BY THE COMPTROLLER GENERAL 12848

Report To The Congress

OF THE UNITED STATES

F/A-18 Naval Strike Fighter: Its Effectiveness Is Uncertain

Preliminary tests indicate that the F/A-18 weapon system is superior in a number of areas to the aircraft it is to replace--the F-4, A-4, and A-7. However, until the F/A-18's deficiencies, including those in its armament systems, are resolved, its effectiveness to perform its missions is uncertain.

Delays in testing and in correcting problems may be costly if significant production occurs before corrections are made, but Navy officials contend that increased costs caused by a production slowdown could exceed the costs of correcting problems after the aircraft has been produced.

Contractor production difficulties and overly optimistic cost and schedule estimates are contributing to significant cost growth in the program. Program funding uncertainties are also having an adverse impact on the ability to control costs.

GAO makes a number of recommendations to the Secretary of Defense, including delaying the production rate increase until performance problems are corrected and testing is completed, giving priority attention to the F/A-18's self-protection and all-weather capability, and reassessing the cost of the program and reporting it to the Congress.

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FEBRUARY 14, 1980

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 CW000001

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This report presents our views on the major issues concerning the Navy's F/A-18 strike fighter program. Agency officials associated with the program reviewed a draft of this report, and their comments have been incorporated as appropriate.

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 1981 requests for funds.

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

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

F/A-18 NAVAL STRIKE FIGHTER: ITS EFFECTIVENESS IS UNCERTAIN

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-engined aircraft can be based on aircraft carriers and will perform such missions as fighter escort, fleet air defense, interdiction (bombardment of enemy lines), and close air support.

However, the F/A-18 and its armament systems have problems. The flight test program has identified problems in areas critical to performance, including acceleration and range. The aircraft's mission effectiveness is limited by the armament it carries and by delayed development of its self-protection and all-weather capabilities. These problems must be corrected if the aircraft is to fulfill its mission requirements effectively. (See ch. 2.)

Despite delays in testing and in correcting performance problems, the Navy is adhering to its tight program schedule. It is not delaying production decisions, and this may be costly. In past aircraft programs that developed and produced a system at the same time, numerous performance problems proved to be costly both in dollars and lessened aircraft performance. The Congress should not permit the F/A-18 program to follow this path. (See ch. 3.)

Costs of the F/A-18 program have grown markedly and could grow more, even though cost reduction efforts have been made in such critical areas as testing for reliability and maintainability. (See ch. 4.)

Contractors' production problems and problems in areas not controlled by the Navy, such as

This report was discussed with Department of Defense officials responsible for the F/A-18 aircraft program. Their remarks were included as appropriate.

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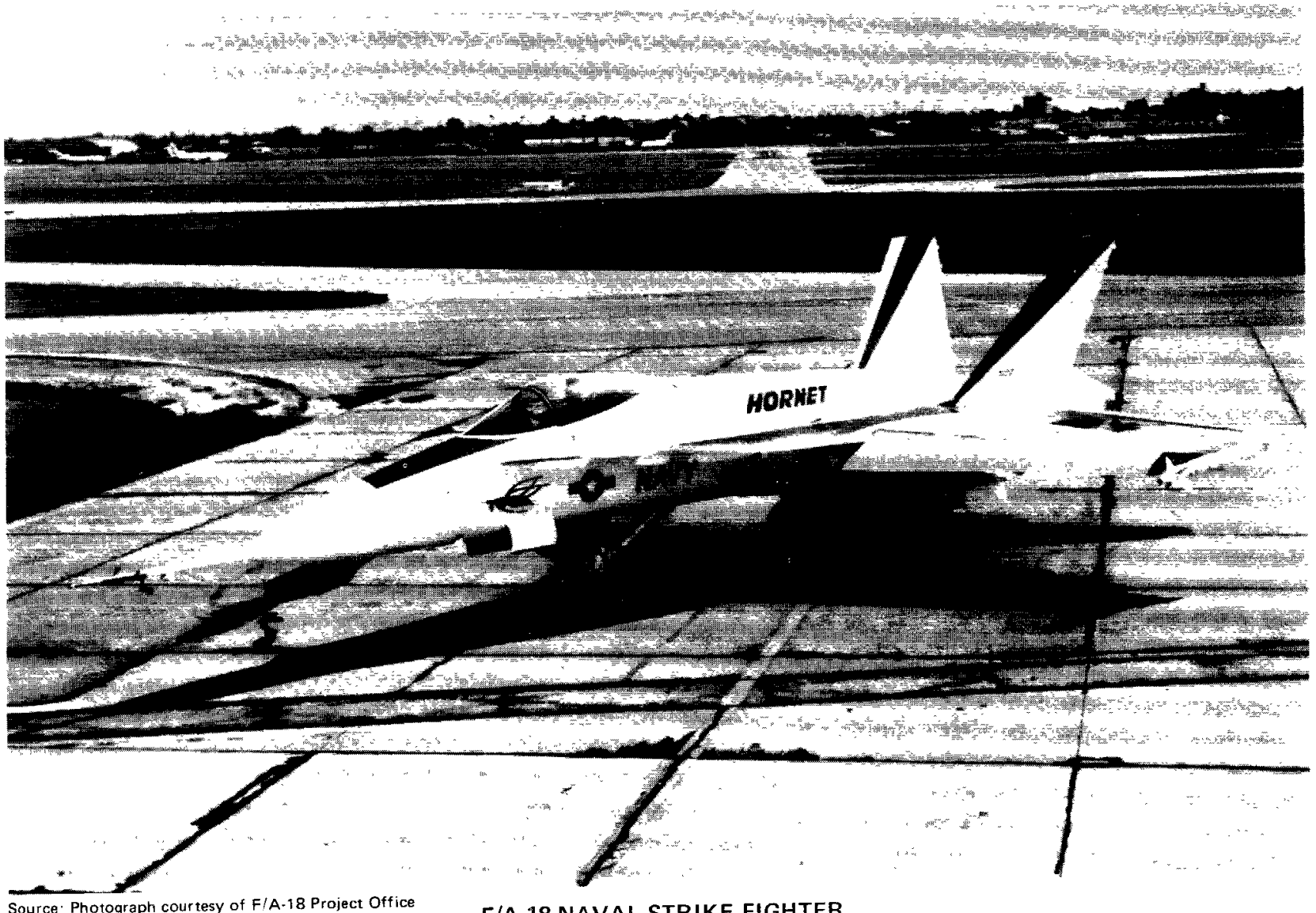


Source: Photograph courtesy of F/A-18 Project Office

F/A-18 NAVAL STRIKE FIGHTER

CHAPTER 1

INTRODUCTION

The F/A-18 strike fighter is a twin-engined aircraft that can be based on aircraft carriers. It is 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 fighter escort, fleet air defense, interdiction, and close air support.

F/A-18 full-scale development began in early 1976, and the first flight was made in November 1978. The 11th and final development aircraft to be produced is expected to be delivered by January 1980. The Navy anticipates beginning full-scale production in March 1980, with the first squadrons deployed in 1983. The Navy estimates the cost of developing and procuring 1,377 aircraft to be $24 billion.

The F/A-18 fighter and attack configurations will be identical, except for different external equipment or ordnances 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 only 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 or Walleye); a forward-looking, infrared, laserspot tracker; and strike cameras for air-to-ground attack. The internal 20-millimeter gun and wingtip Sidewinders will be retained in all configurations. (See app. I for number and type of armaments.)

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 capabilities for attack operations. It is capable of providing a multitude of information to the pilot upon command.

F/A-18 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 for the F/A-18. McDonnell

of the latest evaluations made in flight testing the F/A-18. This knowledge, in turn, might have affected our conclusions on the severity of problems facing the F/A-18 program and the aircraft's mission capability.

We were not given access to Navy evaluations of flight test data, particularly that data related to identified performance deficiencies. For example, although we first requested them in July 1979, as of December 20, 1979, we were unable to obtain Navy analyses of the Navy Preliminary Evaluation testing conducted in April 1979. On December 20, 1979, Navy officials advised us that test results expected to be published by December 31, 1979, would be provided to us. Receipt at this late date would not permit sufficient time for us to analyze and comment on the results and include such comments in this report.

building the F/A-18. These generally are more stringent than the Defense thresholds.

The F/A-18 threshold for acceleration has not been attained, and initial specifications for several performance areas, including range, have not been achieved. (See app. II.) Additionally, the speed required for nose-wheel lift-off on the aircraft was higher than predicted. To varying degrees, excessive weight, drag, and possibly reduced engine thrust have contributed to these performance problems.

Acceleration threshold not reached

Based on the Defense threshold, the F/A-18 should accelerate from Mach 0.8 to Mach 1.6 at 35,000 feet within a specified period of time. As of November 21, 1979, this requirement had not been met in F/A-18 flight tests. The tests showed that the aircraft's time was over the Defense threshold from 9 to 27 percent. Neither the Navy nor contractor officials could say specifically why the aircraft did not accelerate as expected, what will be done to correct the problem, or exactly when this problem will be corrected. Navy officials said the acceleration problem occurs in a speed range which will be infrequently flown. They also said the problem could be solved easily by increasing engine thrust, but this would reduce engine reliability and durability, two factors given high priority in the F/A-18 program.

As of November 21, 1979, McDonnell had informed the Navy that the acceleration time had been brought down to just over the threshold through minor aircraft design changes. Navy verification of this and any other related corrective action is scheduled for February or March 1980.

Range is short of Navy expectations

Defense and Navy thresholds are also established for the range of the F/A-18. Based on test results and analytical projections, the F/A-18 as of November 21, 1979, could not meet those specifications. While Navy officials said added range could be achieved through the use of extra fuel tanks, such a move is not desirable. We are not aware of any currently proposed solutions to this problem by either the Navy or McDonnell.

Navy officials stated that range performance will be reevaluated in February and March 1980 after modifications to the aircraft.

Navy officials said a contractor weight reduction program for 341 pounds has been approved, which, if successful, will get the total aircraft weight back down to the Navy's approved weight. However, the full 341-pound reduction would not take effect until the 123d aircraft.

While 1,600 pounds of excess weight might be acceptable, the potential for additional unacceptable weight growth does exist. Much testing remains to be done; and, when problems are discovered, the solutions frequently add weight. Historically, aircraft programs have encountered weight growth after the aircraft were in production. We have no reason to believe this will not happen to the F/A-18 as well. Navy officials believe weight growth in the production aircraft should be minimal due to better planning, better control, and earlier testing in the program.

Higher-than-anticipated drag

The less wind resistance (drag) an aircraft is designed to have, the greater its flight performance in areas such as range and acceleration will be. Navy officials feel that drag is contributing to the F/A-18 performance problems.

An F/A-18 is being flown to assess the effect of airflow patterns on it. Various changes have been made to the airframe to redirect the airflow and reduce the aircraft's drag. Until more flight test data has been received and evaluated, prime contractor officials cannot predict the changes required or the time needed to design and incorporate the appropriate changes into the F/A-18.

Lower engine thrust

Prime contractor officials stated that the engine thrust is above specifications at sea level, but they feel that thrust problems are occurring at higher altitudes. They think that a partial solution would be to preheat the engine, by using the afterburner in flight for about 2 minutes, to improve performance. However, Navy and engine contractor officials disagree and state that test results show the engine meets thrust requirements at high altitudes as well as at sea level. They also believe that the engine operates best at the design temperature levels and feel that using the afterburner to heat up the engine would not be practical from the standpoint of fuel consumption and, therefore, would not be operationally effective. The Navy said that further testing for compliance of engine thrust specifications is a part of the planned test program and that specific tests of the engine's thrust are scheduled for early 1980.

ammunition is ineffective. Past attempts to improve the ammunition deficiencies have been given low priority and have not been funded by the Navy. A proposed $467,000 product improvement program is currently pending in the Navy, but as of November 20, 1979, it had not been approved for funding.

Sparrow missile reduces F/A-18 survivability

The F/A-18's ability to evade enemy fighters enhances its survivability; however, this capability is negated by the Navy's plans to use the Sparrow. This missile requires the aircraft to keep its radar locked on target until after the missile hits. During this period of restricted maneuverability, the F/A-18 is, as are all other fighter aircraft, vulnerable to enemy fighters.

Sidewinder missile capability limited

The Sidewinder is a short-range, infrared guided missile. To hit a target, the missile locks on the heat being emitted by the target. Recent tests have shown that enemy aircraft can successfully elude the Sidewinder.

Harm deficient

The Harm missile is an air-to-surface guided missile to be used by the Navy and Air Force for destroying or suppressing the radar of enemy air defense artillery and surface-to-air missile systems. The system which will be used on the F/A-18 aircraft includes an air-to-surface missile and equipment on the aircraft to interface with onboard avionics and to provide guidance data to the missile.

Navy officials acknowledge that Harm development missiles are experiencing some performance deficiencies, which they say will be corrected prior to a production start. They emphasized that Harm operational missiles will meet full performance requirements.

We plan to issue a report on the Harm missile in February 1980.

ADVANCED SYSTEMS PLANNED FOR F/A-18 SLOW IN DEVELOPMENT

The Navy has determined that the F/A-18's success against future threats will depend largely on its all-weather capability and advances in survivability. The advances will

for an identification system. Navy officials stated that they plan to develop a noncooperative target recognition capability which would enable the pilot to identify all known aircraft. They hope to get these development efforts underway sometime after March or April 1980.

Late aircraft deliveries slowed flight testing

Delivery of each developmental aircraft was late an average of 2 months, thus contributing to the flight test program delay. The total program setback caused by the delivery delays, according to the Navy, is from 2 to 3 months.

Late deliveries were primarily attributed to Northrop's production problems, as indicated by the results of Navy reviews and comments by various officials at Northrop, McDonnell, and the Navy. They felt that Northrop underestimated the production requirements for the F/A-18. Northrop estimated 67,500 production hours per developmental aircraft but actually took between 93,000 and 147,000 hours per aircraft. Contributing to Northrop's production problems were poor plant layout; required major redesign of the F/A-18's environmental control system for improved maintainability; and recurring problems with fit, access, and leakage of the F/A-18's fuel cells.

Weather conditions delayed flight testing

The F/A-18 program is the first Navy program employing single-site testing. Under this concept, almost all contractor and Navy flight testing is done at one facility, in this case the Naval Test Center, Patuxent River, Maryland. Although Navy and contractor officials agreed that, in concept, single-site testing is more efficient, they also noted that weather conditions have actually delayed flight testing. McDonnell requires visibility of 5,000-feet high for a distance of 5 miles for most flight testing. Officials said that, on approximately 30 days between April 1979 and August 1979, these weather conditions could not be met and flight tests were canceled. Furthermore, the contractor feels that between October 1979 and March 1980 weather will be even more of a hindrance and has consequently reduced the number of test pilots and support staff committed to the program at the Center during this time. While Navy officials acknowledge delays due to weather at Patuxent River, they said single-site testing has led to greater knowledge about the aircraft earlier in development than previous aircraft programs.

FURTHER TESTING DELAYS DUE TO SYSTEM DEFICIENCIES

The flight test program has advanced to the stage at which aircraft system problems have been identified. Many

if necessary, in the air. Two starters are installed on each aircraft, one for each engine. In a test flight, a starter failed. A problem analysis revealed that an inner bearing had caused a series of reactions that eventually led to the failure.

The specified reliability requirement for the starter is 7,800 hours. Contractor officials thought that the starter would probably never meet the 7,800-hour requirement. They estimated that 500 to 1,000 hours would probably be more realistic. As a result, they are considering a basic redesign as well as an alternate design from another supplier. It will take between 1-1/2 to 2 years to incorporate a new starter into the production line. Improved versions of the existing starter are being flight-tested, and increased inspections are being accomplished to preclude another inflight failure.

Oil temperature exceeds allowable limits

On at least eight flights, critical oil temperatures were approached or exceeded in the airframe mounted accessory drive (a unit which drives some of the hydraulic and secondary power systems) and in the hydraulic systems. The oil in these systems is cooled by the aircraft's fuel. These high temperatures have caused operating restrictions in aircraft flights, and consideration is being given to redesigning the oil cooling systems.

Air-conditioning system does not provide adequate cooling

The environmental control system provides the air-conditioning for the cockpit and the avionics equipment. Installation difficulties combined with maintenance problems disclosed by laboratory tests led to redesigning the system. However, problems were encountered with proper cooling and the system's producing a mist. Contractor and Navy officials believe appropriate corrections have been made for most of the problems and point out that the system now exceeds its design requirement for maintainability. However, the Navy has not tested and verified the corrections.

FURTHER TESTING DELAYS POSSIBLE IF SYSTEM DELIVERIES LATE

The absence of corrective action for delays in radar and mission computer deliveries opens the door to future testing

CHAPTER 4

COST GROWTH IMMINENT IN THE F/A-18 PROGRAM

F/A-18 program costs have grown during the developmental phase, and current estimates are that costs will keep growing for the remainder of development as well as for production. Program cost increases have caused some redirection of the program and could possibly cause more. The incurred and anticipated cost growth can generally be attributed to (1) contractor production problems, (2) problems found during flight testing and system development, (3) factors beyond the Navy's control, and (4) frequent fluctuations in procurement quantities.

F/A-18 COST GROWTH

The current estimated cost for the approved F/A-18 program of 1,377 aircraft is $24 billion--an average cost of $17.4 million per aircraft. This is an $11.1 billion program increase over the Navy's initial estimate of $12.9 billion for 811 aircraft ($15.9 million per aircraft). Navy officials said their actual F/A-18 requirement will be 1,845 aircraft at a total program cost of approximately $30 billion.

Navy officials also said that some reliability and maintainability testing will not be done as a result of cost reduction efforts. We were informed that only about half of the items on the reliability critical items list were selected for operational mission environment testing. Such items as the stores management set, main landing gear wheels and brakes, and the skid control system were not included in this testing. A Navy representative stated that the items selected for operational mission environment testing from the reliability critical list were chosen following a cost-effectiveness analysis of all the critical items to decide which ones to test. This reduction has occurred despite the high priority that reliability and maintainability are supposed to receive in the program.

CONTRACTORS' PRODUCTION PROBLEMS SPAWN PROGRAM COST GROWTH

Inability of F/A-18 contractors and subcontractors to accurately predict the requirements for producing deliverable aircraft parts has already caused cost growth totaling approximately $281 million in the full-scale development program and in all probability will cause production cost growth.

For example, computer units for the F/A-18 program are expected to cost $100,000 to $125,000. Additionally, the research and development program now nearing completion is 18 months late. To meet delivery schedules, incomplete F/A-18 computers have been delivered, which may require retrofit at an estimated cost of $1.4 million. Further retrofit costs are expected, and unanticipated computer support requirements will cost the F/A-18 program another $1.4 million.

Navy officials primarily attribute the computer research and development delays and $16 million of the $30 million cost growth to the contractor's poor management and pricing estimates. Additionally, the F/A-18 mission computer underwent several design and configuration changes, often at the request of the Navy or McDonnell. These changes delayed deliveries and added costs.

Radar production problems could have long-term cost impact

At the time of our review, Hughes was losing money under its radar contract with McDonnell and was behind delivery schedule by five radar units due to production problems.

Hughes is experiencing problems in manufacturing electronic hybrid chips which are parts used in the radar. Hughes officials admit that they underestimated the radar's complexity and the state of the art required to produce hybrid assemblies. They have established a comprehensive program to improve the design and production of hybrids, but manufacturing and testing equipment will not be in place to support full production of the radar for more than a year.

Although no specific cost increase related to this problem was cited by either the Navy or Hughes, we believe that actions to correct difficulties in producing hybrids could, in turn, lead to cost increases in future radar production.

Possible subcontractor production problems pose potential for cost growth

Many subcontractors contribute to the development and production of the F/A-18. Because many of them are working under fixed-price contracts, neither the Navy nor the major contractors formally monitor these subcontractors' cost performances. The extent to which subcontractor financial problems will raise program costs when contract negotiations

to compile budget estimates are prescribed by the Office of the Secretary of Defense in accordance with Office of Management and Budget instructions. The rates range from 5.4 percent to 6.3 percent for full-scale development and production. This compares to the current Bureau of Labor Statistics inflation estimate of 13 percent and an Air Force estimate of 19 percent for the aerospace inflation rate. Consequently, the program is facing more costs than currently estimated, thus forcing program constraints.

Contractor overhead rate increased

Overhead in the F/A-18 program is generally a constant figure based on that percent of a contractor's facilities devoted to the program. The overhead rate for the F/A-18 has been high from the beginning for a number of reasons. One reason is the currently small number of aircraft to which the total overhead pool can be applied for such a potentially large program. However, additional overhead costs are being incurred by one contractor.

Northrop Corporation has, in addition to the F/A-18, been responsible for building F-5 fighters. Consequently, Northrop's overhead was shared by these two programs. However, Northrop's F-5 production has been reduced, resulting in an 8-percent cost increase in F/A-18 program overhead. Navy officials said similar overhead cost increases will be faced as McDonnell's F-15 fighter production program is reduced.

Foreign military sales could reduce costs

Historically, aircraft contractors have sought foreign military sales as a means of reducing production costs as well as extending their production runs and business base into later years. The F/A-18 program has been hampered in this area.

McDonnell and Northrop have received considerable interest in the foreign market for both the carrier-based and land-based models of the F/A-18. Canada has selected the carrier-based model as one of the finalists for its fighter aircraft program and should announce the winning aircraft shortly. Both the carrier-based model and the land-based model are finalists in Australia's and Spain's current competitive programs. Final decisions on both programs are expected by mid-1980. Other countries, including France, Israel, Sweden, Greece, and Turkey, have also expressed varying degrees of interest.

CHAPTER 5

MANAGEMENT DEVICES NOT ADEQUATE

Reports on various performance requirements have been established, supposedly to better manage the F/A-18 program and to apprise the Congress of the program's progress. However, some of these reports have been incomplete.

CURRENTLY REPORTED DESIGN-TO-COST INFORMATION USELESS

A design-to-cost threshold was established for the F/A-18 program in an effort to get the best aircraft design for the money. Based on this threshold, related contractor design-to-cost goals were also established. Navy and contractor performance, when compared to these requirements, are intended to provide a good measure of their management effectiveness. However, the currently reported F/A-18 design-to-cost threshold and goals are not useful. Since their establishment, various factors which were used to develop the program's design-to-cost threshold and goals have fluctuated frequently because of Department of Defense and congressional decisions.

Because of these fluctuations, the Navy has not been able to revise the program's design-to-cost threshold and consequently has stopped monitoring it. However, the Navy has continued to report the useless, old design-to-cost threshold to the Congress, even though it concedes the threshold has probably been exceeded.

Additionally, the absence of clear, concise Defense direction has resulted in confusion over what design-to-cost thresholds should include and what design-to-cost means. For example, F/A-18 officials feel design-to-cost data should reflect fluctuations in only those cost factors, such as labor hours and material quantities required, which are controllable. However, others believe that even uncontrollable factors, such as wages, overhead, and materials, should be included in design-to-cost computations.

Because reports generally do not adequately explain how design-to-cost data is computed, its usefulness as an indicator of F/A-18 progress is limited. F/A-18 officials feel that design-to-cost data is a management tool only and that to attempt to explain its makeup in documents such as the

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

The F/A-18 is superior to other Navy aircraft in some areas. Its mission capability is uncertain, however, because its planned performance has been reduced and several performance problems remain uncorrected.

Delays in correcting performance problems and in scheduled performance testing have resulted in greater concurrency risks in the already tight F/A-18 program schedule. Past aircraft programs with similar levels of concurrency and performance problems have proven to be costly both in dollars and lessened aircraft performance. Consequently, any decision to increase the current F/A-18 monthly production rate should depend on whether these problems are resolved and tested and whether Navy assessments show the aircraft can accomplish its missions. Also, the Congress should not permit the F/A-18 program to repeat concurring problems of former aircraft.

The F/A-18 program has experienced much cost growth; and it is likely to grow more, even though cost reduction efforts in such critical areas as testing for reliability and maintainability have been made. Contractors' production problems and problems in areas not controlled by the Navy, such as inflation and fluctuations in the number of aircraft planned for production, have primarily contributed to the present cost growth. These problems and expected development costs necessary for F/A-18 advanced self-protection and all-weather capabilities are expected to be primary contributors to future cost growth. Also, contractors have had to purchase long-lead parts and materials in advance of Navy funding authorizations, which could significantly affect the cost of the program.

The Department of Defense and the Navy have been ineffective in developing and monitoring various data important to proper management of the F/A-18 program. Also, Defense reports have not adequately presented information to keep the Congress informed of the progress in the program.

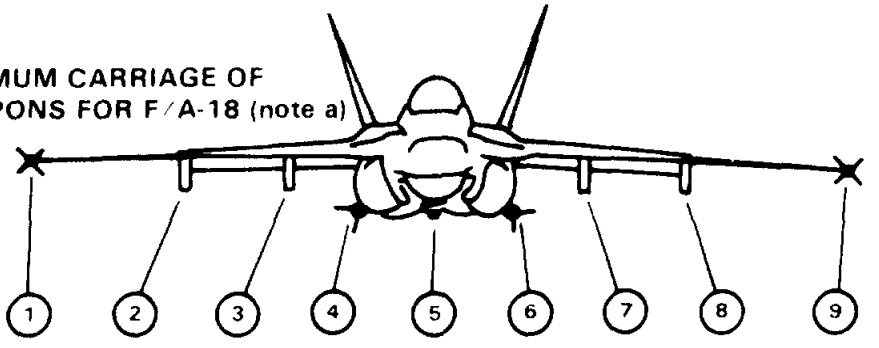
RECOMMENDATIONS

We recommend that the Secretary of Defense:

--Delay increasing the F/A-18's monthly production rate until performance problems have been corrected and adequate testing has been completed for the Navy to assess the aircraft's mission capability.

APPENDIX I

PLANNED MAXIMUM CARRIAGE OF SPECIFIED WEAPONS FOR F/A-18 (note a)



Station number	1	2	3	4	5	6	7	8	9	TOTAL
Sparrow (AIM-7F) Missile	-	1	-	1	-	1	-	1	-	4
Sidewinder (AIM-9L) Missile	1	1	-	-	-	-	-	1	1	4
Rockeye II/APAM Missile	-	2	2	-	2	-	2	2	-	10
MK-82 LD/HD Bomb	-	2 (6)	2 (6)		2 (3)	-	(6) 2	(6) 2	-	(27) 10
MK-82 LD (Conical Fin) Bomb	-	2 (6)	2 (6)		2 (3)	-	(6) 2	(6) 2	-	(27) 10
MK-83 LD Bomb	-	2	2		1		2	2	-	9
MK-82 LGB or MK-83 LGB Bomb	-	1	1			-	1	1	-	4
MK-84 LD Bomb	-	1	1		-	-	1	1	-	4
MK-84 LGB Bomb	-	1	-			-	-	1	-	2
B-57 Nuclear Bomb	-	1	-		-	-	-	1	-	2
B-61 Nuclear Bomb	-	1	-		-	-		1	-	2
MK-106 Practice Bomb	-	(6)	(6) -		(3) -	-	(6) -	(6)	-	(27)
AGM-65E Maverick Missile	-	1	1		-	-	1	1	-	4
AGM-88 Harm Missile	-	1	1		-	-	1	1	-	4
Advanced FAE II Bomb	-	2	2		2	-	2	2	-	10
FLIR Pod 1 Sensor	-	-	-		-	1		-	-	1
Walleye I Missile	-	1	-	-	-	-	-	1	-	2
Walleye I (ER/DL) Missile	-	1	-			-	-	1	-	2
AN/AWW-7B (Mod) (Walleye DL POD)	-	-	-		1	-	-	-	-	1
Fuel Tank	-	-	1		1	-	1	-	-	3
MK-76 Practice Bomb	-	(6)	(6) -		(3) -	-	(6) -	(6)	-	(27)
BDU-11/12 Nuclear Practice Bomb	-	1	-		-	-		1	-	2
BDU-20 Nuclear Practice Bomb	-	1				-	-	1	-	2
BDU-36 Nuclear Practice Bomb	-	1	-			-		1	-	2
LST/Strike Camera Tracker	-	-	-	1		-	-		-	1
LAU-61/A, LAU-68B/A, LAU-10D/A, Rocket Launchers	-	TBD	TBD	-		-	TBD	TBD		TBD

[a] Quantities in parentheses are carriages using multiple ejector racks

NAVY APPROVED REDUCTION TO F/A-18 CONTRACT PERFORMANCE SPECIFICATIONS

	Fighter configuration			Attack configuration		
	Development	Production	% performance reduced	Development	Production	% performance reduced
Range (nmi./lb.)	.180	.163	9.4	.109	.088	19.3
Level flight acceleration (sec.)	98	109	11.2	a/-	-	-
Combat ceiling (ft.)	49,350	48,900	.9	-	-	-
Maximum speed (Mach)	.98	.99	-1.0	-	-	-
Sustained buffet freeload factor (g.)	6.1	5.8	4.9	-	-	-
Specific excess power (ft./sec.)	753	689	8.5	-	-	-
Minimum usable approach speed (kn.)	125	130	4.0	128	133	3.9
Single-engine rate of climb (ft./min.)	689	607	11.9	540	461	14.6

a/Hypen (-) in columns indicates no specification requirement stated for tne attack configuration.

APPENDIX II

--Give priority attention to developing the advanced self-protection and all-weather capability the F/A-18 will need to fulfill its missions.

--Develop strategies for assuring advance funding when needed to support contractors in their long-lead purchase obligations.

--Reassess the estimated cost of the F/A-18 program in light of identified problems and report this to the Congress.

--Ensure that needed management reporting devices are established and monitored.

--Revise reporting requirements to ensure reporting on most recent testing data.

selected acquisition reports would be a burdensome staff requirement. They felt that the estimated total program cost is a more informative figure for the Congress.

SELECTED ACQUISITION REPORTS INCOMPLETE

The selected acquisition report is prepared quarterly to provide current information to the Congress and top Defense managers on how various programs are progressing. The reports on the F/A-18 program do not completely reflect the program's progress because results of most current testing are not provided.

The Navy has carried out numerous test flights aimed at evaluating various F/A-18 performance requirements, including acceleration, range, and maintainability. The results of these tests have not always been reported in the selected acquisition reports as demonstrated performance.

Navy officials said that development aircraft number 9 is the official demonstration aircraft and that, until this is flown in June 1980 and the resulting data is thoroughly analyzed by the Navy and the contractor, no demonstrated performance data will be reported. If the Navy is allowed to wait until an official demonstration report is issued to bring out F/A-18 performance problems, important data may not be available to the Congress when needed. For example, the Navy's preliminary evaluations performed in April through June 1979 identified numerous performance deficiencies; yet, as of December 20, 1979, no report had been issued.

Contractors' differences over rights to market various versions could impede foreign military sales. Although Northrop and McDonnell have formal agreements for sharing foreign sales or markets, this agreement is currently under dispute. Northrop has filed suit against McDonnell, claiming that it is violating certain sharing arrangements and principles. Additionally, until very recently, sales have been impeded by a Presidential decision prohibiting foreign military sales of weapon systems not in use by the U.S. military. Sales were further impeded, according to some sources, by the vigorous opposition of competitive aircraft programs which the Office of the Secretary of Defense appeared to support.

FLUCTUATIONS IN PROCUREMENT QUANTITIES COULD AFFECT PROGRAM COSTS

The number of F/A-18s planned for procurement each fiscal year has changed frequently due to Defense Department, Presidential, and congressional decisions affecting the program. Additionally, the total number of aircraft to be procured has fluctuated. These fluctuations have caused many program uncertainties which could affect F/A-18 program cost and schedule.

F/A-18 contractors currently must order engine-related parts and materials 39 months before they are needed and airframe-related parts and materials 44 months before they are needed. Program fluctuations force contractors to (1) assume risks by buying large quantities of these materials for an uncertain number of aircraft or (2) wait each year until the Congress approves the number of aircraft for the program before buying long leadtime items.

Both situations pose great potential for cost increases. The first could be reflected in higher contractor pricing to offset the risk that fewer than expected aircraft may be approved for the program, thus leaving the contractors with excess inventory. The second situation would result in production delays, which would increase program costs.

To date, F/A-18 contractors have purchased their materials in advance in the absence of Navy or congressional approval. Multiyear funding for weapon systems could reduce budget uncertainties and allow contractors to plan for more efficient production.

begin is unknown, according to Navy officials. Poor cost performance may result in unexpected cost increases when new subcontracts are awarded.

UNDEVELOPED AND UNRESOLVED ITEMS CAN CAUSE COST GROWTH POTENTIAL

Some systems which have not yet been developed will add to the cost of the F/A-18 program. For example, the F/A-18 program does not include an advanced self-protection system or an aircraft identification system. Although plans have been made for these systems in the F/A-18, they are still in development and, to date, no money has been budgeted nor contracts negotiated to produce these systems.

Also, correcting deficiencies found in the flight test program will increase program costs. The Navy and McDonnell originally allotted $9 million under the prime contract for all contingencies, including corrections of flight test deficiencies. Navy officials said that additional funds will be required.

The estimated life-cycle cost of the F/A-18 engine may also increase. The number of throttle movements the engine was designed for was greatly underestimated. Originally, the Navy estimated 47,000 throttle movements during a specified time period. A reevaluation led to a revised estimate of 447,000 throttle movements for the same time period. Consequently, some parts will have to be replaced more often, leading to higher life-cycle costs.

The Navy does not agree that life-cycle costs will increase. They contend that, although the design life of engine parts was not changed, the parts will stand up under the additional throttle movements.

PROGRAM COST GROWTH RESULTS FROM UNCONTROLLABLE FACTORS

Some of the cost growth is beyond the Navy's control. These factors, which will probably continue to cause major cost growth, include inflation and contractor overhead increases. Additionally, the opportunity to reduce cost through foreign military sales has not occurred.

Program inflation not accurately reflected

Navy officials identified inflation as the single largest factor causing cost growth in the F/A-18 program. The inflation rates being used by the F/A-18 project office

Northrop manufacturing problems primary cause of cost growth

Northrop Corporation manufactures and assembles the F/A-18 center and aft sections; however, it underestimated the amount of time to do this. For example, to build the full-scale development aircraft sections, Northrop spent more than twice as many assembly hours as originally expected. Consequently, all costs went up. Not only was the additional assembly time costly to Northrop, but its inability to deliver needed aircraft parts caused costly delays to the F/A-18 flight test program. As of October 26, 1979, the estimated program cost growth incurred by Northrop was $159 million.

Navy officials attribute Northrop's assembly time difficulties to Northrop's inaccurate estimates of the job's complexity and requirements, incorrect installation sequences, improper tooling, and late delivery of parts by suppliers. Northrop officials believe they can recover from past performances in time to avoid cost growth in production aircraft. To accomplish this they have developed manufacturing productivity improvement plans which they say are currently being met or exceeded. To illustrate their confidence, Northrop officials have negotiated a fixed-price production contract based on these plans.

McDonnell officials expressed concern over Northrop's ability to recover, and, as a consequence, contract negotiations between the Navy and McDonnell and between McDonnell and Northrop have been impeded. Although both contractors were building production aircraft, they were unwilling to agree on the amount of the initial production lot contracts. The Navy and McDonnell have recently agreed that the first production airframe contract will cost no more than $268 million for nine aircraft.

Mission computer costs escalating

The contracting manufacturer is responsible for developing and producing the F/A-18 mission computer, which controls the armament systems and coordinates the data received from the radar. This contractor initially estimated that the computer research and development phase would cost $6 million (for the three original users) and that the cost to the F/A-18 program for each computer would be $35,000. Current estimates are that this phase will cost $30 million more because of the requirements of many new users and cost growth.

and production delays. This would obviously increase program cost and possibly delay the aircraft's introduction into the fleet.

The F/A-18 development program calls for 14 radars. Hughes has been behind in delivering five radars by at least 5 months. It attributes this delay to the unanticipated time required for radar hybrid (electronic chips) assemblies, and as of October 31, 1979, the problem had not been resolved. As a result, Hughes' laboratory test program will fall a year behind schedule. Correction of the hybrid assembly problem is not expected until March or June 1980.

The F/A-18 mission computer controls the aircraft ordnances and cockpit displays. Delivery dates for the computer were changed several times and sometimes missed, generally to afford the contractor time to incorporate changes requested by the Navy and the prime contractor, McDonnell. Further, the Navy found that the contractor has encountered an 18-month delay in its computer research and development program because of poor management and unrealistic contract goals. As a consequence, some mission computer specifications were waived so that the computer could be delivered in time for flight testing. In some cases, this has resulted in costly retrofits and/or flight test delays due to computer failures.

Navy and contractor officials informed us that, although these systems were late, they did not contribute to the delayed deliveries of the development aircraft.

of the problems identified are being corrected with minor adjustments. However, several problems are significant and may require design changes to the aircraft or to other subsystems before they can be corrected.

Navy and contractor representatives stated that none of the problems requiring major changes is unresolvable. However, time will be needed to make the corrections due to the required redesign. The following problems in the F/A-18 typify these deficiencies:

--Software problems are occurring in computer systems.

--The air turbine starter may not meet reliability requirements.

--Oil temperatures exceed allowable limits.

--The air-conditioning system does not provide adequate cooling.

Software problems with computer systems

The use of advanced computer technology in the F/A-18 gives it superior performance capabilities when compared to other fighter or attack aircraft. This capability is not being acquired without difficulty. Correcting software-related problems in computer systems caused a 2-month delay in the program last year, and more software problems are being experienced.

For example, the F/A-18 is expected to be able to automatically perform maintenance checks on itself. Many of these built-in tests for subsystems, such as the radar, and the preflight test check have not been possible because of software problems.

Another software problem involves the flight control system. Its entire software will be revised in order to (1) provide a more simplified flight control system, (2) improve the handling qualities of the aircraft, and (3) reduce computer memory needs necessary because almost all available memory has been used and additional demands are being made.

Air turbine starter may not meet reliability requirement

The air turbine starter is a component of the secondary power system needed to start the F/A-18 on the ground and,

CHAPTER 3

CONCURRENT TESTING AND PRODUCTION COULD LEAD TO HIGHER COSTS

We believe the F/A-18 program may involve too much concurrency. 1/ Not only are production decisions made before testing and evaluation are completed, but technical problems have affected the testing schedule and time is not available for correcting and retesting identified deficiencies.

In our report on the F/A-18 last year, we pointed out the risks associated with impending concurrent testing and production; that is, increased costs and a possibly ineffective aircraft. This is fast becoming a reality. The Navy is faced with production decisions at the same time problems which could increase the risks inherent in concurrency go unresolved. They include:

--The flight test program which is behind schedule due to late aircraft deliveries and poor weather conditions.

--Major performance problems which have not been corrected and tested by the Navy.

--Delivery of major aircraft subsystems which might be late.

FLIGHT TEST PROGRAM BEHIND SCHEDULE

By March 1980, the F/A-18 flight test program was scheduled to provide information showing the results of 1,200 flight-hours involving numerous tests of the aircraft. Also, a lifetime fatigue test was to have been completed. According to Navy officials, neither will be accomplished because the current testing is behind schedule. As of November 4, 1979, the Navy had logged 481 flight-hours over a 12-month period and was approximately 40-percent finished with fatigue testing.

1/Concurrency refers to production before development is completed and the system is approved for service use.

be in missile launch and leave capability, advanced electronic counter-countermeasures, and advanced aircraft identification capabilities. While some work is ongoing, developments in these areas have been slow and thus may not be ready when the F/A-18 is introduced into the fleet. Until these capabilities are incorporated into the F/A-18, its mission effectiveness will be uncertain.

All-weather capability

In various congressional testimony, the Navy has stated that all-weather capability is critical in order to accomplish its missions. However, all-weather requirements for the F/A-18 are limited to air-to-air fighter conditions. Navy officials stated that this requirement will be achieved, in addition to some air-to-ground capability. However, the Navy was unable to provide a time frame when these capabilities will be evaluated. The F/A-18 does not currently have an all-weather attack requirement. In light of Navy testimony and the changes in perceived threats, the F/A-18's all-weather capability and the time to incorporate a new capability may not be adequate.

Launch and leave capability

The ability to launch a missile and leave the area to avoid retaliation is considered critical for the F/A-18 in the future. The Amraam missile is being developed to meet this requirement, and the Navy hopes to achieve an Amraam missile initial operational capability in 1985.

Electronic counter-countermeasure capability

Electronic counter-countermeasures will allow the F/A-18 to defend itself against attempts to jam its radar systems. Countermeasure hardware requirements have been designed and built into the radar, but software has not been refined and tested. The software is primary to electronic counter-countermeasure development, and yet it tends to be the last mode developed. This is because the operating radar has to be developed before determining how to protect it. This has happened with the F/A-18. Electronic counter-countermeasures also have to compete with other systems for use of available laboratory and flight test time.

Aircraft identification capability

Although the ability to differentiate between enemy and friendly aircraft from beyond visual range is also expected to enhance F/A-18 survivability, F/A-18 contracts do not call

Wing-carry-through bulkhead failure

In early December 1979, a major F/A-18 airframe bulkhead failed during testing of the fatigue test unit. This bulkhead is one of the three bulkheads where the wings attach to the fuselage.

The failure occurred early in fatigue testing. The Navy plans that the F/A-18 will be tested to two design lifetimes. The F/A-18 design life is 6,000 hours; thus, fatigue testing would be performed for a minimum of 12,000 hours. The wing-carry-through bulkhead failed at 328 test hours. The bulkhead failed when subjected to a 9-g load for the ninth time. During each 1,000-hour test cycle, the airframe is tested to 9-g's 27 times. This would amount to 324 loadings to 9-g's over the full 12,000 test hours.

McDonnell has reanalyzed the failed bulkhead and expects to have a redesigned bulkhead ready for testing by March 1980. According to a Navy official, McDonnell demonstrated that the failed bulkhead can be removed from the F/A-18 fuselage and a new bulkhead can be installed.

McDonnell estimates that redesigned bulkheads could be installed in the production aircraft beginning with airframe number 21. This is the first of the limited production aircraft. Airframe numbers 1 through 11 are the development aircraft, and numbers 12 through 20 are the pilot production aircraft. These airframes would have to be retrofitted to meet new design specifications.

F/A-18 WEAPON SYSTEM LIMITED BY PROBLEMS WITH ARMAMENTS

The effectiveness of the F/A-18 weapon system depends not only on the aircraft's performance, but also on the performance of the armaments it carries. The 20-millimeter gun, Sparrow missile, Sidewinder missile, and the Harm missile are scheduled for or are in use on various Navy aircraft already in the fleet and all are scheduled for use on the F/A-18. These armaments are experiencing performance problems. While these problems are outside the control of the F/A-18 project office, if not corrected, they will reduce the weapon system's effectiveness.

The 20-millimeter gun capabilities too limited

The M61A1 20-millimeter gun has been used on Navy aircraft for approximately 10 years. Recent evaluations have shown that, while the gun is reliable and maintainable, its

High nosewheel lift-off speed

Nosewheel lift-off is particularly important for the F/A-18 because it operates primarily from a carrier. The speed required for nosewheel lift-off on the F/A-18 was 25 knots higher than the Navy had predicted.

Navy officials stated that the problem has been corrected by toeing in the rudders during takeoff and eliminating the snags in the horizontal stabilators. Navy officials maintain that the corrections were verified during initial sea trials conducted October 30 through November 2, 1979, and that the airplane's nosewheel lift-off now meets expectations. The Navy agrees, however, that the corrections will have to be demonstrated on a fully loaded aircraft.

Excess weight contributes to F/A-18 performance problems

Weight affects many aircraft performance areas, including acceleration and range. Since the F/A-18 will weigh considerably more than planned, aircraft performance has suffered.

As of October 1, 1979, the F/A-18 was reported to be about 9 percent, or 1,962 pounds, over its initial specification weight of 20,146 pounds. Navy officials attribute approximately 166 pounds of the increased weight to combining the previously separate fighter (F-18) and attack (A-18) aircraft into the F/A-18. The heavier of the two aircraft--the A-18--was expected to weigh about 144 pounds more than the fighter version.

Officials attribute another 490 pounds to the Navy's decision to improve various reliability and maintainability features. The remaining 1,306 pounds of weight growth represents overly optimistic initial engineering estimates of what the aircraft should weigh given various established reliability and maintainability goals and performance characteristics and decisions to improve the aircraft's survivability and design-to-life-cycle cost.

Navy officials feel that increased weight up to 1,600 pounds and a resulting 5-percent lessened capability will not keep the F/A-18 from fulfilling its mission. Of the 1,962 pounds of excess weight, the Navy predicted 1,600 pounds and has reported this to the Congress since 1976. However, as of October 1979, the Navy had approved a production aircraft 1,631 pounds over initial specifications.

CHAPTER 2

IF F/A-18 IS TO CARRY OUT ITS MISSIONS, TECHNICAL PROBLEMS MUST BE RESOLVED

The missions planned for the F/A-18 are many. After considering the threats the F/A-18 may encounter, the Department of Defense and the Navy established performance requirements that the aircraft would have to meet to carry out these missions. According to Navy officials, preliminary flight tests indicate that in most areas the F/A-18 is a significant improvement over fighter and attack aircraft now in the fleet. However, whether the F/A-18 weapon system can fulfill its initially prescribed missions, as well as any newer mission necessitated by a change in perceived threats, is uncertain at this time.

The flight test program has revealed performance problems, and these problems must be addressed and corrected in order for the aircraft system to effectively fulfill its mission requirements. These include

--slower than anticipated acceleration,

--range limitations, and

--problems in getting the nosewheel off the ground during takeoffs.

Additionally, the F/A-18's mission effectiveness could be reduced by limitations in its armaments and delayed development of critical self-protection capabilities.

According to Navy officials, the extent to which the F/A-18 will be able to perform the prescribed missions will be determined during operational evaluation testing. Also, the flexibility provided by a software-oriented airplane will give the F/A-18 a capability to respond much more quickly to a change of threat than any present airplanes.

PERFORMANCE PROBLEMS

The Department of Defense sets various performance standards for the aircraft (thresholds). The Navy is expected to meet these before the Department of Defense will authorize the development and production of the F/A-18. The Navy, in turn, imposes performance requirements (specifications) that the contractor is to meet when developing and

has overall weapon system performance and technical management responsibility. It designed and builds the forward fuselage, wings, and stabilator subassemblies and is responsible for the landing gear, arresting gear, crew station, and avionics integration. 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 builds the center and aft fuselage, vertical fins, environmental control system, hydraulics, secondary power and starting unit, and several other F/A-18 systems. Northrop designed the YF-17 aircraft, the prototype of the F-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-GE-400 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 for engine and airframe interface.

The F/A-18 is being flight-tested at the Naval Test Center at Patuxent River, Maryland. For the first time, the Navy is using a single-site testing approach to this phase of the development program. Under single-site testing, the Navy expects the development program to be more efficient by doing almost all flight testing at one naval facility, thus increasing Navy and contractor coordination.

SCOPE OF REVIEW

We did our audit work at the F/A-18 project office and other related Department of Defense activities, particularly within the Naval Air Systems Command. We also conducted work at locations of various contractors responsible for developing, building, and testing the F/A-18 aircraft. These included McDonnell, Northrop, Hughes, and General Electric. We reviewed various regulations, reports, and records which related to the program.

On several occasions we were not granted access to information we felt critical to our evaluation. This information, we believe, would have provided valuable knowledge

inflation and fluctuations in the number of aircraft planned for production, have contributed to cost growth. (See pp. 20 and 22.) These problems, together with expected costs to develop the F/A-18's advanced self-protection and all-weather capabilities, are expected to cause further cost growth. Also, contractors have had to purchase long-lead parts and materials in advance of Navy funding authorizations, which could significantly affect the program's cost. (See p. 22.)

The Department of Defense and the Navy have been ineffective in developing and monitoring various data important to proper management of the F/A-18 program. Also, Defense reports have not adequately presented information to keep the Congress informed of progress in the program. (See ch. 5.)

RECOMMENDATIONS

The Secretary of Defense should:

--Delay increasing the F/A-18's monthly production rate until performance problems have been corrected and adequate testing has been completed for the Navy to assess the aircraft's mission capability.

--Give priority attention to developing the advanced self-protection and all-weather capabilities the F/A-18 will need to fulfill its missions.

--Develop strategies for assuring advance funding when needed to support contractors in their long-lead purchase obligations.

--Reassess the estimated cost of the F/A-18 program in light of identified problems and report this to the Congress.

--Ensure that needed management reporting devices are established and monitored.

--Revise reporting requirements to ensure reporting of most recent testing data. (See ch. 6.)