U. S. GENERAL ACCOUNTING OFFICE

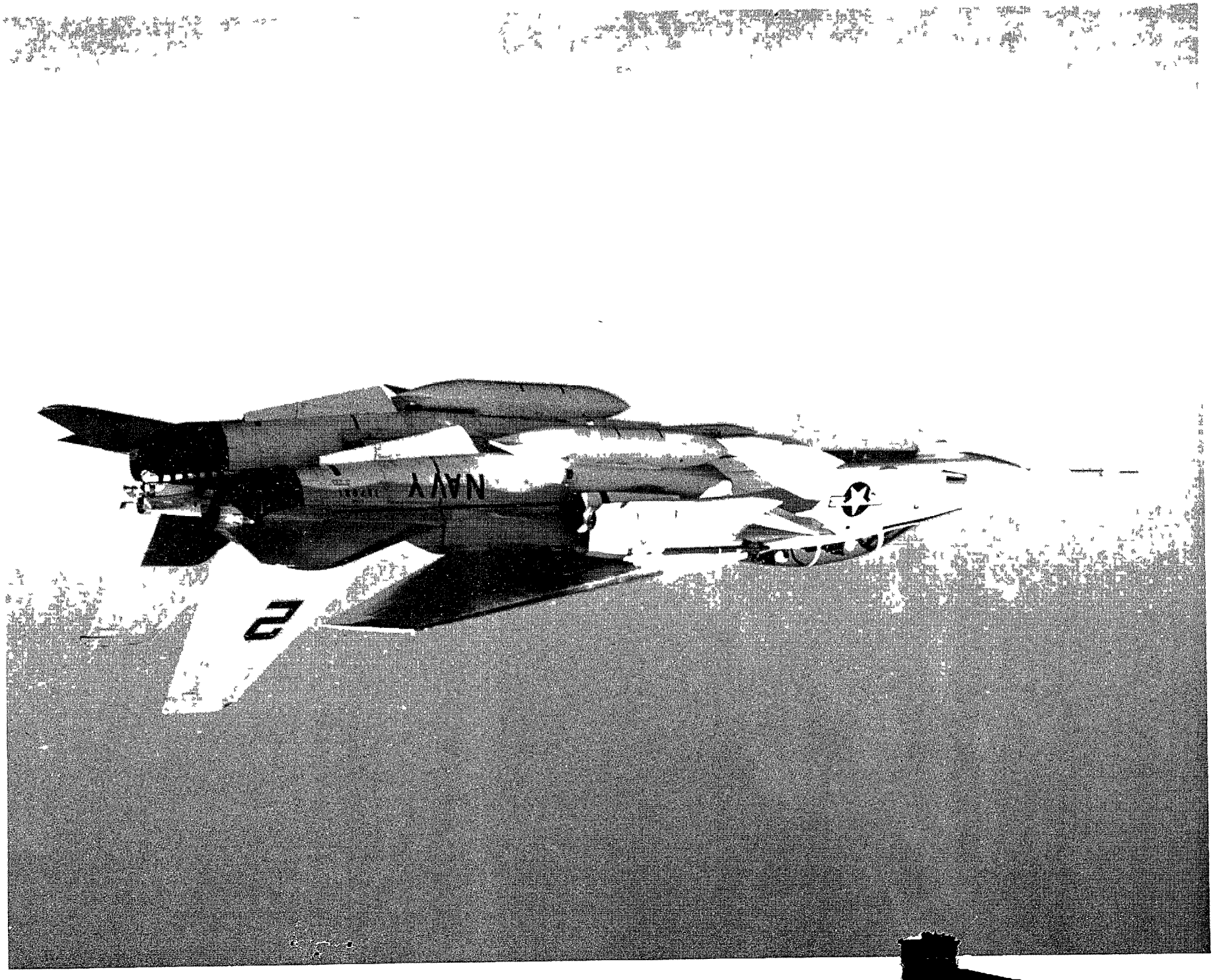
STAFF STUDY

ON

THE F-14/PHOENIX WEAPON SYSTEM

DEPARTMENT OF THE NAVY

MARCH 1974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C O N T E N T S

C O N T E N T S

ABBREVIATIONS

APN	Aircraft Procurement, Navy
ATE	Advanced Technology Engine
BIS	Board of Inspection and Survey
CADC	Central Air Data Computer
CETS	Contractor Engineering Technical Services
DCP	Development Concept Paper
DLC	Direct Lift Control
DOD	Department of Defense
ECCM	Electronic Counter Countermeasure
GAO	General Accounting Office
IOT&E	Initial Operational Test and Evaluation
JET	Joint Evaluation Team
MQT	Military Qualification Test
NATC	Naval Air Test Center
NPE	Navy Preliminary Evaluations
O&MN	Operations & Maintenance, Navy
OPEVAL	Operational Evaluation
OTE	Operational Test and Evaluation
PAMN	Procurement Aircraft & Missiles, Navy
PFRT	Preliminary Flight Rating Test
QT	Qualification Test
RDT&E	Research, Development, Test and Evaluation
SAR	Selected Acquisition Report
TECHEVAL	Technical Evaluation
TPS	Test Program Set
VAST	Versatile Avionics Shop Tester

SUMMARY

SYSTEM DESCRIPTION

The F-14 is an all-weather, carrier based, airborne weapon system capable of performing air-to-air combat and air-to-surface attack missions. It is a twin-engine, two-place, variable sweep wing, supersonic fighter capable of engaging multiple targets simultaneously at altitudes from sea level to over 80,000 feet. The F-14 is replacing the F-4 in Fleet Air Defense and other fighter roles in the 1973 to 1985 time frame. The weapon systems for the F-14 includes the PHOENIX (AIM-54A), SPARROW (AIM-7E and -7F) and SIDEWINDER (AIM -9G,-9H and -9L) missiles, an internal gun (VULCAN M-61), and various air-to-ground ordnance.

The Navy had originally planned two versions of the F-14 weapon system. The first, the F-14A, which is in concurrent development and production, uses the TF30-P-412 engine which is an outgrowth of the TF30-P-12 engine developed for the F-111 aircraft. The TF-30-P-412 engine is in production and is undergoing service acceptance trials by the Navy. The second version, the F-14B, would use the new Advanced Technology Engine (ATE) the F401-PW-400 which is being developed jointly with the Air Force F-15, F-100 engines.

The F401-PW-400 engine is in the development cycle and according to the Navy there are no plans for production at this time.

The PHOENIX is the primary weapon of the F-14 for Fleet Air Defense but is secondary to the SPARROW and SIDEWINDER in the fighter role. The PHOENIX is a long-range, air-to-air missile capable of being used in single or multiple near-simultaneous launches of up to six missiles against multiple targets. The PHOENIX will not replace any other missile.

The AWG-9 weapon control system is capable of functioning with all of the weapons on the F-14. This includes the provision of the following

--Air-to-air search, detection, and tracking of single or multiple targets.

--Radar launching of PHOENIX, SPARROW or SIDEWINDER missiles against single targets.

--Near simultaneous radar launching of up to 6 PHOENIX missiles against multiple targets.

--Computations for M-61 gun firings.

--Computations for air-to-ground weapon delivery.

Both the PHOENIX and the AWG-9 weapon control system have been developed and are in full-scale production.

COMING EVENTS

--Final Board of Inspection and Survey (BIS) Trials, designed to test suitability of the F-14 and its support equipment for service use, began in February 1973 and are scheduled for completion in mid-1974.

--The first F-14A operational squadron was formed in December 1973, prior to the completion of Navy testing. It will be deployed from carriers in the fall of 1974.

--Navy support of PHOENIX is scheduled to begin in July 1976.

COST

The total current estimated program cost of the F-14A, F-14B and PHOENIX programs, as reported in the September 30, 1973, Selected Acquisition Reports (SARs), totaled $7,621.8 million for 334 aircraft. (See Appendix I.) This represents a cost increase of $919.4 million over the development estimate of $6,702.4 million for 469 aircraft and an increase of $1,236.5 million over the June 30, 1972, estimate of $6,385.3 million for 313 aircraft.

F-14A

From June 30, 1972, to September 30, 1973, the current F-14A program estimate of $6,110.6 million had increased $1,202.1 million from a unit cost of $15.7 million to $18.3 million. This increase was primarily the result of (1) a program stretchout directed by the Deputy Secretary of Defense on June 7, 1973, (2) the settlement of the contractual dispute between the Navy and Grumman which broke the existing airframe contract, and an increase in the fiscal year 1977 procurement of 21 additional aircraft over those previously programmed for a new program total of 334 aircraft.

F-14B

At September 30, 1972, the F-14B was still in the development phase of the acquisition cycle. From June 30, 1972, to September 30, 1973, the current RDT&E estimate of $398.1 million had increased $35 million. This increase was primarily due to the slippage and stretchout of the F-14B program due to engine problems.

PHOENIX

From June 30, 1972, to September 30, 1973, the current PHOENIX program estimate of $1,113.1 million had decreased $.6 million. This decrease was the net result of (1) a $3.8 million increase due to scheduled changes in missile procurement, (2) a $1.5 decrease due to the transfer of Contractor Engineering Technical Services (CETS) from the procurement to the O&MN budget account, (3) a $2.6 million decrease due to revised requirements for missile spares, and (4) a $.3 million decrease due to the final pricing of spares orders.

Cost Not Being Reported

In accordance with DOD memorandum of May 1972, neither the F-14 or the PHOENIX SAR report an estimate for replenishment spares. The last estimate reported was in the March 31, 1972, F-14 SAR in the amount of $37.8 million. The F-14 Deputy Project Manager for Support informed us in November 1973 that the cost for replenishment spares for fiscal years 1975 through 1977 would be $132.6 million for the F-14A aircraft alone. We believe that costs such as these should be reported in the F-14 and PHOENIX SAR's in order to provide full disclosure of related procurement costs.

Escalation

The June 30, 1973, F-14A current program estimates included approximately $259 million for escalation which is an increase of $13 million over the amount included in the development estimate.

FUNDING STATUS AND OUTYEAR PLAN

As shown in the September 30, 1973, SAR, and in Appendix VIII, the Congress has appropriated $4,027.4 million for the F-14/PHOENIX program through fiscal year 1973. For fiscal year 1974, $851.7 million is required leaving a remainder to complete of $2.742.7 million for a program total of $7,621.8 million.

The program funding by weapon system as presented in the DOD budget for fiscal year 1975 includes $744.5 million for procurement and $11.8 million RDT&E for the F-14A and $99.5 million for the PHOENIX programs. Also included is a fiscal year 1974 funding increase, over that shown in the September 30, 1973, SAR of $.3 million for the F-14A.

CONTRACT DATA

Definitized contract data, as of June 30, 1973, for the airframe, PHOENIX missile, AWG-9 weapon control system, TF30-F-412 F-14A engine and F401-PW-400 F-14B engine development is included in Appendix II. The contractors involved are as follows.

--Airframe (aircraft & trainers only)	- Grumman Aerospace Corp.
--Engines	- Pratt & Whitney Aircraft Division, United Aircraft Corporation
--AWG-9 Weapons Control System and PHOENIX Missile	- Hughes Aircraft Comapny

Airframe

At June 30, 1973, the Navy had ordered 134 F-14 aircraft (Lots I through V) from Grumman under fixed price type contracts. The basic target price of these aircraft (including maintenance and flight trainers) according to Grumman was $1,215 million.

In September 1973, Grumman and the Navy entered into a new and separate fixed price incentive (FPI) contract for the fiscal year 1974 procurement of 50 F-14A aircraft at a target price of $306.5 million.

Grumman estimated (See Appendix III) that losses on Lots I through V would amount to $208 million.

Engines

At June 30, 1973, the Navy had ordered 358 TF30-P-412 engines for the F-14A from Pratt & Whitney under fixed price type contracts. The first 260 of these engines cost an average of $904,000 each. Firm prices had not been established at the time of our review, for the remaining 98 engines. In October 1973, another 73 engines were ordered for delivery in calendar year 1975. Firm target prices had not been established.

The F-100-PW-100 (Air Force)/F401-PW-400 (Navy) engine contract provides for design, development, and testing of the two engines on a cost-plus-incentive-fee basis at a target cost of $272 million. At August 31, 1973, Pratt & Whitney estimated that due to development problems, the estimated cost for the joint development program would be $472 million or an overrun of about $200 million. Since the Navy shares the cost equally with the Air Force, the portion of the overrun to be funded by the Navy was $100 million for a total cost of $236 million.

AWG-9 Weapon Control System

At June 30, 1973, the work required under the prototype and preproduction contracts for the AWG-9's was almost completed. The contractor estimated that the final contract price would be $105.3 million.

Fiscal years 1971, 1972 and 1973 production options were exercised for a total of 136 units. The contractor estimated that the final contract price for these options would be $547.5 million. The fiscal year 1974 option for an additional 54 units was exercised on October 30, 1973, and the Navy's estimated target price exclusive of spares and ground support equipment is $92.3 million.

Three additional options remain to be exercised through fiscal year 1977 for a total additional quantity which ranges from 124 to 386 units.

PHOENIX

The basic separation and test contract for prototype and value engineered missiles has been completed. The contractor estimated that the final contract price would be $29.4 million.

The fiscal years 1971, 1972, and 1973 production options were exercised for a total of 489 units. The contractor estimated that the final contract price would be $239.6 million. The Navy exercised the fiscal year 1974 option on November 30, 1973, for an additional 240 missiles. The contractor proposed a total price of $56.9 million for this buy exclusive of spares and ground support equipment.

Three additional options remain to be exercised through fiscal year 1977 for a total additional quantity which ranges from 600 to 1,800 units.

SCHEDULE

At June 30, 1973, deliveries of F-14A engines, AWG-9's and PHOENIX missiles were generally on schedule. Airframe deliveries, F-14B engine development, and Navy F-14A testing had experienced slippages.

Airframe

The 12 R & D aircraft in Lots I and II including an F-14B configuration aircraft had been delivered as of September 1973. The 26 Lot III procurement aircraft, scheduled to be delivered by June 30, 1973, were delivered by October 1973. Appendix IV shows the original delivery schedule, the revised schedule, and the actual deliveries of the 122 production aircraft (Lots III, VI, and V) at December 31, 1973.

Engines

At June 30, 1973, 189 TF30-P-412, F-14A engines had been delivered. Two other engines scheduled for delivery by that date were delayed by a temporary parts shortage and were delivered in July 1973.

Three F401-PW-400, F-14B engine development milestones scheduled for 1972-1973 were not completed on schedule.

--Acceptance of the first prototype engine was delayed from December 31, 1972, to January 26, 1973, due to slippages in the Preliminary Flight Rating Test (PFRT).

--The PFRT slipped from December 31, 1972, to January 9, 1973, due to development problems.

--Two Military Qualification Tests (MQT's) scheduled for completion by February 28, 1973, were deleted and replaced by a less stringent 60-hour substantiation test. The deletion of the MQT was due to (1) slippages in the MQT of the Air Force engine which impacted on the Navy schedule, and (2) lack of adequate funding.

F-14A testing

Three major Navy test programs scheduled for completion in 1973 slipped due to delays in the flight test program and the delivery of test aircraft.

--Completion of Technical Evaluation (TECHEVAL) has slipped from December 1973 to June 1974.

--Completion of Operational Evaluation (OPEVAL) has slipped from December 1973 to December 1974.

--Completion of Board of Inspection and Survey (BIS) trials has slipped from August 1973 to May 1974.

Other slippages were noted under the Scheduled Milestones caption of the September 30, 1973, SAR for the F-14A and PHOENIX. Production delays and continuing efforts of the loss of aircraft were cited to be the cause of the slippages

--Complete F-14A Static Tests, scheduled for October 1972 slipped to November 1973.

--Fleet Introduction of the F-14A/PHOENIX, scheduled for April 1973 slipped to December 1973. The Navy stated that this milestone was completed in accordance with the revised schedule.

--Approval of the PHOENIX for Service Use, scheduled July 1973 slipped to December 1973. The Navy stated that further slippage to June 1974 are expected.

--Navy Support Date for the PHOENIX, scheduled for January 1974 slipped to September 1975. This slippage was not reflected in the September 30, 1973, SAR.

PERFORMANCE

Our analysis of the F-14A SAR at September 30, 1973, showed that (1) 17 of the 20 demonstrated performance or design characteristics had not achieved their development goal, (2) two were above their goal, and (3) one had not been demonstrated. We do not believe that the Navy intends to achieve all of the development goals since the performance specifications

for the fiscal year 1974 procurement include what has been demonstrated and not what was initially required in the development contract.

The PHOENIX missile's technical performance, based on missile firings, continues to indicate that most technical parameters will be met, and in some cases, exceeded.

TEST AND EVALUATION

There are certain areas of concern in the test and evaluation phase of the F-14/PHOENIX program. Among them are

--Navy and contractor test programs have not been completed even though aircraft are being introduced into the fleet.

--Testing of the PHOENIX under all weather conditions, and launches at certain altitudes has not been demonstrated.

--The Navy did not fully disclose to the Congress the Fiscal Year 1974 President's Budget Estimate the results of operational testing in accordance with Section 506 of Public Law 92-156.

--The completion of Grumman's flight test program has slipped from January 1974 to November 1974.

--Hughes testing was completed in May 1973 with certain test objectives being satisfied with data from Navy PHOENIX/AWG-9 testing.

RELATIONSHIP TO OTHER SYSTEMS

The F-14/PHOENIX weapon system is viewed as the replacement for the role intended for the F-111B in its fleet defense mission and as an improved high performance fighter to phase-out and replace the F4J in other fighter roles in the 1973-1980 time frame. It is also intended to have all-weather capability for delivery of the SPARROW missile and SIDEWINDER, operation of the M-61 gun and delivery of air-to-ground ordnance using the AWG-9 weapon control system. Certain avionic subsystems will

depend on the Versatile Avionics Shop Tester (VAST) for diagnosis and fault isolation. The SPARROW, SIDEWINDER, and VAST are currently being reported on in separate GAO staff studies. The VAST is also discussed in Chapter 4.

SELECTED ACQUISITION REPORTING

The F-14 aircraft, PHOENIX and VAST are related systems which are reported on in detail in separate SARs. We believe that a more meaningful report would result if the reports were to include information on the status of each system. For example, the F-14 SAR would primarily report on the F-14 aircraft program but, in addition, would also include some pertinent program information on the PHOENIX and VAST. In addition the following should be included to provide full disclosure of program status.

--The replenishment costs discussed on page 21 .

--The impact on the program of the loss of three aircraft.

--Milestones for OPEVAL and TECHEVAL which are key phases in the Navy test program.

MATTERS FOR CONSIDERATION

There are several areas of concern in the F-14 program which the Congress may wish to discuss with OSD and Navy officials

--The Air Force F-100 engine, which is basically similar in design and developed jointly with the F-401-PW-400 engine, is currently in production and in use in the F-15 aircraft. The F-401-PW-400 is still in development having decreased from a $100 million dollar funding level in fiscal years 1972 and 1973 to a level of

$17 million and $27 million in fiscal years 1974 and 1975 respectively. Although the performance of the F-401-PW-400 engine was a key factor for its initial selection for use with the F-14B, the Navy does not appear to have a definite plan for (1) the production of the F-401-PW-400 engine, and (2) its use with the F-14B aircraft.

--The impact on Development Concept Paper (DCP) thresholds as a result of the reduced performance specification requirements included in the fiscal year 1974 procurement of 50 F-14A aircraft. These specifications are based on what has been demonstrated and not what was initially required by the development contract.

--The degree of concurrency in the F-14A program. As of September 24, 1973, 184 aircraft had been contracted for before the completion of Navy and contractor testing.

--The deficiencies and critical issues discussed in the F-14A initial operational test and evaluation (IOT&E) report which were not addressed in the report submitted to Congress under Section 506 of Public Law 92-156.

--The impact on program cost and F-14A aircraft availability which could result from continued delays in the development of VAST test program sets. Further, what the Navy plans are for assuring that the required VAST support level will be maintained. (See Chapter 4 and VAST staff study of March 1974).

AGENCY REVIEW

A draft of this staff study was reviewed by DOD officials associated with the management of this program and their comments were incorporated in the report as we believe appropriate. We know of no residual difference with respect to the factual materials presented herein.

CHAPTER 1

INTRODUCTION

SYSTEM DESCRIPTION

The F-14 is an all-weather, carrier based, airborne weapon system capable of performing air-to-air combat and air-to-surface attack missions. It is a twin-engine, two-place, variable sweep wing, supersonic fighter capable of engaging multiple targets simultaneously at altitudes from sea level to over 80,000 feet. The F-14 is replacing the F-4 in Fleet Air Defense and other fighter roles in the 1973 to 1985 time frame. The weapon system for the F-14 includes the PHOENIX (AIM-54A), SPARROW (AIM-7E and 7F) and SIDEWINDER (AIM-9G, 9H, and - 9L) missiles, and internal gun (VULCAN M-61) and various air-to-ground ordnance.

The Navy had originally planned two versions of the F-14 weapon system. The first, the F-14A, which is in concurrent development and production, uses the TF30-P-412, engine which is an outgrowth of the TF30-P-12 engine developed for the F-111 aircraft. The TF30-P-412 engine is in production and is undergoing service acceptance trials by the Navy.

The second version, the F-14B, would use the new F-401-PW-400 advanced technology engine (ATE). The F401-PW-400 is being developed jointly with the Air Force's F-100 engine for the F-15 weapon system. Due to development problems, there are no current plans to produce F-14B aircraft. Depending on the success of the continuing development effort, decisions will ultimately have to be made to abandon the program, apply the technology to future aircraft programs or produce F-14B's. If the latter choice is made, there could be several hundred F-14A's in the fleet

(184 had been ordered as of September 1973) and consideration (cost and performance trade-offs) would be given to retrofitting the A's to B's or supporting two versions of the aircraft in the fleet.

The PHOENIX is the primary weapon of the F-14 for Fleet Air Defense but is secondary to the SPARROW and SIDEWINDER in the fighter role. The PHOENIX is a long-range, air-to-air missile capable of being used in single or multiple near-simultaneous launches of up to six missiles against multiple targets. The guidance system can home in on heavy enemy electronic radar-jammers and track a target with its own built-in independent radar system when it is a certain distance from the target. The PHOENIX will not replace any other missile.

The AWG-9 weapon control system, in addition to functioning with the PHOENIX, is also capable of functioning with other weapons to be used with the F-14. This includes the provision of the following

--Air-to-air search, detection, and tracking of single or multiple targets.

--Radar launching of SPARROW or SIDEWINDER missiles against single targets.

--Computations for M-61 gun firings.

--Computations for air-to-ground weapon delivery.

Both the PHOENIX and the AWG-9 weapon control system have been developed and are in full-scale production.

SCOPE

We reviewed the F-14/PHOENIX weapon system test program and interim results, the status of development problems, and analyzed changes in technical performance, schedule, and cost reported in the June 30, 1973, and September 30, 1973, Selected Acquisition Reports. Information was obtained by reviewing plans, reports, correspondence and other records, and by interviewing contractor and Navy officials.

The review was conducted at the following locations

--Naval Air System Command - F-14/PHOENIX Weapon System Project Office, Arlington, Virginia.

--Naval Plant Representative Office, Bethpage, New York and, East Hartford, Connecticut.

--Naval Plant Branch Representative Office, West Palm Beach, Florida.

--Naval Missile Center, Point Mugu, California.

--Grumman Aerospace Corporation, Bethpage and Calverton, New York.

--Hughes Aircraft Company, Culver City, California.

--Pratt & Whitney Aircraft Division, United Aircraft Corporation, West Palm Beach, Florida and East Hartford, Connecticut.

In our review, no attempt was made to assess the military threat, develop technological approaches, or take part in program decisions as they were being made.

CHAPTER 2

WEAPON SYSTEM STATUS

COST

The total current estimated program cost of the F-14A, F-14B and PHOENIX program as reported in the September 30, 1973, SAR's was $7,621.8 million. As shown below and in Appendix I, this represents a cost increase of $919.4 million over the development estimate, of $6,702.4 million for 469 aircraft, and an increase of $1,236.5 million over the June 30, 1972, estimate of $6,385.3 million for 313 aircraft.

PROGRAM	DEVELOPMENT ESTIMATE	SAR CURRENT PROGRAM ESTIMATE (as of June 30, 1972) ($ in millions)	SAR CURRENT PROGRAM ESTIMATE (as of September 30, 1973
F-14A	5,923.0	4,908.5	6,110.6
F-14B	243.0	363.1	398.1
PHOENIX	536.4	1,113.7	1,113.1
	6,702.4	6,385.3	7,621.8
QUANTITIES			
F-14A	469	313	334
PHOENIX	2,384	2,457	2,457
PROGRAM UNIT COST			
F-14A	12.6	15.7	18.3
PHOENIX	.225	.453	.453
F-14A/B	13.1	16.8	19.5

F-14A

At September 30, 1973, the estimated F-14A aircraft total program cost (without PHOENIX) had changed from the February 3, 1969 development estimate of $5,923 million for 469 aircraft to the current estimate of $6,110.6 million for 334 aircraft.

From June 30, 1972, to September 30, 1973, the current F-14A program estimate increased $1,202 1 million. This increase was primarily the result of (1) a program stretchout directed by the Deputy Secretary of Defense on June 7, 1973, (2) the settlement of the contractual dispute between the Navy and Grumman which broke the existing airframe contract, and (3) an increase in the fiscal year 1977 procurement of 21 additional aircraft over those previously programmed for a new program total of 334 aircraft

The program stretchout was directed by the Deputy Secretary of Defense in a June 7, 1973, memorandum to the Secretary of the Navy The previous program plan was to buy 88 and 91 aircraft in fiscal years 1974 and 1975, respectively. This was changed to quantities of 50 each in fiscal years 1974 through 1977.

F-14B

At September 30, 1972, the F-14B was still in the development phase of the acquisition cycle Estimated RDT&E costs had changed from the February 3, 1969 development estimate of $243 million to the current RDT&E estimate of $398.1 million.

From June 30, 1972 to September 30, 1973, the current RDT&E estimate increased $35 million This increase was primarily due to the slippage and stretchout of the F-14B program due to engine problems

PHOENIX

At September 30, 1973, the estimated PHOENIX total program cost had changed from the June 29, 1963 development estimate of $536.4 million for 2,384 missiles (45 development and 2,339 production) to the current estimate of $1,113.1 million for 2,457 missiles (37 development and 2,420 production).

From June 30, 1972, to September 30, 1973, the current program estimate decreased $.6 million. This decrease was the net result of (1) a $3.8 million increase due to scheduled changes in missile procurement, (2) a $1.5 decrease due to the transfer of Contractor Engineering Technical Services (CETS) from the procurement to the O&M budget account; (3) a $2.6 million decrease due to revised requirements for spare missiles, and (4) a $.3 million decrease due to the final pricing of spares orders. There were no changes in the current estimate between June 30, 1973, and September 30, 1973.

Escalation

The June 30, 1973, F-14A current program estimate included approximately $259 million for escalation which is an increase of $13 million over the amount included in the development estimate. The rates used for escalation were approximately 4 percent per year for APN and PAMN and 5 percent for the R&D account Those rates were based on instructions issued by the Comptroller of the Navy

Other costs

The F-14 SAR also includes an estimate of $65 million for additional procurement cost. This estimate was prepared several years ago and was to cover anticipated but undefined modifications The Navy stated that they have no record of the basis for this estimate, and informed us it was based on prior Navy programs for aircraft with similar missions. We believe the Navy's estimate may not be adequate now in view of the high degree of development, test and production concurrency on the program.

A DOD memorandum in May 1972 deleted from SAR reporting, an estimate for replenishment spares. The last SAR estimate reported for replenishment spares was in the March 31, 1972, F-14A SAR in the amount of $37.8 million. The F-14 Deputy Project Manager for Support informed us in November 1973 that replenishment spares for fiscal years 1975 through 1977 would cost $132.6 million for the F-14A alone. We recommend that DOD establish a baseline for replenishment spares and that variances from it be identified in the SAR.

CONTRACT DATA

Definitized contract data, as of June 30, 1973, for the airframe, PHOENIX missile, AWG-9 weapon control system, F401-PW-400(F-14B) engine development, and TF30-F-412(F-14A) engine is included in Appendix II. The contractors involved are as follows.

--Airframe (aircraft & trainers only)	- Grumman Aerospace Corp. Bethpage, New York Calverton, New York

--Engines	- Pratt & Whitney Aircraft Division, United Aircraft Corporation East Hartford, Connecticut West Palm Beach, Florida
--Weapon Control System	- Hughes Aircraft Company Tuscon, Arizona
--PHOENIX Missile	- Hughes Aircraft Company Culver City, California

Airframe

At June 30, 1973, the Navy had ordered 12 development (Lots I and II) and 122 production (Lots III, IV and V) aircraft from Grumman under fixed price type contracts. The target price of these aircraft (including maintenance and flight trainers) according to Grumman was $1,215 million and they estimated that the final price would be about $226 million higher or $1,441 million. They also estimated the cost would be $1,649 million resulting in a $208 million loss. (See Appendix III)

The increased price includes the Government's share of the cost overruns ($111 million) and contract changes ($115 million). Only $35.1 million of contract changes had been negotiated at June 30, 1973, on Lots I to III (38 aircraft). The principal ones negotiated were

	Million of dollars
Schedule slip due to loss of aircraft number 1 and other changes	$21.0
Modification of various display groups	3.8
Contractor furnished in lieu of Government furnished engine start system for F-14B	1.9
Revision of electrical system in the F-14B's	1.5
Addition of receiver decoder group in the F-14A	1.2
Incorporation of instrumentation provisions in the F-14A	1.1
Other miscellaneous changes	4.6
Total changes	$35.1

In September 1973 Lots IV (48 aircraft) and V (48 aircraft) were negotiated. The Lot IV price included an $18 million increase over the option ceiling price because of aircraft changes and the slip in delivery schedule resulting from the crash of aircraft number 1 in December 1970. Lot V was negotiated at the option ceiling price in accordance with Public Law 92-436 (DOD fiscal year 1973 appropriation authorization). Grumman estimates that on Lot V alone they will incur a loss of $87.8 million.

Grumman financial problems

Because of their financial problem, Grumman's revolving line of credit with certain banks was withdrawn. On August 8, 1972, the Department of the Navy provided assistance through advance payments under an advance payment pool agreement with Grumman.

At December 1972, advances of $54 million had been authorized. Since that time, advances to Grumman and partial repayments were as follows

	Amount (in millions)
Total advanced at December 1972	$54.0
Repayment June 1973	40.1
Amount outstanding	13.9
Additional advance August 1973	10.1
Amount outstanding November 1973	$24.0

The June 1973 repayment was made with a Federal Income Tax refund resulting from the write-off of corporate losses on the F-14 program.

The agreement provides for interest at 6 7/8 percent and placed numerous requirements on Grumman to furnish the Navy with financial information. It also restricted Grumman in areas such as payment of dividends and salaries, transfer of fixed assets and changes in management.

When the Navy exercised the option for 48 Lot V aircraft in December 1972, Grumman publicly announced that they would not proceed because in their opinion the option was invalid, unenforceable and would result in severe financial losses. The Secretary of the Navy and the President of Grumman settled the dispute on March 8, 1973, when Grumman agreed to produce the 48 Lot V aircraft and the Navy agreed not to exercise any of the remaining contract options. It was also agreed that contract progress payments would be increased or the restrictions in the advance payment pool agreement would be amended. The agreement was amended on March 8, 1973, to permit payment of dividends and salary increases within certain limits, and changes

in management. It also reduced the frequency of reporting financial information to the Comptroller of the Navy from monthly to quarterly and deleted the requirement for reporting on program expenditures and contract awards.

TF30-P-412 (F-14A) engine

At June 30, 1973, the Navy had ordered 358 TF30-P-412 engines from Pratt & Whitney for the F-14A under fixed price type contracts. The first 260 of these engines cost an average of $904,000 each. Firm prices had not been established at the time of our review, for the remaining 98 engines. In October 1973 another 73 engines were ordered for delivery in calendar year 1975. Firm target prices had not been established.

F-401-PW-400 (F-14B) engine

The F-401-PW-400 engine intended for use on the F-14B is being developed by Pratt & Whitney under a joint Air Force/Navy project which includes the F-100 engines for the Air Force's F-15 program. The contract provides for design, development, and testing of the two engines on a cost-plus-incentive-fee basis at a target cost of $272 million. At August 31, 1973, Pratt & Whitney estimated that due to development problems, the estimated cost for the joint development program would be $472 million or an overrun of about $200 million. Since the Navy shares the cost equally with the Air Force, the portion of the overrun to be funded by the Navy was about $100 million or a total Navy cost of about $236 million.

AWG-9 Weapon Control System

At June 30, 1973, the work required under the prototype and pre-production contract for the AWG-9's was almost completed Hughes estimated that the final contract price would be $105.3 million

The following AWG-9 production contracts were in process at June 30,1973

	Fiscal Year		
	1971	1972	1973
	($ In Millions)		
Percent complete	94	80	33
Estimated price at completion	$ 179 2	$ 207 8 1/	$ 160 5 1/
Quantity	38	50	48
Average unit price	$ 4.7	$ 4 2	$ 3.3

The fiscal year 1972 and 1973 contracts awarded in September 1971 and 1972 were negotiated together in November 1973 for a firm-fixed-price of $262.1 million.

The fiscal year 1974 option for an additonal 54 AWG-9's was exercised on October 30, 1973, and the Navy's estimated target price, exclusive of spares and ground support equipment, is $92 3 million. The contract has three remaining options to be exercised in fiscal years 1975 through 1977 The total quantity available under the remaining options ranges from 124 to 386 units

PHOENIX

The basic separation and test contract for prototype and value engineered missiles has been completed at an estimated price of $29 4 million

The following PHOENIX missile production contracts are in process

1/These figures include undefinitized changes.

	Fiscal Year		
	1971	1972	1973
	($ In Millions)		
Percent complete	97	70	23
Estimated price at completion	$ 83 8	$ 85 3	$ 70 5
Quantity	69	240	180
Average unit price	$ 1 2	$ .4	3 4

The Navy exercised its fiscal year 1974 option on November 30, 1973 Hughes proposed a total price of $56 9 million exclusive of spares and support equipment for this buy of 240 missiles Contract options available for fiscal years 1975 through 1977 provide for a total additional quantity which ranges from 600 to 1,800 units The ceiling price, excluding spares, for the 1,800 units is estimated at $304.9 million

SCHEDULE

At June 30, 1973, deliveries of TF30-P-412 engines, AWG-9's and PHOENIX missiles were generally on schedule Airframe deliveries, F401-PW-400 engine development, and Navy F-14A testing had experienced slippages The Navy support data (NSD) for the F-14A was achieved, according to the Navy, in January 1974 This is the date the Navy is supposed to maintain the aircraft, including maintenance and spare parts Some of the systems, however, such as the central air data computer and certain ground support equipment are not being supported by the Navy The Navy stated that they expect to achieve full support at time of deployment

Airframe

The 12 R & D aircraft in Lots I and II, including an F-14B configured aircraft had been delivered as of September 1973. The 26 Lot III procurement aircraft scheduled to be delivered at June 30, 1973, were delivered by October 1973. Appendix IV shows the original delivery schedule, the revised schedule and the actual deliveries of the 122 production aircraft under contract at December 31, 1973.

Some of the reasons given by Grumman for late deliveries are

--crash of aircraft number 10 and the resulting requirement to instrument aircraft number 17 as its replacement,

--incorporation of changes, and

--replacement of defective components.

Engines

At June 30, 1973, 189 TF30-P-412 engines had been delivered. Two other engines scheduled for delivery by that date were delayed by a temporary parts shortage and were delivered in July 1973.

The three F-401-PW-400 engine development milestones scheduled for 1972-1973 were not completed on schedule.

Milestone	Date		
	Original	Revised	Accomplished
First F-401 (prototype) engine accepted	3/31/72	12/31/72	1/26/73
Preliminary flight rating test (PFRT)			
Completion of	2/29/72	12/31/72	1/9/73
Approval of	5/31/72	3/31/73	10/31/73
Qualification test (QT):			
Completion of	2/28/73	QT requirement was deleted	
Approval of	5/31/73	from contract	

Due to development problems, the PFRT was not completed until January 9, 1973. The test was run under modified conditions with the requirement for later substantiation (See Chapter 3). This, as well as normal post-test clean up work, was completed in August 1973. The test report was approved in October 1973.

The acceptance of the first prototype engine was delayed until the engine capabilities had been demonstrated during the PFRT.

The requirement for two 150-hour qualification tests was deleted from the contract and replaced by a less stringent 60-hour substantiation test. This latter test is similar to the PFRT and will qualify for flight an improved version of the PFRT engine which would expand the flight envelope. At least two factors contributed to the deletion of the qualification testing. Qualification of the Air Force engine had slipped 8 months resulting in delay of the Navy engine qualification. Also, the Navy had problems obtaining funds to support the development program beyond the scheduled completion date. Since the Navy shares the development costs equally with the Air Force, they in effect are funding half the additional costs resulting from slippage in the Air Force engine qualification.

Navy F-14A testing

Three major Navy F-14A test programs, scheduled for completion in 1973, have slipped 6 to 12 months due to delays in the flight test program and delivery of aircraft.

Technical evaluation (TECHEVAL) is the developing agency's test to determine whether a weapon system and its support systems meet the design specifications. It was to be completed by December 1973 but is now estimated to be finished by June 1974.

Operational evaluation (OPEVAL) is the test of a technically acceptable system under service operating conditions. It's estimated completion date has slipped from December 1973 to December 1974.

The Board of Inspection and Survey (BIS) trials are conducted to determine whether the aircraft is capable of performing its basic mission and is suitable for service use. An initial trials phase was begun in November 1972 and the final trials phase began in February 1973. The estimated completion date of August 1973 was not met. The Navy now plans to complete the testing around May 1974 with a final BIS report being issued around mid-1974.

Other milestones

Other slippages noted in the Schedule Milestone reported in the September 30, 1973, SAR are as follows

--The scheduled date for establishment of the first operational F-14/PHOENIX squadron slipped 5 months to December 1973 The SAR attributed this to delays in the flight test program and delivery of production aircraft. The operational date is the date the Navy will have its first deployable squadron. Deployment from carriers will not begin until the latter half of 1974 after completion of carrier suitability testing The Navy stated that this milestone was completed in accordance with the revised schedule.

--The Navy support date for the PHOENIX has slipped from January 1974 to July 1976. Although the slip is significant, it is not expected to impact heavily on the PHOENIX missile's operational capability We were advised by Project Office officials that the slip was caused by a decision to delay ordering depot level support equipment when the program was unstable. The effect of delaying the Navy support date results in relying on the prime contractor for depot level maintenance and repairs

--The scheduled date for completion of F-14A static tests slipped from October 1972 to November 1973

--The scheduled date for approval of the PHOENIX for service use slipped from July 1973 to June 1974

F-14A concurrency

In prior reports GAO stated that the Navy would be buying a number of production aircraft before BIS trials. With the negotiation of the fiscal year 1974 buy, 184 aircraft have been ordered before the completion of BIS and development.

The Navy and Grumman, however, have amended the contract to reflect stretched-out deliveries for Lots I to V. The amendments cost the Navy about $39 million and reflect the revised deliveries resulting from the loss of aircraft number 1 as well as other contract changes. By stretching deliveries, 77 aircraft should be delivered by the completion of BIS testing in May 1974, rather than the originally scheduled 86 aircraft. This reduction in concurrency should reduce the retrofit cost needed to correct deficiencies noted during the test program.

PERFORMANCE

F-14A airframe and engines

Our analysis of the SAR at September 30, 1973, showed that 17 of the 20 performance or design characteristics had not achieved their development goals, two were above, and one characteristic had not been demonstrated Where the actual performance had not always achieved the goal, in most cases it was close to it. For example, of the 17 characteristics, 12 were within 10 percent and one was within 18 percent of the goal The other four were not measurable on a percentage basis and one characteristic had not been demonstrated.

We do not believe that the Navy intends to achieve these goals. Recently concluded contract negotiations (See Chapter 5) for the purchase of 50 F-14A's in fiscal year 1974 included new performance specifications These specifications reflected the demonstrated performance and not what was initially required in the development contract.

PHOENIX

The PHOENIX missile's technical performance, based on missile firings, continues to indicate that most technical parameters will be met, and in some cases, exceeded.

SELECTED ACQUISITION REPORTING

DOD reports status of the F-14, and related systems such as the PHOENIX and VAST separately.

We do not believe that this approach clearly presents the status of the F-14 program We believe that a more meaningful report would result by including in the SAR's pertinent information on the status of each system For example, the F-14 SAR would report in detail on the F-14 aircraft program but in addition, would also include some pertinent program information on the PHOENIX and VAST.

Previous SAR's have explained the loss of test aircraft (aircraft number 1 on December 30, 1970, and aircraft number 10 on June 30, 1972). The June 30, 1973, SAR reported the loss of aircraft number 6 on June 20, 1973. While the SAR's have reported the crashes, they have not identified the overall impact of the crashes on the program in terms of cost, schedule and technical performance. The loss of aircraft number 1 has been cited as the reason for production delays, number 10 caused a 5-month delay in restarting carrier suitability tests and the loss of aircraft number 6 is expected to delay Grumman's missile separation tests by 9 months.

We believe the SAR's should have attempted to assess the overall impact on the program as a result of these crashes.

The F-14A SAR does not contain milestones for either OPEVAL or TECHEVAL testing although, as discussed elsewhere in this report, these are key test phases in the Navy test program.

As discussed on page 21, . the SAR does not currently include an estimate for replenishment spares. In order to provide full disclosure of program status we believe that costs such as these should be reported.

CHAPTER 3

TEST AND EVALUATION

F-14A operational squadrons are being formed prior to the completion of Navy and contractor testing Since June 30, 1972, the Navy completed the second preliminary evaluation and started service acceptance trials. Contractor flight testing will continue through most of calendar year 1974, with the completion of ground tests slipping into 1975.

NAVY PLANS AND ACCOMPLISHMENTS - F-14A

Through October 28, 1973, the Navy had made 635 flights in F-14A's totaling 1,260 hours The original approach to Navy testing was to coordinate Navy Preliminary Evaluations (NPE), Board of Inspection and Survey (BIS) Trials, and Technical and Operational Evaluations through an Operational Test and Evaluation (OTE) working group. The Navy completed the second of three planned NPE's in August 1972. However, the third NPE, scheduled for December 1972 was cancelled because of time constraints and other testing was substituted. The Navy established the Joint Evaluation Team (JET) in November 1972 to consolidate and execute remaining test efforts

Joint Evaluation Team

The Navy was forced to revamp their OTE program due to slippages in the F-14A development program and the late delivery of production aircraft. In order to satisfy BIS and certain TECHEVAL and OPEVAL requirements, the Navy established a JET program to implement the OTE objectives This program was to integrate BIS, TECHEVAL and OPEVAL testing

requirements and to pool available assets in order to accelerate testing and reduce redundancies. However, JET appears to have been geared more toward satisfying BIS requirements than those of TECHEVAL and OPEVAL.

Board of Inspection and Survey Trials

The Board of Inspection and Survey began its initial phase of service acceptance trials in November 1972. BIS trials were originally scheduled to begin in June 1972 but slipped primarily due to the crash of aircraft number 1 in December 1970. The conduct of BIS was further delayed when aircraft number 6 crashed on June 20, 1973, during contractor testing, requiring the JET team to provide a test plane (aircraft number 5) to Grumman as a replacement for the lost aircraft.

BIS trials are being conducted in two phases, initial and final trial phases. The initial trial phase was held at the Naval Missile Center, Point Mugu, California from November 13, 1972, to February 28, 1973, to evaluate the F-14A's avionics, weapons control system, and missile firing performance. The formal BIS trials final phase began February 28, 1973.

During BIS, the aircraft is evaluated by three Naval Air Test Center (NATC) divisions-the Weapon System, Flight, and Service Test divisions-to determine service suitability. Weapon Systems evaluates the F-14A's avionics, weapon control

system and stores compatability. This segment of BIS has been completed and their findings are scheduled to be published in December 1973 The Flight Test Division reviews the aircraft's flying qualities and carrier suitability This segment should be completed in March 1974. The Service Test Division is responsible for evaluating aircraft system and engine performance, all weather flight capability, and human factors and is scheduled for completion in May 1974. According to Navy officials the final BIS report is not expected until mid-1974.

Navy technical evaluation

The F-14A program TECHEVAL was planned to run from July 1972 through December 1973. However, it did not begin until November 1972, and is expected to continue through June 1974. The delay in initiating TECHEVAL was also due to late aircraft deliveries and aircraft crashes.

The Weapon System BIS effort was to have satisfied certain TECHEVAL objectives under the JET concept, but due to delays, the trials' scope was reduced. This resulted in the partial reduction or deletion of TECHEVAL test items. Therefore, much of TECHEVAL remains to be done with follow-on effort contemplated after the completion of BIS.

Navy operational evaluation

OPEVAL was scheduled between October 1972 and December 1973. However, formal OPEVAL started in July 1973 and is now scheduled

to be completed in December 1974. OPEVAL was delayed in part by late aircraft deliveries and the non-fulfillment of certain OPEVAL requirements during the BIS trials by the Joint Evaluation Team.

The Navy also changed the F-14A's OPEVAL scope by adding an Initial Operational Test and Evaluation (IOT&E) to satisfy the requirements of Section 506 of Public Law 92-156. This law requires the Secretary of Defense to report operational test and evaluation results to the Congress when procurement funds are requested. Since OPEVAL had not begun, the Navy added the IOT&E to the OPEVAL plan and conducted it in September and October 1972. The IOT&E report issued in November 1972 concluded that the F-14A Weapon System demonstrated the potential to significantly enhance the attack carrier striking force's fleet air defense and fleet air superiority posture. The favorable results of the IOT&E were included in the Fiscal Year 1974 President's Budget Estimate, Aircraft Data Sheet. The IOT&E report, however, also discussed several deficiencies and stated that certain critical issues impacting on the total F-14A operational effectiveness and suitability were not addressed due to the limited scope of the test. This classified information, which would have provided full disclosure, was not included in the submission to the Congress.

Results of Navy testing

During Navy testing deficiencies are reported utilizing a BIS "yellow sheet" report format. Each deficiency is classified

according to its seriousness with Part I deficiencies being the most serious. According to the Navy, all Part I deficiencies should be corrected before acceptance of the aircraft for service use.

At October 12, 1973, 714 F-14A yellow sheets had been issued as a result of all Navy testing including 238 Part I's. We were told that it is not unusual to have hundreds of yellow sheets generated during testing of an aircraft. The seriousness of Part I yellow sheets vary, for example, from excessive defueling time to major engine deficiencies. In addition, some yellow sheets are written based on pilot preference or are due to a deficiency of a particular F-14A aircraft.

A yellow sheet is considered open until corrective action is taken and evaluated or a decision is made that a solution is either too expensive or impractical. At October 12, 1973, 324 yellow sheets remained open including 125 Part I's. The Navy told us they were using one aircraft specifically to review and close out as many yellow sheets as possible. There may be open yellow sheets when the aircraft is deployed into the fleet but we were advised that they would not be serious deficiencies.

CONTRACTOR PLANS AND ACCOMPLISHMENTS - F-14A

Pratt and Whitney completed engine development in 1971, and Hughes concluded its AWG-9/PHOENIX demonstration program in May 1973. At September 5, 1973, Grumman had completed its reliability and maintainability, and electrical demonstrations.

Required segments of structural, aerodynamics, power plant, armament, equipment, avionics, and carrier suitability demonstrations remained to be done.

Airframe and engines

Flight test program

Through October 28, 1973, 12 contractor F-14A flight test aircraft had made 1,021 flights totalling 1,845 hours. Ten of these aircraft were used for Grumman tests and two for Hughes testing. The schedule and assignment of the 12 aircraft to the elements of the test program is shown in Appendix VI.

Our 1972 Staff Study indicated that contractor F-14A flight testing was scheduled to be completed in January 1974, however, Grumman's flight test program has been stretched to November 1974 primarily due to the crash of aircraft number 6 during a SPARROW missile separation. The crash had an immediate schedule impact of 9 months. This schedule change reflects the time needed to instrument aircraft number 5 to replace aircraft number 6 and to complete weapon separation tasks. The schedule may be further extended if additional tests are required to determine the integrity of the missile launcher. The Navy will pay about $4 million for the delay and for aircraft number 5's re-instrumentation

Other reasons for flight test program slippage included the adoption of the maneuvering slats test and spin prevention programs, minor structural anomalies and engine problems.

Ground test program

Major airframe ground testing remaining to be completed includes structural and simulator tests.

Structural tests include static, fatigue, and drop tests. Static tests involve the exertion of force without motion on the structure and/or component to evaluate stress levels. Fatigue tests isolate any structural tendencies to weakness or breaking through dynamic stressing. Drop tests determine the load limits of landing gear and other structural components. The status of structural tests is shown in Appendix VII.

The scheduled completion of structural tests slipped from August 1974 to February 1975. Grumman officials attributed slippages generally to changes in design load testing conditions and the need for re-testing.

Simulator (system integration) tests involve simulating different flying environments to determine if the flight control systems are functioning properly The automatic carrier landing system has not yet been integrated with the other flight control systems delaying completion of the test from August 1973 to December 1973.

Corrected problems

Grumman has corrected, subject to Navy review, five of the more serious problems identified in our prior report. These include gun gas ingestion, hydraulic lines, Central Air Data Computer (CADC) reliability, nosewheel vibrations and aircraft spin problems.

Corrective action for the gun gas ingestion was done at Grumman's expense. The modifications to alleviate nosewheel vibrations must be reviewed by the Navy but will involve no additional expense to the Government. Certain hydraulic tubing in Lots I and II aircraft was replaced at a cost to the Government of $2 million.

The CADC provides data for the flight control system. The original dual channel CADC did not meet reliability specifications and was redesigned to a single channel unit at no cost to the Government. The new design was subsequently modified to a super single channel CADC, and is being installed in Lot IV aircraft at an estimated cost of about $1.9 million. Lot I - III retrofit and Lot V production costs have not been determined. The new design must undergo a reliability and maintainability qualification test in December 1973. A final cost determination will be made when and if the new unit is approved.

Grumman was authorized $221,000 for study work on the spin problems. In March 1972 the Navy adopted a spin prevention program in lieu of the spin recovery program. The spin prevention program required the development and testing of an aileron rudder interconnect (ARI), a spin prevention device. The device was installed on aircraft number 2 with favorable flight test results and will be demonstrated to the Navy in July 1974. The Navy and Grumman have agreed to an interim billing price of $516,000 for developing, installing and testing the ARI. Production and retrofit cost will be determined when and if the Navy decides to make the ARI a production item.

Two problem areas, turbine nozzle overheating and fuel nozzle spraying pre-ignition, that affected the F-14A engine, have been corrected by Pratt and Whitney. The turbine nozzle overheating problem was corrected by two engineering changes. As a result, 33 engines were to be retrofitted at a total cost of $5,778. Retrofit kits to correct the fuel nozzle spraying problem will cost in total about $72,000 and will be installed during normal maintenance.

PHOENIX /AWG-9

Hughes testing was completed on schedule in May 1973 but with several deviations from original objectives. The contractor development and evaluation test plan, approved by the Navy in May 1972 called for development and evaluation flight testing to last from February 1972 to November 1972 followed by a 6-month contractor demonstration. The contractor demonstration was to precede all Navy evaluation programs to ascertain the readiness of the armament system to enter Government evaluations.

As with Navy testing, various delays (such as crashes) have compressed the time available for Hughes development and evaluation testing. This made it necessary to conduct Navy and contractor evaluations simultaneously. As a result, Hughes used data accumulated in NPE II to satisfy a significant portion of their formal demonstration requirements. The NPE II data used was supplemented by results of Hughes development and evaluation testing. Of 352 contractor demonstration objectives, 140 were

satisfied prior to commencement of the contractor demonstration primarily with NPE II data

Overall, Hughes considers the portion of the contractor's demonstration completed in May 1973 to have had a highly satisfactory success rate -- 84 percent of the test objectives met or exceeded specifications. Remaining objectives were either deleted/deferred (13 percent) or not tested (3 percent). The reason for deleting or deferring certain objectives was attributed by Hughes to such things as nonavailability of certain assets (high speed/high altitude targets, specially configured missiles, safety of flight consideration, and nonfeasibility of instrumentation). The Navy witnessing team for the demonstration and Hughes agreed that certain demonstration objectives would be deleted or left as open items to be demonstrated as assets become available.

A report by the Navy team which witnessed the demonstration had not been issued at the end of our review. According to the witnessing team, the Navy generally agrees with the numerical results of the demonstration as presented by Hughes. However, the witnessing team did not believe Hughes demonstration plan, as approved by the Navy, called for specification requirements to be fully demonstrated. Hence, the Navy witnessing team was unable to make a specification compliance assessment for some test objectives The Navy intends to use data from other Navy PHOENIX/AWG-9 test programs to satisfy specification compliance requirements.

Accomplishments

At December 31, 1973, a total of 76 PHOENIX missiles had been launched. There were 55 successes and seven no-tests resulting in an 80 percent success ratio. Of 32 PHOENIX launchings from the F-14A, 26 were successful and there were three no-tests resulting in a 90 percent success ratio.

The missile however, still has not been tested to its full designed operating parameters, primarily because of test range limitations. Specifically, the missile has not been tested under all weather conditions, against certain types of targets, or over all extremes of its planned operating envelope.

Corrected problems

In our prior report we identified several technical problems and potential areas for future problems on the AWG-9 and PHOENIX. Since then, the Navy and Hughes have completed additional testing which shows most of the issues have been alleviated.

The AWG-9's multiple track capability has been improved, although further demonstration is required. There have been design changes to the transmitter and gridded traveling wave tube which have improved its performance and reliability. Weapon control system computer operations problems have been overcome. The AWG-9 detection of high-speed targets has improved. Software changes will be needed to make the increased capability possible.

Operational testing of the electronic counter countermeasure (ECCM) was performed in October 1972 by the Navy, but the Navy report concluded that ECCM needed improvement. Hughes has begun an improvement

program The advance capabilities were verified in a test bed in December 1973 and testing in a F-14A is scheduled for May 1974

CURRENT PROBLEMS - F-14A

Airframe and engines

Current problems in the airframe and engine which had been reported previously include tail clearance, aircraft weight, engine stalls, and engine nozzle shroud outer seal failure

Tail clearance

During carrier landings, it is possible that the F-14's tail could strike the carrier deck This possibility is increased when the Direct Lift Control (DLC) feature is employed DLC increases the aircraft's pitch during a carrier approach The problem's operational significance was to be determined during the Navy's carrier suitability sea trials scheduled to begin in November 1973. We were subsequently informed by the Navy that tail clearance was not a problem in the sea trials

Aircraft weight

Aircraft weight growth continues to be an area of concern. While actual reported weights have increased since June 1972, the Navy advised that the rate of increase on this program is less than that experienced on prior Navy aircraft programs

Engine stalls

The F-14A engine has experienced engine stalls at high speed/high altitude and low speed/high altitude

High speed/high altitude stalls are due to engine air inlet distortion which produces engine/inlet incompatability Grumman has modified the inlet ramp schedule to improve inlet/engine compatability

Low speed/high altitude stalls occur in both afterburner and non-afterburner modes. The non-afterburner stalls occur during horizontal aircraft movements, which produce inlet distortions making the engine more susceptible to stalls. Pratt and Whitney submitted a comprehensive and costly ($6 million) proposal addressing both afterburner and non-afterburner stalls The Navy, however, rejected this due to its cost and complexity and chose a feature which provides greater stall margin through a 10 degree rudder switch. Grumman is to prepare a proposal for this solution.

Afterburner stalls occur when shutting down from afterburner to low power Although the total Pratt and Whitney proposed solution was rejected, the Navy is evaluating a portion of the proposal which calls for afterburner control refinements

Nozzle shroud outer seal failures

During November 1971 Navy flight tests, the F-14A engines' nozzle shroud outer seals -- also known as "flipper seals" -- broke off because of stress concentrations at seam welds The seals provide a smooth contour between the exhaust nozzle of the engine and the aircraft Navy and Pratt and Whitney representatives stated that loss of seals has a small drag effect on aircraft operation but does not effect performance

Two tested redesigns have failed to solve this problem, although initial results of a third redesign being tested appear encouraging. Pratt and Whitney estimates that $243,100 had been spent through August 31, 1973, on this problem and that a solution will necessitate retrofit of all engines.

AWG-9

Since 1971, testing of the AWG-9 system has been limited slightly because of limitations of the test facilities

Pulse doppler performance of the AWG-9 radar system in the clutter region remains slightly below specification

PHOENIX

Testing of the missile has been slightly limited due to test range limitations and the lack of realistic targets

The missile has experienced some problems with certain warhead mechanisms in the areas of reliability and their ability to function properly in an all weather and chaff environments

F-14B DEVELOPMENT

Pratt and Whitney is continuing development work on the F-401 "B" engine which began in March 1970 Funding of the development effort has decreased from a $100 million level in fiscal years 1972 and 1973, to $17 and $27 million in fiscal years 1974 and 1975.

The original "B" engine development test plan provided for various tests including a PFRT and two QT's The PFRT was to demonstrate the engines suitability for flight test use while the QT demonstrates the engines suitability for production As of August 31, 1973, about 12,000 hours of full-scale engine testing including 5,400 hours on Navy engines had been completed In addition, about 4,100 hours of joint Navy/Air Force flight, ground, and core engine testing had been completed at that date

Preliminary Flight Rating Test

PFRT for the F 401 engine was completed on January 9, 1973. A total of 438 discrepancies were recorded during the PFRT and the post-test inspection. Of these, 124 were considered as normal wear and required no specific action. The Government required the contractor to correct 234 of the discrepancies to meet QT requirements and 26 of the discrepancies prior to the first YF401/F-14B flight. For the other 54 discrepancies, fixes were either required or considered highly desirable for incorporation into flight test engines.

The original contract specification required 12 hours of altitude testing at Mach 2.4 during PFRT. The PFRT test plan, however, required 10 hours at Mach 2.2 and only 2 hours at Mach 2.4. The engine was actually run for 12 hours at Mach 2.2. According to Pratt & Whitney and Naval Plant Branch Representative Office officials, the test was run at Mach 2.2 in order to avoid the fan blade flutter problem.

In March 1973 the Navy notified Pratt and Whitney that an F 401 engine having a fix to the flutter problem would have to be tested at Mach 2.4, but the Navy did not specify the number of test hours In August 1973 Pratt and Whitney informed the Navy that the test requirement had been met by running an engine at Mach 2 4 for 4 24 hours, and that discrepancies noted during the PFRT had been corrected. The PFRT report which was to have been approved by March 31, 1973, was conditionally approved on October 31, 1973 The Navy stated that the contractor does not concur with some of the conditions and negotiations are taking place

Qualification tests

QT's were scheduled to be completed by June 30, 1973. However, in August 1973 the contract was modified to delete the QT requirements and added a 60-hour substantiation test This modification was necessary because available Navy funding was not sufficient to continue the development and testing program through completion of QT.

The purpose of the 60-hour test is to evaluate several design changes that have been incorporated in the F 401 engine since the completion of the PFRT The improved engine would increase the flight envelope The 60-hour test scheduled to be completed by September 30, 1973, started on September 10, 1973 On September 21, however, the test engine experienced a failure and was destroyed by fire. The failure occurred in the fourth-stage compressor area, due to a loose rear compressor variable van lever arm

A second 60-hour substantiation test began November 5, 1973, and failed on November 27, 1973, due to second stage turbine failure resulting from fatigue of the turbine spacer Alternate spacer designs are being evaluated As of March 18, 1974, the Navy was in the process of determining future program direction and the test had not been resumed

F-14B flight test program

The first F-14B, aircraft number 7, made its first flight on September 12, 1973, at Grumman's facility in Calverton, New York. The flight test aircraft has attained speeds of 1 6 Mach at 42,500 feet using PFRT prototype F-401-PW-400 engines. According to Grumman, the objectives of the flight were satisfactorily met. There were, however, 117 flight restrictions in effect. One additional aircraft designated for the B program, aircraft number 31, is in storage pending a Navy decision on the F-14B program.

The completion of Grumman's flight test program has slipped from October 1974 to April 1976. Grumman officials attribute the slip to engine development problems and late engine deliveries.

Continuance of F-14B development beyond June 1974 will depend on the Navy's ability to fund the effort. Flight testing through June 1974 will focus on safety of flight and engine testing

Corrected problems

Pratt & Whitney has encountered several development problems Most of the problems have been experienced on the Air Force's F-100 engine which is in a more advanced development stage than the Navy F 401-PW-400 engine However, development problems generally involve both engines since their design is similar

Problems that have been corrected include exhaust nozzle overtemperature, main fuel pump and combustor liner durability and high engine operating temperatures Other problems which have been corrected include fan stator deflection, fan blade flutter, compressor disk growth and turbine blade cracking. The correction of these problems has added to the total costs incurred in the engine development program.

Current problems

Two problems present in the F 401-PW-400 engine development program involve fan stall and compressor durability.

Fan stall

Early flight testing of the Air Force's F-15 aircraft identified areas where improved fan stability would be needed for the aircraft to achieve stall free operation throughout the flight envelope

During the engine development program Pratt & Whitney investigated a number of fan configurations, however, none achieved the desired fan stability goals Subsequently, a bulged or "reduced span" fan was developed for use in the F 100 engine, which improved fan stability However, the

Navy expects fan stall problems during the F-14B flight test program As a result, the bulged fan is also being considered for the F 401-PW-400 engine.

Compressor durability

Various malfunctions or failures associated with compressor durability have occurred throughout the F 401-PW-400 engine development and test program The most significant failures have been those in which compressor blades or vanes have cracked or broken off In several instances, the failures have caused fires and extensive damage to the test engines.

Efforts to increase compressor durability have been directed toward strengthening compressor blades and vanes by increasing their thickness. To reduce the recurrence of fires, many compressor components have been replaced with components made of a less flammable alloy Engines with these changes have demonstrated a marked improvement in compressor durability. There were however, six unresolved problem areas associated with F 401-PW-400 compressor durability, most of which were classified as minor by Pratt & Whitney

CHAPTER 4

STATUS OF THE VERSATILE AVIONICS SHOP TEST (VAST)

The VAST is an automated station for testing avionics components installed in the F-14 aircraft VAST is also supporting the E-2C and S-3A aircrafts and will be installed on aircraft carriers and at shore sites The first carrier deployment with VAST will be in support of the F-14A and E-2C (which is scheduled to be accomplished in calendar year 1974)

VAST stations are being procured by the Navy under contracts with PRD Electronics VAST test program sets (TPS's), which provide software interface between the VAST station and the avionic unit to be tested, are developed by Grumman and are funded by the F-14 project office

At June 30, 1973, estimated F-14A TPS costs had increased $20 5 million from the $68 5 million estimate of September 1971 This increase, according to the Navy, was primarily due to (1) a $13 1 million increase in fiscal year 1970 and prior years TPS costs which were previously omitted, and (2) delays which have occurred in the development of F-14A TPS's, generally due to testing problems which require software modifications

At June 30, 1973, 15 VAST stations had been delivered Ten of the stations were delivered to Grumman for use in the development of computer TPS's The remaining five were delivered to Navy shorebased sites at Point Mugu and Miramar, California

Original Navy plans for VAST/F-14 support called for the development of 243 TPS's for selected avionics components As of September 15, 1973, Navy plans called for the development of 232 TPS's, of which 49 have been delivered.

We were informed by the Navy that no major compatability problems have been experienced in the VAST/F-14A effort and that TPS development delays have occurred but serious support problems are not anticipated When the F-14A is deployed, the Navy plans to test manually with VAST and provide additional avionics spares for those units for which TPS's are not available We believe (see GAO VAST staff study of March 1974) that the availability of VAST hardware and TPS's are essential because their nonavailability could impact on the effective logistic support of the F-14A, E-2C, and S-3A aircraft programs In this regard, we noted that the Congress could inquire into the following areas of concern

--Navy plans to assure that the required level of spare avionic support is provided until the complete software package is made available.

--Navy plans to assure that the software in use is updated concurrently with installed aircraft avionic equipment

CHAPTER 5

FISCAL YEAR 1974 AIRFRAME PROCUREMENT

On September 24, 1973, the Navy and Grumman executed a new contract for 50 F-14A aircraft to be effective upon enactment of the Department of Defense Authorization and Appropriation Acts for Fiscal Year 1974.

CONTRACT PROVISIONS

The fixed price incentive contract for the 50 F-14A aircraft and Integrated Logistic Support Management Program includes the following contract targets.

Target cost	$281,500,000
Target profit	25,000,000
Target price	$306,500,000

The contractor's 8.9 percent target profit is subject to a 80/20 Government/contractor cost sharing for any amount of over or underrun of target cost, however, in no event shall the final (ceiling) price exceed $325,000,000. The payment provisions include the August 8, 1972, Advance Payment Pool Agreement.

The contractor is to deliver 6 aircraft per month from May through December 1975, except for September and November when 7 aircraft are scheduled for delivery.

The aircraft are to be furnished in accordance with an August 3, 1973, specification which revised the original specification

contained in the development contract. The new aircraft specification requires somewhat lesser performance to reflect performance actually demonstrated to date under the development contract.

F-14/PHOENIX
PROGRAM COST DATA
(DOLLARS IN MILLIONS)

Cost Category	Development	Current (June 30, 1972) SAR	Current (Sept. 30, 1973) SAR
Development			
F-14A	$ 731.0	$ 1,097.2	$1,103.8
F-14B	243.0	363.1	398.1
PHOENIX	94.0	166.2	166.2
	1,068.0	1,626.5	1,668.1
Procurement			
F-14A	5,192.0	3,804.6	4,999.6
PHOENIX	442 4	947.5	946.9
	5,634.4	4,752.1	5,946.5
Military Construction			
F-14A	0	6.7	7.2
Total Program Cost	$6,702 4	$ 6,385.3	$7,621 8
Quantities			
F-14A	469	313	334
PHOENIX	2,384	2,457	2,457
Program Unit Cost.			
F-14A	12 6	15.7	18.3
F-14A/B	13 1	16 8	19 5
PHOENIX	225	453	453

DEFINITIZED CONTRACT DATA ON MAJOR F-14/PHOENIX CONTRACTS
AT JUNE 30, 1973
(DOLLARS IN MILLIONS)

	Effective date	Type of contract 1/	Target cost	Target profit amount	Target profit percent of cost	Target price	Ceiling or firm fixed price	Ceiling as percent of target cost	Sharing ratio on incentive contracts (Government/contractor)
Airframe (aircraft and trainers only)									
-N00019-69-C-0422 Lot I	2/3/69	FPI	$368 4	$36 3	9 86	$404 7	$458 2	124 4	70/30
Lot II	12/31/69	FPI	118 8	13 3	11 1	132 1	141 1	118 8	70/30
Lot III	9/30/70	FFP					238 2	N/A	
PHOENIX missile									
-N00019-69-C-0633	7/1/69	CPIF	24 5	2 0	8 1	26 5	32 2	135 5	80/20 over - 60/40 unde
-N00019-71-C-0187	11/20/70	FPI	66 1	6 4	9 7	72 5	81 0	122 5	80/20
Weapon control system									
-N00019-70-C-0207	10/23/69	FPI	85 2	8 5	10 0	93 7	100 0	117 4	85/15
-N00019-71-C-0385	10/1/70	FPI	125 8	12 6	10 0	138 4	146 6	116 5	85/15
F-14B engine development									
-F33637-70-C-0600 2/	3/1/70	CPIF	272 0	21.8	8 0	293 8	458 6 2/ 3/	N/A	90/10
F-14A engines									
-N00019-71-C-0138	1/29/71	FPI	79 0	10 0	12 6	89 0	94 8	119 6	55/45
-N00019-72-C-0185	12/7/71	FFP 4/					111.6	N/A	

1/ FPI - Fixed Price Incentive FFP - Firm Fixed Price CPIF - Cost Plus Incentive Fee

2/ Navy and Air Force shares the cost equally

3/ Estimated price at completion

4/ Originally issued as an FPI contract Converted to FFP in March 1973

GRUMMAN AEROSPACE CORPORATION'S
ESTIMATE AT COMPLETION OF THE PRICE COST AND LOSS ON 134 AIRCRAFT
EXCLUDING SPARES AND SUPPORT EQUIPMENT
AT JUNE 30, 1973
(Dollars in Millions)

Lot number	Number of Aircraft	Original target price	Price of authorized charges	Government share of cost overrun	Estimate at completion		
					Price	Cost	Profit (loss)
I	6	$ 388 0	$ 34 9	$ 55 1	$ 478 0	$ 506 4	$ (28 4)
II	6	173 6	10 0	14 9	198 5	214.0	(15 5)
III	26	242 1	28 4	1/	270 5	299 3	(28 8)
IV	48	227 0	41 4	27 9	296 3	343 7	(47 4)
V	48	184 6	-	13 1	197 7	285 5	(87 9)
	134	$1, 215 3	$114 7	$111 0	$1,441 0	$1,648 9	(207 9)

1/ Since lot III was firm fixed price, the Government does not share the cost overrun

COMPARISON OF ORIGINAL AND REVISED SCHEDULES WITH ACTUAL AT FRAM DIVISIONS
LOTS III IV V
AT DECEMBER 31, 1973

	Lot III			Lot IV			Lot V	
Month	Original Schedule	Revised schedule	Actual	Original schedule	Revised schedule	Actual	Original schedule	Revised schedule
Jan 1972	1							
Feb	1							
March	1							
April	1							
May	1	1	1					
June	1	1	1					
July	2	2	0					
Aug	2	1	1					
Sept	4	1	1					
Oct.	4	2	2					
Nov	4	1	1					
Dec	4	1	2					
Jan 1973		2	1	4				
Feb		2	0	4				
March		3	1	4				
April		3	3	4				
May		3	1	4				
June		3	2	4				
July			1	4				
Aug			3	4				
Sept			1	4	1			
Oct			3	4	5	2		
Nov				4	5	5		
Dec				4	5	9		
Jan 1974					5			
Feb					5			
March					5			
April					4			
May					4		6	
June					4		6	
July					5		6	
Aug							6	
Sept							6	

COMPARISON OF ORIGINAL AND REVISED SCHEDULES WITH ACTUAL AIRFRAME DELIVERIES
LOTS III IV V
AT DECEMBER 31, 1973

Month	Lot III			Lot IV			Lot V	
	Original Schedule	Revised schedule	Actual	Original schedule	Revised schedule	Actual	Original schedule	Revised schedule
Oct							6	5
Nov							6	5
Dec.							6	5
Jan 1975								5
Feb								6
March								6
April								6
Total	26	26	25 1/	48	48	16	48	48

1/ Aircraft 31, an F-14B version, is in storage pending a Navy decision on the F-14B program

UTILIZATION OF F-14A AIRCRAFT IN FLIGHT STATUS AT SEPTEMBER 30, 1973

Number of aircrait	Use
7	Contractor test program
4	Awaiting Navy acceptance/delivery
7	Training at Naval Air Station Miramar
6	Being used by the Operational Squadrons
11	Navy test programs
35	In flight status

F-14A CONTRACTOR FLIGHT TEST PROGRAM
STATUS AT SEPTEMBER 21, 1973

Aircraft number	Test	Test schedule Begin	Test schedule End	Months slippage (improvement) since December 5, 1972
1	High speed performance, flying qualities	August 1971	December 1973	2
2	Low speed performance, flying qualities	May 1971	January 1974	5
3	Structrual calibration and demonstration	September 1971	June 1974	7
4	Hughes Airborne Weapon Control System evaluation & demonstration	October 1971	February 1973	1
5	Grumman Airborne Weapon Control System evaluation and demonstration	November 1971	May 1973	(2)
5 (6) 1/	Missile separation/ equipment demonstration	November 1971	November 1974	11
8	Aeronautical performance demonstration	December 1971	May 1973	(7)
9	Hughes Airborne Weapon Control System evaluation/demonstration	December 1971	3/	-
11	Grumman Airborne Weapon Control System evaluation demonstration	March 1972	July 1974	7
13	Functional compatability	April 1972	May 1974	6
14	Reliability/Maintenance demonstration	May 1972	August 1973	(3)
17(10) 2/	Carrier suitability demonstration	February 1972	March 1974	2

1/ Aircraft 5 replaced aircraft 6 which crashed June 20, 1973

2/ Aircraft 17 replaced aircraft 10 which crashed June 30, 1972

3/ Hughes required testing completed in May 1973 Hughes still occasionally uses aircraft when the Navy isn't

STATUS OF F-14A STRUCTURAL TESTS

TEST	Percent completed at September 15, 1973	Scheduled completion
Static		
Ultimate Design	100	
Failing	47	February 1974
Fatigue	20 1/	February 1975
Drop		
Ultimate Design	100	-
Failing	0	March 1974

1/ Grumman had reported fatigue tests to be 23 percent complete at September 15, 1973. However, this figure was the completion rate of only one of three fatigue test phases.

FUNDING STATUS AND OUTYEAR PLAN
FROM INFORMATION CONTAINED IN THE
September 30, 1973 SAR
(Dollars in Millions)

	Current and Prior Years (Appropriated)	Budget Year (FY 74)	To Complete	Current Estimate
Development				
F-14A	1,063 4	40 4[1]	0	1,103.8
F-14B	353 6	17 0	27 5	398 1
PHOENIX	164 6	1.6[1]	0	166.2
Total Development	1,581.6	59.0	27.5	1,668 1
Procurement				
F-14A	2,066 4	693 1	2,240.1	4,999 6
PHOENIX	375.6	96 2	475 1	946 9
Total Procurement	2,442 0	789 3	2,715 2	5,946 5
Military Construction				
F-14A	3 8	3 4	0	7 2
PHOENIX	.0	0	0	0
Total Military Construction	3 8	3 4	0	7.2
Total Program	4,027.4	851 7	2,742 7	7,621 8

[1]The program acquisition costs by weapon system as presented in the DOD Budget for FY 1975 were reviewed Included for FY 1975 were $756 3 million for the F-14A and $99 5 million for the PHOENIX programs Also included were FY 1974 costs which showed RDT&E increases of $ 3 million for the F-14A over those costs shown in the September 30, 1973, SAR