estimate to the $29.7 billion and $41 billion estimates are attributable to (1) an increase in procurement quantity, including changes in attack, reconnaissance, and trainer requirements, (2) inflation, including adjustments for inflation for the baseline quantity and inflation associated with the added production aircraft, and (3) other cost growth.

Related to these three factors, the $28.1 billion increase to arrive at the $41 billion estimate consists of $3.9 billion (14 percent) for quantity changes, $18.2 billion (65 percent) for inflation, and $6 billion (21 percent) for other cost growth.

Quantity increase

In fiscal year 1979, the Navy increased the F/A-18 procurement quantity from 811 to 1,377 aircraft and increased the program cost estimate by $8.6 billion. Approximately $3.9 billion of the increase was attributed to the procurement of the 566 additional aircraft, associated program changes, and additional support costs. Projected inflation associated with the added production aircraft and inflation adjustments for the baseline estimate accounted for the remaining $4.7 billion.

Other cost growth

Based on the $41 billion estimate, the program has experienced about $6 billion in cost growth attributable to scheduling 1/, engineering, estimating, and support changes, as well as overruns in the full-scale development, pilot production, and limited production phases of the program. Navy officials estimated that $5.2 billion of the $6 billion is attributable to approved program changes other than quantity changes (such as production rate changes), thus contending that other cost growth incurred in the development and production of the F/A-18 is only about $800 million.

McDonnell, Hughes, and Northrop are experiencing cost growth because of program changes and cost overruns. The following illustrate the types of cost growth being experienced in the program:

--McDonnell's full-scale development costs (including Northrop's costs) have increased $625 million. Abnormal fluctuations in the economy, Hughes/Northrop supplier contract awards, and change proposals account for $211 million of the increase. The remaining $414 million is due to program cost overruns. McDonnell's pilot and limited production costs have increased $49 million and McDonnell anticipates an additional $3 million increase.

1/Scheduling changes have been directed by the Congress, OSD, and the Navy.

--Northrop's full-scale development costs have increased an additional $69 million since our report last year due primarily to correction of deficiencies. In our previous report, we noted that Northrop had incurred a $159 million increase in full-scale development costs because it had underestimated its assembly man-hour requirements. Northrop has shown improvements in that area and appears to be making progress toward successfully reducing the man-hour requirements to its planned goal.

--Northrop projects an immediate $27 million cost overrun on a recently negotiated fixed-price contract for pilot and limited production aircraft. Northrop attributes this overrun to the use of understated overhead rates during contract negotiations and the acceptance of a contract price which was less than the projected contract costs. As of October 1980, an additional cost increase of $14 million was being projected due to fuel cell, bulkhead, and quality control problems.

--Hughes has incurred cost increases which have caused it to forego all profits and sustain a substantial loss on the current contract. For example, the cost of one complex hybrid chip increased from an estimated $40 to over $1,000. Hughes also estimates that the average radar cost for fiscal year 1982 will be $1.29 million, a 44-percent increase over the fiscal year 1981 cost of $894,000.

There are indications that other subcontractors who are under fixed-price contracts with McDonnell have also sustained losses on their contracts. McDonnell does not report actual costs incurred by its subcontractors. It reports only the contractors' ceiling prices. Consequently, total F/A-18 program costs are understated by an undeterminable amount of the losses sustained by McDonnell's subcontractors. Moreover, these cost overruns could be indicative of future increases in production costs.

Inflation

Although there has been other cost growth, about 65 percent of the difference between the Navy's baseline cost estimate and the $41 billion estimate is attributable to (1) low-inflation rates being used for the baseline cost estimate and (2) inflation attributable to the 566 aircraft added to the program in fiscal year 1979. Periodic adjustments for actual inflation rates or to revise the projected rates have significantly increased total program costs.

We anticipate cost estimates will continue to be understated because of the continued use of low-inflation rates.

The Navy is required to use inflation rates prescribed by OSD in accordance with the Office of Management and Budget instructions. Inflation rates have been lower than actual inflation 1/ and consequently have resulted in an inaccurate estimate of F/A-18 program costs. Navy officials agree that DOD inflation rates are too low to keep pace with the steady increases in aerospace industry costs. For example, one Navy official said that if aerospace industry inflation rates had been used, the fiscal year 1981 budget submission for 60 aircraft would have been 15 percent higher than the actual submission.

In addressing the problem of understated rates, OSD makes periodic adjustments to its inflation indexes. Since fiscal year 1979, the indexes have been increased several times. Current projections also appear to be understated. The projected rates for fiscal year 1981 through 1986 average 7.9 percent. This average is well below the projection by aerospace industries of 13.3 percent over the same period.

Another problem caused by low-inflation projections is related to budgeting. The Navy's budget is based on the prescribed inflation rates. As a result, according to Navy officials, approved budgets for the F/A-18 program since fiscal year 1977 have not included adequate funding for the inflation which has occurred between the time funds are requested and the time they are spent. They said that the deficit totals about $600 million and that they have had to resort to such measures as reducing program needs, delaying work, and delaying acceptance of deliveries.

OTHER FACTORS WHICH COULD AFFECT FUTURE F/A-18 PROGRAM COSTS

Several other factors exist which could affect the F/A-18 program costs estimate. The uncertainty associated with these factors, however, makes it difficult to assess their impact.

1/According to Navy officials, only the inflation rates for years since mid-1978 have been lower than actual inflation.

Production rates

The yearly F/A-18 production rate significantly affects F/A-18 program and unit costs. Economies of scale is an important factor. Larger annual procurement quantities allow overhead costs to be spread over more aircraft, resulting in less cost per aircraft. In addition, large procurement quantities in the early production years allow the program to be paid for with less inflated dollars. According to the Navy, the increase in procurement quantity from 48 to 60 F/A-18s for fiscal year 1981 resulted in a 5-percent reduction in F/A-18 unit flyaway cost. 1/ However, the number of F/A-18s which will be procured in each production year remains uncertain. The F/A-18 program continues to have various procurement alternatives for the initial production years which extend through 1986.

This uncertainty in actual procurement quantities does not allow contractors time to adequately plan for the long term procurement of raw materials and components necessary for future production. Long term procurement helps contractors avoid long production leadtimes which result in schedule delays and additional program costs.

AV-8B aircraft program

The U.S. Marine Corps is scheduled to receive a portion of the 1,377 F/A-18s currently planned for production. The Marine Corps and some congressional officials, however, have expressed preference for the AV-8B Advanced Harrier as their attack aircraft because it has vertical/short takeoff and landing capability. If a decision is made to procure the AV-8B, the F/A-18 procurement quantity will be reduced, the total F/A-18 program cost estimate would decrease, and the average unit cost per aircraft would increase.

Foreign sales

A number of foreign countries are expressing varying degrees of interest in purchasing the F/A-18. Canada has already contracted to purchase the F/A-18 after an independent assessment of available alternatives. In addition, Australia and Spain have initiated requests for proposals for purchase of aircraft. Foreign purchase of the F/A-18 could result in considerable reductions in program and unit

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1/Unit flyaway cost is defined as the cost of producing the airframe, engine, and avionics.

costs. For example, a Navy official said that the Canadian purchase will reduce F/A-18 program costs by $0.5 billion to $1 billion. The reduction associated with aircraft purchases approved for fiscal year 1981 could be as much as $90 million. Future foreign sales would have a similar impact on F/A-18 program costs.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The F/A-18 has continued to improve during development and has made noteworthy achievements in certain areas. For example, according to DOD and Navy officials, acceleration is impressive between 0.8 and 1.2 Mach, the area they feel most critical to the F/A-18's mission requirements. Also, successful results were reported by the Navy in the F/A-18's missile and gun firing tests. A special DOD review group has concluded that, pending the successful demonstration of the roll-rate modification, the F/A-18 is expected to be operationally suitable to meet its mission. Among other issues, the review group considered the F/A-18's inability to achieve acceleration and range thresholds before arriving at its conclusion.

However, cost and technical problems continue. The two recent F/A-18 crashes have unquestionably set the program back, but the total effect is not known. Although there has been some cost growth, costs have soared primarily because of the inflation impact. Also, even though substantial increases have already been reported, the current program cost estimate is based on projected escalation rates which are considerably lower than those projected by industry. If actual escalation rates continue to be higher than rates used by DOD, program cost estimates will continue to be understated.

Work to resolve technical problems reported last year continues along with efforts on recurring fuel cell leakages and a roll-rate problem. In addition, the loss of two F/A-18s compounds the Navy's problems in developing the aircraft.

Navy reliability and maintainability reports have been favorable even though certain subsystems have failed to achieve expected levels. Such subsystems as the number 4 fuel cell; the air turbine starter; and the computer systems' software, including the built-in test programs, have been especially damaging to reliability and maintainability performance.

Action has been taken by the Navy and the contractors on some of the problems discussed last year such as initiating the development of advance systems, improving the all-weather air-to-ground capability by incorporating the Marine Radar Beacon Forward Air Controller System, and improving the manufacturing process on the electronic hybrid chips used in the radar.

A major benefit to the program, since our last report, was the decision by the Canadian Government to buy the F/A-18 after an independent assessment of available alternatives. Also, other foreign governments have expressed an interest in the F/A-18.

RECOMMENDATIONS

We recommend that during fiscal year 1982 budget hearings, the Secretary of Defense should

--identify the development, production, and operational risks associated with the outstanding technical problems;

--identify the production cost estimates associated with higher and lower production quantities than requested for fiscal year 1982, including the most efficient and economical production rate; and

--provide a program cost estimate based on realistic inflation rates.

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