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U. S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

ON

[ THE F-14/PHOENIX AIRCRAFT PROGRAM ]

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DEPARTMENT OF THE NAVY

APRIL 1973

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## ABBREVIATIONS

NPE	Navy Preliminary Evaluation
SAR	Selected Acquisition Report
GAO	General Accounting Office
BIS	Board of Inspection and Survey
DOD	Department of Defense
OPEVAL	Operational Evaluation Testing
TECHEVAL	Technical Evaluation Testing
NAVAIR	Naval Air Systems Command
PMO	Project Management Office
CONEVAL	Concurrent Evaluation
ECCM	Electronic Counter Countermeasures
NTR	Navy Technical Representatives
PPM	Project Profile Manual
WBS	Work Breakdown Structure
PMIS	Program Management Information System
AFPRO	Air Force Plant Representative's Office

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## SUMMARY

### SYSTEM DESCRIPTION

The F-14/PHOENIX weapon system is being developed as a supersonic, tandem two seat, twin engine, variable wing-sweep, carrier-based fighter aircraft capable of performing several missions including combat air patrol (air superiority) and fleet air defense. It is in concurrent development and production.

### COMING EVENTS

- Resolution of problems associated with contracting for Lot VI, and the future of the program beyond Lot V for a total of 134 aircraft.
- BIS trials by the Navy were begun in February 1973. The results of these trials will determine whether the aircraft with its support equipment is suitable for service use.
- June 1973 - the scheduled date for the first flight of the F-14B prototype and the date for military qualification tests for the F-14B (F401) engine.

### COST

The Navy's current estimate of program cost of the F-14/PHOENIX at June 30, 1972 was \$6.4 billion. The estimated cost progression since inception for the program excluding the PHOENIX missile follows:

<u>At</u>	<u>Aircraft Quantity</u>	<u>Estimate</u>	<u>Unit Cost</u>
		-millions-	
Development estimate	469	\$6,166	\$13.1
June 30, 1969	469	6,373	13.6
June 30, 1970	722	8,279	11.5
June 30, 1971	313	5,212	16.6
June 30, 1972	313	5,272	16.8

The greater part of the cost decrease was due to the reduction in the quantity of aircraft. Offsetting increases were primarily due to economic escalation, the crash of two test aircraft, schedule changes, and increased development costs on the F-14B engines. The unit cost has risen primarily because increased development costs are spread over fewer aircraft.

Program funding to June 30, 1972, was:

	<u>Development</u>	<u>Procurement</u>	<u>Construction</u>
		-millions-	
Appropriated	\$1,119	\$1,459	\$3
Obligated	1,251*	1,201	3
Expended	1,168	388	3

\*Reprogramming actions

### CONTRACT DATA

The principal contractors on this program are Grumman Aerospace Corporation, Hughes Aircraft Company, and Pratt and Whitney Aircraft. Grumman, the airframe prime contractor, wrote off as a corporate loss \$85 million attributable to the first four contract lots. The Navy exercised its option for Lot V for 48 aircraft on December 8, 1972. Grumman stated that it considers the option invalid and unenforceable and it cannot produce this lot without incurring substantial additional losses.

Public Law 92-436, September 1972, authorized appropriations for not less than 48 aircraft with no increase in the ceiling price except in accordance with the terms of the contract. The act provides that the Secretary of Defense report to the Congress within 90 days after a determination that the procurement cannot be met under the conditions set forth in the act.

### PERFORMANCE

There has been a decrease in the number of F-14 design/performance characteristics previously reported below specifications. A successful demonstration of the four multi-shot capability was accomplished on December 20, 1972 when an F-14 engaged four of five target drones.

### PROGRAM MILESTONES

In fiscal year 1972, additional schedule slippages were reported in the SAR for both the F-14 and PHOENIX. Production delays and continuing effects of the loss of the first development aircraft in December 1970 were cited as the causes of slippage. The SAR did not report the impact on the program from the loss of a second aircraft on June 30, 1972.



#### RELATIONSHIP TO OTHER SYSTEMS

The F-14A aircraft 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 F-4J in other fighter roles in the 1973-1980 time frame. It is also intended to have all-weather capability for delivery of the PHOENIX, SPARROW and SIDEWINDER missiles, operation of the Vulcan cannon and delivery of air-to-ground ordnance using the AWG-9 airborne control system. Certain subsystems of the F-14 will depend on the Versatile Avionics Shop Tester for maintenance and repair.

#### SELECTED ACQUISITION REPORTING

The GAO believes that DOD's practice of reporting the status of the F-14 and the PHOENIX programs in two separate Selected Acquisition Reports does not clearly present the status of the weapon system.

The bases for changes to the current program estimate were not adequately substantiated by the F-14/PHOENIX project office records. In addition, the GAO noted several areas where Selected Acquisition Report improvements could be made.

#### TEST AND EVALUATION

GAO is concerned about certain areas in the test and evaluation phase of the F-14/PHOENIX program. These areas

stem from both the Navy and contractor test and evaluation programs.

Among them are:

- Navy test phases are still at an early stage.
- there is little room for schedule adjustment in the Navy program without causing further delays.
- minimal formal demonstration data has been supplied to the Navy by contractors.
- certain elements of the weapon system are not attaining their required objectives.
- go-no-go decision points were not established by the Navy in managing the PHOENIX missile progress.

#### PROGRESS MEASUREMENT

The performance measurement system at the F-14/PHOENIX project Office is geared toward keeping current on program status and providing current cost, schedule and performance information which can be used in the decisionmaking process. However, performance measurement information being provided by Grumman has weaknesses which limits its effectiveness as a Navy management tool. The system at Hughes is meeting its objective of providing visibility to the Navy over contract cost and schedule status on the AWG-9/PHOENIX programs.

#### MATTERS FOR CONSIDERATION

The Navy has exercised its option for 48 additional aircraft under Lot V and Grumman has stated it will perform under this option despite considerable losses. Precise contractual arrangements for the production

of Lot V and the relationship of such arrangements to future lots are not clear at this time. Other Grumman Government programs could be affected by renegotiation of future F-14 production lots.

Grumman and the Navy entered into an Advance Payment Pool Agreement on August 8, 1972, which calls for advance payments to Grumman for the sole purpose of making payments for cost relating to Government contracts. The latest amendment to this agreement on December 12, 1972, increased the advances to \$54 million. The extent of these advances are contingent upon Grumman's ability to obtain commercial credit.

#### AGENCY REVIEW

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

## CHAPTER 1

### INTRODUCTION

Our review of the acquisition of major weapon systems this year concentrated on the areas of test and evaluation and progress measurement. This report presents our evaluation of these aspects on the F-14 weapon system and in addition discusses cost, schedule and performance status.

The scope of our review is described on page 11.

### F-14 WEAPON SYSTEM

The F-14 weapon system is being developed as a supersonic, tandem two seat, twin engine, variable wing-sweep, carrier-based fighter aircraft capable of performing several missions including combat air patrol. In addition to its fighter role, which includes carrying SPARROW and SIDEWINDER missiles and an internal gun, the aircraft is designed to provide fleet air defense using PHOENIX missiles, and to perform ground attack missions. It is in concurrent development and production.

The integral elements of the F-14 weapon system and the prime contractors are:

Airframe and Weapon System Performance	Grumman Aerospace Corporation - Bethpage, New York, Calverton, New York
--	--

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

Airframe

The airframe prime contract awarded to **Grumman** Aerospace Corporation (Grumman) in February 1969, contained ceiling-priced options to be exercised yearly by certain dates. The Navy has ordered 86 F-14 aircraft and was contractually required to exercise the next option (Lot V) for at least 48 aircraft by December 15, 1972. On December 8, 1972, the Lot V option was exercised by the Navy. Following this, Grumman announced publicly that the option was invalid and unenforceable and that it could not continue under the option without incurring additional severe financial losses.

The value of Grumman's contract through September 1972 was \$1.3 billion, including about \$177 million for spare parts, ground support equipment and publications.

Engines

The Navy originally planned two versions of the F-14 aircraft. The first, the F-14A, uses the TF30-P-412 engine which is an outgrowth of the TF30-P-12 engine developed for the F-111 aircraft. The second version, the F-14B, will use a new advanced technology engine, the F401-PW-400. This engine is being developed by Pratt and Whitney under a joint Air Force/Navy project. Under this project, two distinct engines are being

developed for the Navy F-14B and the Air Force F-15 aircraft using a common core concept. While the two engines are to be similar in design and utilize identical common core parts (including the compressor, combustor and high pressure turbine), the Navy engine is to have a larger fan and afterburner, and larger external dimensions. The F-14B engine is expected to produce a third more maximum afterburner thrust and weigh about 11 percent less than the F-14A engine.

The F-14A engine is in production and is being flight tested in the Grumman flight test program and Navy Preliminary Evaluation (NPE) flight tests.

The F-14B engine is in the development stage. In July 1971, the program schedule was revised to accommodate a change to an alternate compressor and certain other changes designated as Series II engines. As of August 1972, Pratt and Whitney was working on this revised development schedule.

A separate Navy contract provided options for the procurement of the F-14B production engines at specified prices in a series of production lots. The Navy did not exercise its September 1, 1971, option for production engines and as a result all future options were voided. Any procurement of production engines for the F-14B will necessitate the negotiation of a new contract.

#### Weapon control system

To meet multiple roles of the F-14 aircraft the capabilities of the weapon control system or AWG-9 were expanded to function with other weapons

in addition to the PHOENIX. These weapons include the SPARROW (AIM-7E and -7F) and SIDEWINDER (AIM-9) missiles, the VULCAN (M-61) cannon, and various air-to-ground ordnance.

Capabilities to be provided by the AWG-9 include:

- 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 six PHOENIX missiles against multiple targets.
- Computations for M-61 gun firing.
- Computations for air-to-ground weapon delivery.

As of October 11, 1972, the Navy had ordered 136 production AWG-9's with associated equipment, spares, services and data, at a ceiling price of \$466 million. This number is intended to fulfill the aircraft requirements through Lot V. The fiscal year 1973 option was exercised on September 29, 1972.

#### PHOENIX Missile

The PHOENIX is the largest and most sophisticated weapon to be carried aboard the F-14. It is to be the primary weapon for Fleet Air Defense but secondary to the SPARROW for primary mission of air superiority. The PHOENIX is a long-range air-to-air missile capable of being used in single or multiple near-simultaneous launches against multiple targets. The guidance system can home in on enemy electronic radar-jammers, track a target by using data provided by the AWG-9 radar, or track the target with its own built-in independent radar system when within 10 miles of the target.

At October 11, 1972, the Navy had ordered 309 pilot and regular production missiles with associated equipment, spares, services, and data at a ceiling price of \$153 million. The Navy was to exercise its fiscal year 1973 option on or before December 1, 1972. The Navy informed us that this option was exercised on December 1, 1972 for 180 missiles, and that \$52.2 million was established as a limitation for progress payments. Ceiling price is to be established upon final negotiation.

#### SCOPE

We reviewed the F-14 test and evaluation program, the Navy project management office system for measuring program progress, and analyzed changes in technical performance, schedule, and cost reported in the June 30, 1972, Selected Acquisition Report. 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 Systems Command, F-14/PHOENIX Weapon System Project Office, Arlington, Virginia.

Naval Plant Representative Office, Bethpage, New York

Navy Missile Center, Point Mugu, California

Grumman Aerospace Corporation, Bethpage and Calverton, New York

Hughes Aircraft Company, Culver City, California

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

Program status and a summary of the major changes which occurred during the year ended June 30, 1972, and Selected Acquisition Reporting is also included in this chapter.

SYSTEM COST EXPERIENCE

The estimated cost of the F-14 program, exclusive of the PHOENIX missile portion, was \$5,272 million. The estimated cost progression from inception through June 30, 1972 is as follows:

<u>At</u>	<u>Aircraft quantity</u>	<u>Estimate (millions of dollars)</u>	<u>Unit cost dollars)</u>
Planning estimate	469	\$6,166	\$13.1
Development estimate	469	\$6,166	\$13.1
June 30, 1969	469	\$6,373	\$13.6
June 30, 1970	722	\$8,279	\$11.5
June 30, 1971	313	\$5,212	\$16.6
June 30, 1972	313	\$5,272	\$16.8

According to the Selected Acquisition Report (SAR) most of the total cost decrease was due to the reduction in the quantity of aircraft.

Development costs - airframe and engines

As shown in the June 30, 1972, SAR, the estimated research, development, test and evaluation cost of the F-14A and F-14B airframes and engines was \$1,460 million. This represented an increase of \$486 million since the January 1969 development estimate of \$974 million. The reasons for the changes to June 30, 1971, were previously reported by GAO.

In fiscal year 1972 the development costs increased \$67 million from \$1,393 to \$1,460 million. The reported change was the result of various increases and decreases as shown below.

	<u>Millions of dollars</u> <u>Increase or (decrease)</u>
Increased costs for F401 (F-14B) engine development and additional flight test engines	\$39
F-14A weapon system test delays	14
Additional costs for P-412 (F-14A) engines	7
Navy reprogramming action	<u>(3)</u>
Total Increase	\$57
Other changes - net	<u>10</u>
Net Increase as above	<u>\$67</u>

Procurement costs - airframe and engines

The estimated procurement costs for the F-14A, including airframe, engines, electronics, communications, armament, ground support, training equipment and initial spares at June 30, 1972 was \$3,805 million. This represented a decrease of \$1,387 million since the January 1969 development estimate of \$5,192 million.

The procurement costs in the development estimate of January 1969 were reportedly based on a planned quantity of 463 aircraft. In our prior report we showed that the major changes to the production cost estimates were the planned increase to 710 aircraft in fiscal year 1970 and the subsequent reduction to 301 aircraft at June 30, 1971.

In fiscal year 1972 the procurement estimate decreased from \$3,814 million to \$3,805 million or \$9 million. Some of the larger changes reported were:

	<u>Millions of dollars</u>
	<u>Increase (decrease)</u>
Increased engine procurement and ground support equipment funds	\$23
Decreased funding - airframe and changes	(15)
Electronics and communications	<u>(25)</u>
Total decrease	\$(17)
Other changes - net	<u>8</u>
Net decrease as above	<u><u>\$(9)</u></u>

The following table shows the major changes which occurred through June 30, 1972,

At	Planned Production		Unit cost (millions)
	Quantity of aircraft	Estimated cost (billions)	
June 30, 1969	463	\$5.4	\$11.7
June 30, 1970	710	\$7.0	\$ 9.9
June 30, 1971	301	\$3.8	\$12.6
June 30, 1972	301	\$3.8	\$12.6

Military construction costs

The June 30, 1972, estimate for military construction was \$6.7 million. This is an increase of \$1.8 million since the prior year and was reported as due to changes in locating a training building.

Grumman losses

According to its annual report for the year ended December 31, 1971, the Grumman Corporation lost \$18 million, after tax credits, as a result of a large loss on its F-14A program.

The estimated pre-tax loss on the contract up to the anticipated delivery of the first 86 aircraft by mid 1974 and certain other contract changes was \$65 million which was written off against 1971 earnings. Grumman's report further stated:

"The contract contains further options for the Government to procure varying quantities of aircraft at specified ceiling prices. If the Government exercises any or all of these options at those ceiling prices the Company would incur substantial additional losses. Although the Company is proceeding with the performance of the work\*\*\*\*it has advised the Department of the Navy that it considers the Government's options to be invalid and that it cannot accept orders for additional F-14A aircraft at the ceiling prices now specified in the contract. The Company has entered into discussions with the Department of the Navy to resolve these various problems but it is not possible to predict the outcome of this matter".

In November 1972, Grumman announced that for the first 9 months of 1972 it incurred an additional loss of \$20 million on the first four lots of F-14A's over and above the loss recorded in 1971.

Grumman estimated that the net loss on the contract through Lot IV was \$106 million at September 1972. Grumman informed us that the estimated loss of \$106 million and the recorded loss of \$85 million are comparable since the latter reflects expected profit to be realized on F-14B development effort, dollar limit items, and spare parts.

In testimony before the Ad Hoc Subcommittee on Tactical Air Power, United States Senate Committee on Armed Services, on April 17, 1972, Grumman officials estimated that the Company would lose \$105 million if it performs under the contract ceiling price of 48 aircraft on Lot V.

During July - September 1972, the Navy authorized \$36 million of long lead funding for lot V. In November 1972, Grumman reported that the amendments for long lead effort for these aircraft reflect an accelerated delivery schedule which would tend to somewhat reduce both the cost of producing the aircraft and the magnitude of the potential loss. Under the original terms of the contract, the Navy had until October 1, 1972, to exercise its option to buy at least 48 additional aircraft for calendar year 1974. However, in September it agreed with Grumman to extend the date until December 15, 1972, pending firm appropriations of the required funds.

Public Law 92-436, September 26, 1972, authorized appropriations for the procurement of not less than 48 aircraft on lot V subject to:

- 1) not increasing the ceiling price of the lot V option in the F-14 contract except in accordance with the terms of the contract,

2) the Navy exercising the option at any date prior to December 31, 1972, without additional cost to the government and within the present contract terms and conditions.

The act also provided that, in the event that the Secretary of Defense determines that the procurement cannot be met under the terms specified above, he report such facts to the Congress within 90 days after such determination together with his recommendations regarding the future of the F-14 program. On December 8, 1972, the Navy exercised the option. Grumman publicly announced that they would not proceed under the option principally because it was invalid and unenforceable and would result in severe financial losses.

#### Advance Payment Pool Agreement

On August 8, 1972, the Department of the Navy and Grumman Aerospace Corporation entered into an Advance Payment Pool Agreement providing for an advance payment to Grumman not to exceed \$20 million. Banks which had provided Grumman with a revolving line of credit discontinued these funds and the Corporation was pressed for money to meet its obligations.

The agreement provides for interest at 6 7/8 percent and places numerous requirements on Grumman to furnish the Navy with financial information. It also restricts Grumman in areas such as the payment of salaries and dividends and the purchase or transfer of fixed assets while the advances are outstanding.

The agreement was amended on September 14, 1972, to provide an additional \$16 million, a total of \$36 million. A Grumman letter of November 16, 1972, requested an increase of \$40 million to a total of \$76 million. Findings and Determination by the Assistant Secretary of the Navy dated December 11, 1972, authorized additional advance payments of \$18 million, making the total authorized advances \$54 million. This document indicated a need by Grumman of \$15 million in January and February 1973.

Other actions

During the period July to September 1972, several contractual changes were agreed to between Grumman and the Navy which should provide additional financial relief to the contractor. The contract price was increased \$21 million to reflect part of the effects of the loss of the first test aircraft in December 1970 and certain other changes as follows:

	<u>\$ Millions</u>
Increased costs of flight test program	\$9.2
Reinstrumentation of replacement aircraft and change in hydraulic lines	.5
Revision to delivery schedule - lots I, II (included in the above)	-
Revision to delivery schedule and other changes - lot III	<u>11.3</u>
Total	<u>\$21.0</u>

Grumman told us that it had already taken this increase into account in calculating its loss.



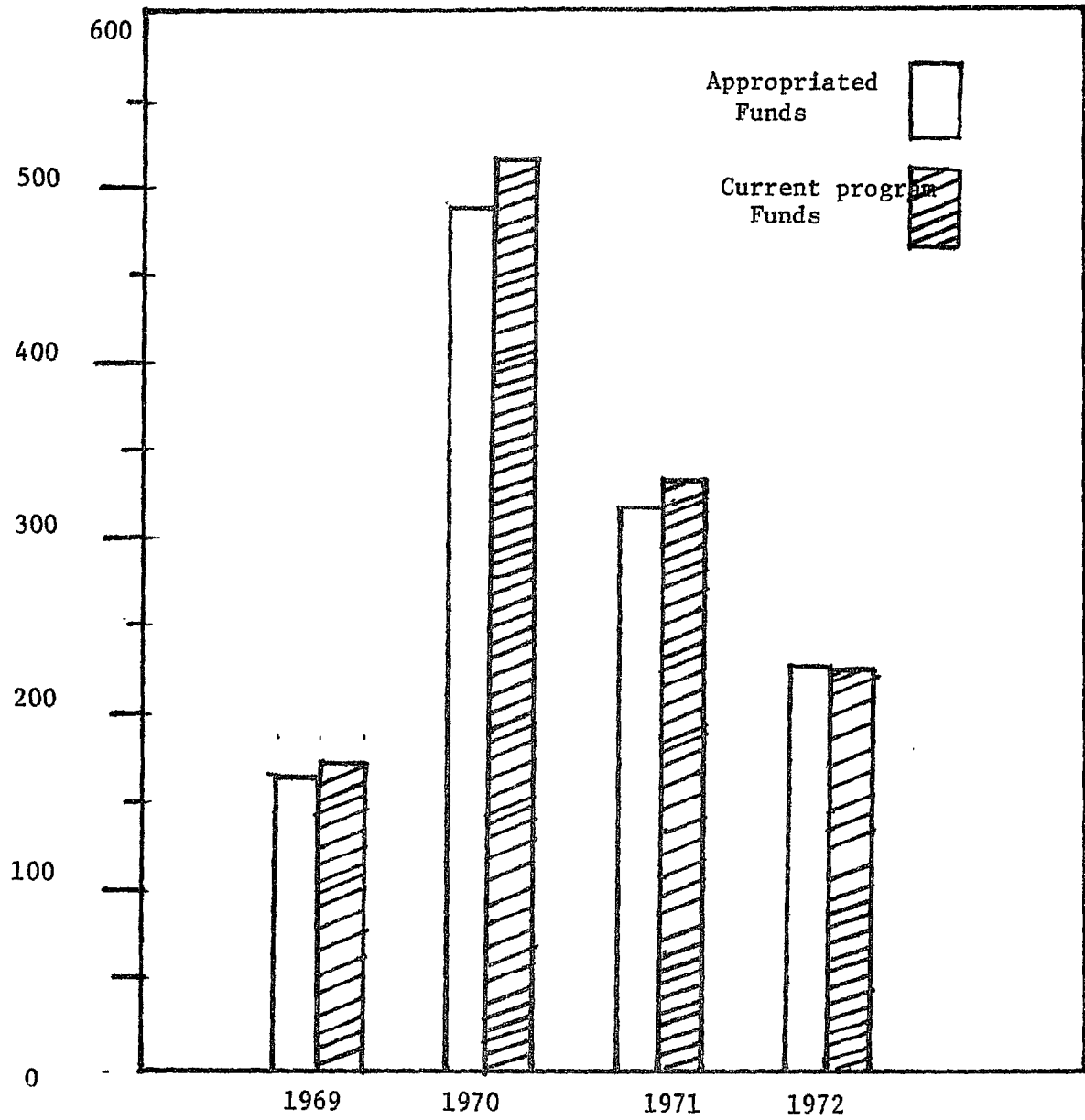
Funding - airframe and engines

The Department of Defense reports on funding **showed** that through fiscal year 1972 \$1,199 million was appropriated for F-14 development, \$1,459 million for procurement, and \$3 million for construction or a total of \$2,661 million. The total program funding including amounts reprogrammed to June 30, 1972 was \$1,257 million for development, \$1,498 million for procurement and \$3 million for construction, a total of \$2,758 million. The following charts show the funding through June 30, 1972. (Figures 1 and 2)

APPROPRIATED AND CURRENT PROGRAM  
FUNDS BY FISCAL YEAR  
RDT&E FUNDS  
F-14 AIRCRAFT

FIGURE 1

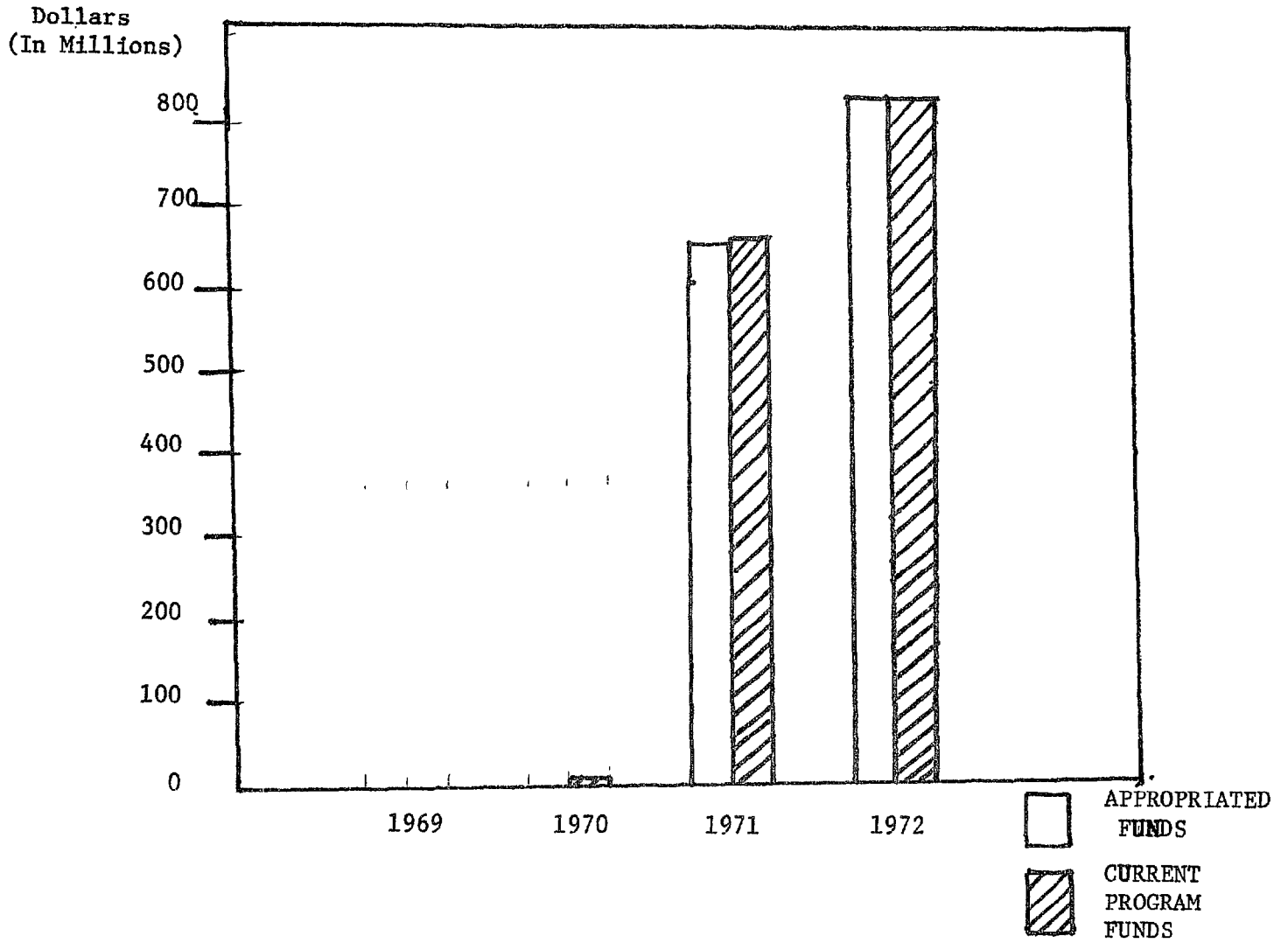
Dollars  
(In Millions)



NOTE: Differences between Appropriated and Current Program Funds in a given fiscal year are the results of reprogramming funds to or from another program.

FIGURE 2

PROCUREMENT FUNDS - F-14 AIRCRAFT  
APPROPRIATED AND CURRENT PROGRAM  
F-14 AIRCRAFT



Inflation - airframe and engines

The June 30, 1972 SAR stated that it included escalation rates of approximately 4 percent and 5 percent for procurement and development costs respectively. The airframe portion of the production cost included additional abnormal escalation for future lots estimated at \$151 million. The following summary shows the approximate amount of costs of inflation included in the current estimate.

Allowance For Price Escalation  
In Program Acquisition Cost Estimates

<u>Planning estimate<sup>a)</sup></u>	<u>Development estimate<sup>b)</sup></u> (millions of dollars)	<u>Current estimate</u>
	<u>\$256</u>	<u>\$225</u>
	4.1%	4.2%

- a) Planning estimate figures not shown in SAR
- b) Includes 4 percent escalation for production costs and 5 percent escalation for research and development costs according to Navy officials.

PHOENIX missile costs

The estimated total program cost of the PHOENIX missile portion of the program as of June 30, 1971, was \$1,252 million for development and production missiles. During the year ended

June 30, 1972, the total program cost decreased by \$138 million, to \$1,114 million. The \$138 million decrease in total procurement cost is due to the reduction in the quantity of production missiles and a reduction in initial spares and fleet support. These reductions were made to adjust the PHOENIX program to agree with a 1974 Program Objective Memorandum which called for a lesser number of missiles to be in the Navy's inventory.

Inflation - PHOENIX missile

An inflation factor of 4 percent compounded annually was applied to portions of this estimate.

Allowance for Inflation  
In Program Acquisition Cost

<u>Planning<sup>a)</sup></u> <u>estimate</u>	<u>Development<sup>a)</sup></u> <u>estimate</u>	-millions-	<u>Current</u> <u>estimate<sup>b)</sup></u>
None	None		<u>\$120</u>
			10.8% <sup>c)</sup>

- a) There is no allowance for inflation included in either the planning or development estimate.
- b) Amount of inflationary allowance included in the current estimate of procurement cost. No inflationary allowance is related to the development phase of the PHOENIX program since this phase was essentially complete by June 30, 1970. This amount is based upon a rate of 4 percent compounded annually, beginning with fiscal year 1972.
- c) This percentage is the ratio of inflationary allowance included in the estimated procurement cost to the total program acquisition cost (\$120 million/\$1,114 million). The ratio of inflationary allowance to estimated procurement cost (\$120 million/\$948 million) is 12.7 percent.

Funding - PHOENIX missile

The program funding through June 30, 1972 is as follows.

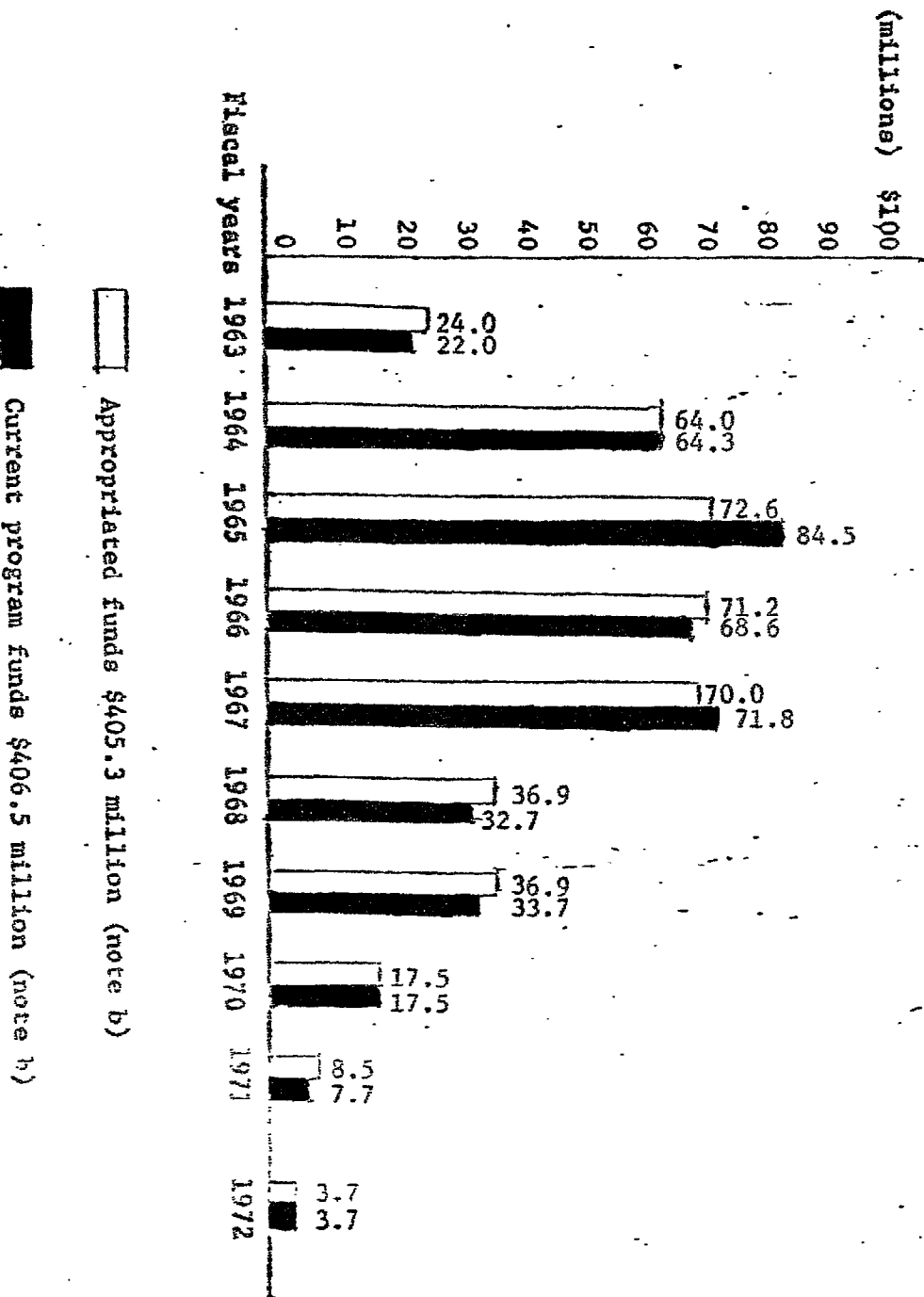
	<u>Amount</u> <u>(\$ millions)</u>
Appropriated	\$713
Obligated	\$661
Expended	\$535

The following charts show program funding through  
fiscal year 1972

(Figures 3, 4)

FIGURE 3

RESEARCH AND DEVELOPMENT FUNDING<sup>a</sup>

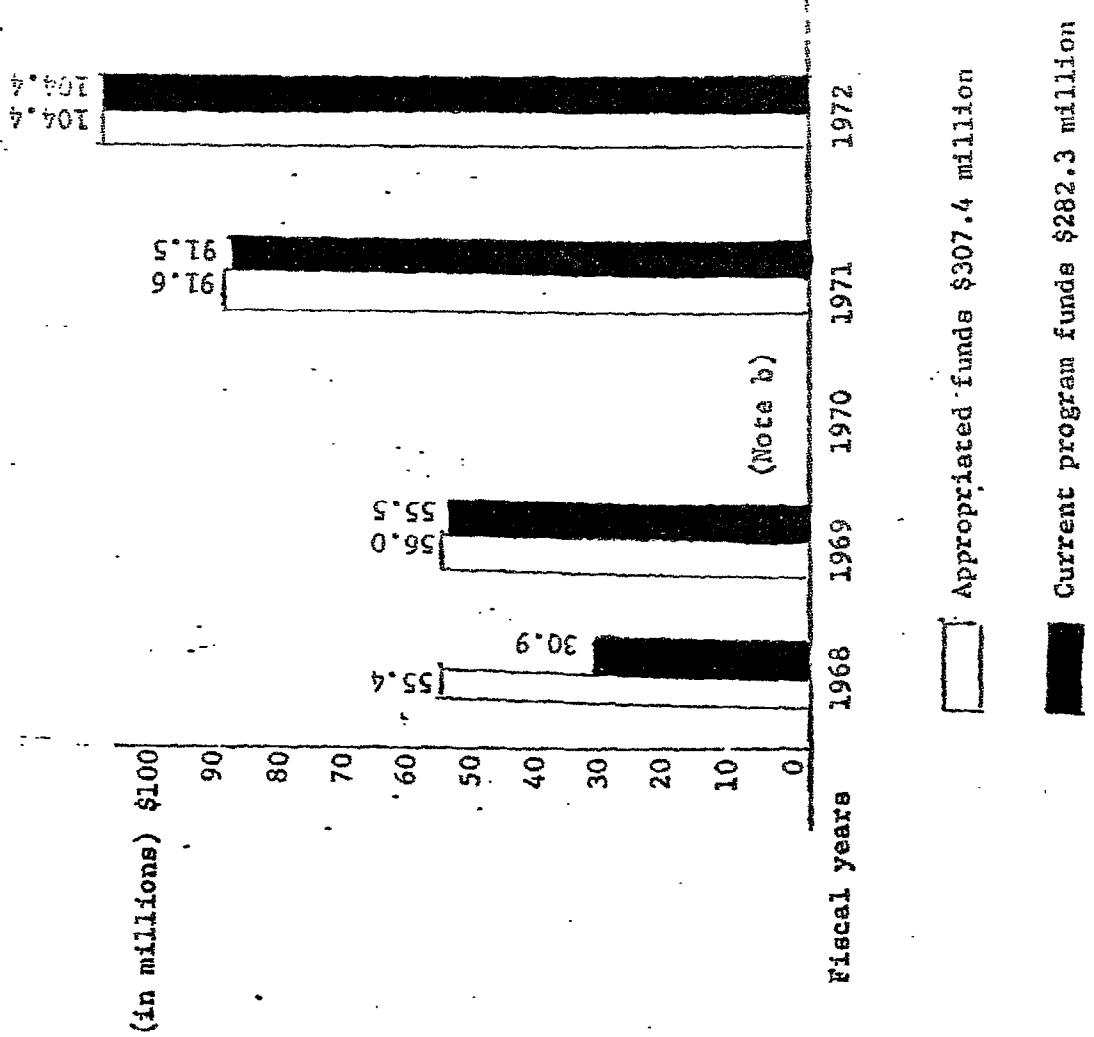


<sup>a</sup>Includes both PHOENIX and AWG-9 funds.

<sup>b</sup>Difference between appropriated and current program funds in a given fiscal year is the result of reprogramming actions.

Figure 4

PROCUREMENT FUNDING<sup>a</sup>



<sup>a</sup> PHOENIX funds only. AWC-9 funds not included.

<sup>b</sup> Because of the change in carrier aircraft from the F-111B to the F-14, it was decided that fiscal year 1970 procurement funds were not required. As a result, none were requested.



## SYSTEM SCHEDULE EXPERIENCE

### Airframe and engines

Several schedule slippages were reported at June 30, 1972. Flight test program, production delays and continuing effects of the loss of the first development aircraft in December 1970, were cited as causes of the slippages. In addition, the loss of another test aircraft on June 30, 1972, was reported but no program impact was cited in the SAR.

### Flight test program delays - F-14A

The second NPE began July 6, 1972, and was completed August 15, 1972. Board of Inspection and Survey (BIS) trials slipped an additional 2 months, and were re-scheduled to begin February 1973, as a result of further slippage in the F-14 development flight test schedule.

### F-14A schedule

The first production aircraft (cited as number 13 on the SAR) was reportedly delivered 2 months later in May 1972 due to production and flight test delays. Actually, aircraft number 21 was designated as the product baseline aircraft in March of 1972. This aircraft was not scheduled to be delivered until December 1972. Differences in configuration between test aircraft (up to number 20) and the product baseline are to be identified and recorded by Grumman.

The expected date for completing static tests included in the SAR was October 1972. However, our review of Grumman's

ground test program shows that the static article load test was not scheduled to be completed until November 1972.

The milestone for activating the replacement airwing did not change since last year and remained scheduled for November 1972. We were told that the readiness squadron, VF-124, will act as the replacement squadron in training both replacement flight crews and maintenance personnel for the operational F-14 squadrons.

The scheduled date for the first F-14 squadron fleet operational date reportedly slipped 3 months to July 1973. The SAR attributed this to flight test program delays. The fleet operational date, we were told, is the date by which the Navy will have its first deployable F-14 squadron.

The Navy support date, or the time when the Navy will be able to maintain the aircraft, including providing training and spare parts, did not change since the prior year and was still scheduled for January 1974.

#### F-14B schedule

The delivery date for the F-14B prototype had not changed during fiscal year 1972 and according to SAR is still expected in April 1973. No schedule milestones were included for the

engine in the June 30, 1972, SAR. However, as discussed later in this chapter, the F401 engine for the F-14B is not scheduled for Military Qualification Testing until June 1973. Actually, the first flight of the F-14B prototype aircraft will not be made until June 1973 and this will be accomplished using prototype (Y401) engines. Installation of F401 engines is not scheduled until November 1973 or just prior to NPE I for the F-14B prototype aircraft.

PHOENIX missile

At June 30, 1972, four of the scheduled milestones reported in the SAR showed slippages. The milestones and slippages were:

<u>Schedule milestone</u>	<u>Slippage</u>
First production contract	2 months
Begin Navy Technical Evaluation	3 months
Begin Board of Inspection and Survey	2 months
Fleet introduction F-14A/PHOENIX	3 months

The first production contract for the PHOENIX was let in December 1971. This milestone at June 30, 1971, was scheduled for October 1971. Navy officials justified the slippage of 2 months on the basis of a reduction in lead time required for additional final assembly and check-out facilities.

During the year ended June 30, 1972, the Navy Technical Evaluation slipped 3 months from June 1972 to September 1972. Information obtained subsequent to SAR preparation date revealed this testing slipped an additional 2 months to November 1972. The Navy attributed the total 5-month slippage to late delivery of the F-14 aircraft to the operational test command.

The two milestones, "Begin Board of Inspection and Survey" (BIS) and "Fleet introduction F-14A/PHOENIX" slipped 2 and 3 months, respectively, during the year ended June 30, 1972. Subsequent to the SAR preparation date, the BIS schedule date slipped to March 1973 for a total slippage of 3 months. The Navy attributed these delays to slippage in the F-14 flight test program.

Development - production concurrency

In prior reports we stated that the Navy would be buying a number of production run aircraft before BIS trials. We commented that with the 8-month slippage in BIS trials, development - production concurrency increased. Since BIS was scheduled for February 1973, the total aircraft on order, including lot V, could be 134 before the Navy's BIS trials are underway. However, in July 1972, the Navy and Grumman amended the F-14 contract to reflect revised delivery schedules for

Lots I to III for the first 37 F-14A's. These revisions stretched-out the deliveries partially to reflect the loss of aircraft number 1. By stretching out deliveries the Navy also acted to reduce significantly the concurrency that was resulting from the slippage of BIS trials.

#### SYSTEM PERFORMANCE EXPERIENCE

##### Airframe and engines

Our analysis of the SAR, at June 30, 1972, showed that 14 out of 20 design or performance characteristics were below their respective specifications whereas only four were above. One characteristic was equal to its required level and one could not be determined.

We found that technical data reported as June 30, 1972 information in the SAR were actually May 1972 data. Had the actual June 1972 data been reported, 11 out of 20 characteristics would have been reported as below their respective specifications with four above. One characteristic would have remained equal to its required level while four could not be compared. On the basis of the June 1972 results, the SAR showed a slight improvement in the number of characteristics below specifications in comparison to the prior year.

The SAR stated that the changes reported resulted from or were anticipated from refinements achieved during the normal

The performance objectives of the PHOENIX program have remained unchanged during the past year.

Relative to recent test results, the June 30, 1972, SAR showed that on August 8, 1972, there was a dual missile launch and that preliminary information confirmed successful intercept by one missile and that data were being reduced to determine ultimate success of the second missile. Information acquired after the SAR preparation date revealed that the second missile failed to successfully intercept the target. The failure was attributed to a missile problem and not a weapon guidance system problem.

At June 30, 1972, neither the reliability percentage nor the missile kill probability performance characteristics has been demonstrated.

#### SELECTED ACQUISITION REPORTING

##### Airframe and engines

DOD continued its practice of reporting the weapon system status for the F-14/PHOENIX project as separate weapon systems- the F-14 and the PHOENIX. Actually, the F-14/PHOENIX is one weapon system. This is reflected in the two separate SAR's themselves which show an interrelationship in the mission statements and contain identical BIS and first squadron operational dates.

In addition, Navy management is based on a single integrated project management organization which includes both F-14 and PHOENIX weapon components.

The Navy's complete cost of the F-14/PHOENIX project resulting from combining the separately reported current estimates at June 30, 1972 were \$6.4 billion consisting of the following.

<u>Cost category</u>	<u>F-14A/ PHOENIX</u>	<u>F-14B</u>	<u>Total</u>
	---millions of dollars---		
Development costs	\$1,263	\$363	\$1,626
Procurement costs	4,753	-	4,753
Military construction costs	<u>7</u>	<u>-</u>	<u>7</u>
	<u>\$6,023</u>	<u>\$363</u>	<u>\$6,386</u>

We believe that a more meaningful report would result by combining both SAR's into one comprehensive report.

The chart below (Figure 5) shows the distinctly different picture that emerges from combining the cost estimates for both parts of the project into an integrated whole.

COMPARISON OF SEPARATE AND INTEGRATED

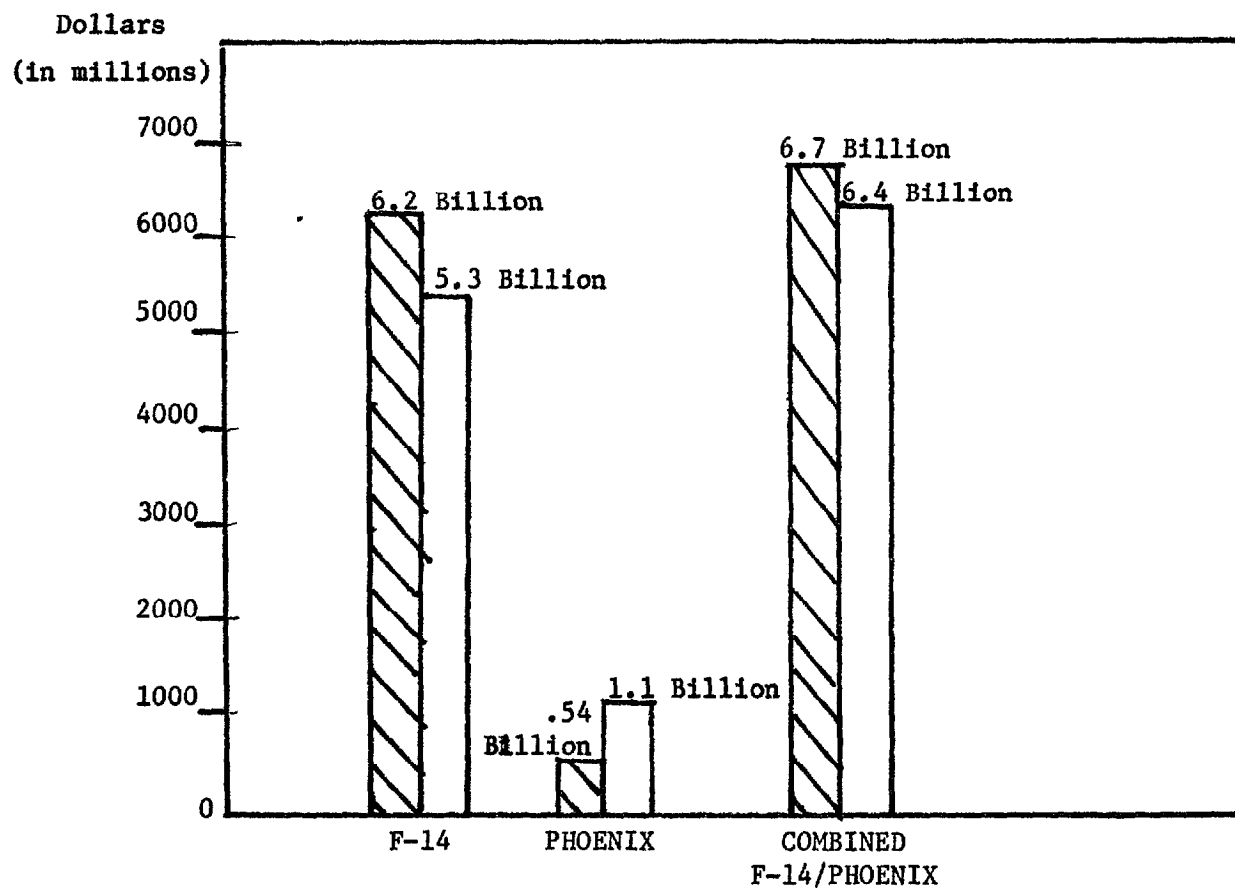
F-14 AND PHOENIX SARs

FOR DEVELOPMENT AND CURRENT ESTIMATES

JUNE 30, 1972

 DEVELOPMENT ESTIMATE

 CURRENT ESTIMATE





We do not believe that as currently reported by DOD, the two separate SAR's present clearly the status of the F-14/PHOENIX project. The Navy advised us that the two SARS are reviewed together and that if combined, the PHOENIX would disappear as a separate entity and the F-14 Program would appear more costly.

In our prior reviews we reported that the airborne weapon control system, or AWG-9 data, was not being reported on the F-14 SAR. Our current review of the F-14 SAR at June 30, 1972, shows that neither technical characteristics (SAR section C) nor the milestones (SAR section D) contain data related to the AWG-9. In addition, the SAR does not contain any key milestones or technical characteristics depicting performance on the F-14B engines.

During our review of the F-14 SAR we were unable to substantiate the basis for various changes in the current estimate for FY ended June 30, 1972. For example, during FY 1972, \$36.6 million was added to the development costs of the F-14B for engine development costs and additional flight test engines. Officials at PMO were not able to identify the data supporting this increase.

Subsequent to our review, the Project Office advised us that \$25.7 million of this amount was supported by a letter

from the Air Force Joint Engine Project Office. The letter indicated that the amount was the result of the Navy's share of an increase in program costs contained in a proposal which had been agreed to with Pratt and Whitney. The F-14 Project Office told us that the remaining \$10.9 million was due to the planned procurement of 6 additional F401 engines.

In the first quarter of FY 1972, SAR reported a decrease of \$8.9 million in costs of initial spares resulting from "configuration adjustments". The data in support of this change showed that it was mainly the result of an increase of \$2 million in FY 1971 and a decrease of \$10.9 million in FY 1973. The aircraft cost analysis worksheet on file at PMO did not identify the reasons for the changes or adequately identify either the particular spare parts involved or the specific configuration changes. No explanation was included as to why the increased costs affecting FY 1971 were not previously reported.

Subsequent to our review, the F-14 Project Office provided us with an analysis showing a further breakdown of the \$10.9 million decrease. It also advised that the increase of \$2 million was the result of a DOD reprogramming action which allocated the amount for the P412 engine in March 1971.

In past reports we recommended better cross referencing of the SAR to supporting data and that better supporting

documentation be kept. Based on our current review, we cannot state whether the changes to the current cost estimate of the F-14 for fiscal year 1972 were correct.

Other matters

The SAR does not contain milestones for NPE III although approved Navy test plans show an NPE III scheduled for November and December 1972. The final phase of an NPE is to determine that the airplane is ready for BIS trials. Current plans according to the F-14/PHOENIX Project Office are to conduct a continuous or running NPE rather than have a specific NPE at a definite point in time.

The F-14 SAR does not contain milestones for either Operational Evaluation (OPEVAL) or Technical Evaluation (TECHEVAL) testing although, as discussed elsewhere in this report, these are key test phases in the Navy Test Program. Also, no milestones for F-14B prototype testing are shown although project plans show that separate NPE and BIS trials are anticipated.

The June 30, 1972, SAR contains a detailed explanation of the loss of test aircraft number 10 which crashed into Chesapeake Bay on June 30, 1972, at the Navy's Patuxent River test center. However, the report does not disclose what effect this would have on the program. Grumman told us that the replacement of aircraft number 10 with number 17 was accomplished October 30, 1972, thus, there was a delay of 4 months in restarting the carrier suitability tests. We believe that the SAR should have attempted to assess the overall impact on the test program as a result of the crash and loss of the test airplane. We were advised that this assessment would be included in the December 1972 SAR.

The F-14 SAR contains, in addition to the current estimate of \$5,272 million, an added estimate of other procurement costs of \$65 million. In arriving at program unit costs,

the SAR is based on 313 aircraft and \$5,272/<sup>million</sup> Consideration of other procurement costs would result in differing unit cost figures. We believe that the Navy should consider the effect of this on the unit cost reported for the F-14 program. Similar comments regarding the PHOENIX missile portion are discussed later in this chapter.

The SAR contains an analysis of cost growth based on comparing the latest current estimate with the development estimate. In the case of the F-14 SAR, DOD is currently reporting that the variance is due to six categories as follows.

	<u>Millions</u> <u>Increase or (decrease)</u>
Quantity change	\$(1,116)
Support change	(3)
Schedule change	64
Unpredictable change	29
Estimating change	(19)
Economic escalation	<u>151</u>
	<u>\$ (894)</u>

DOD instructions permit the use of nine variance categories, including engineering change which represents an alteration in the physical or functional characteristics of the system. As noted above, the F-14 SAR contained no changes resulting from engineering changes. However, Grumman reported in August 1972 that approved

engineering changes for lots I-IV amounted to almost \$36 million. We believe that the SAR variance analysis should more accurately reflect the increased costs associated with engineering changes.

We noted that little time was allowed for project personnel to prepare the SAR for June 30, 1972. DOD instructions provide for the SAR to be submitted by the responsible office to the Assistant Secretary of Defense within 45 days after the end of the reporting period. However, Navy implementing instructions have effectively limited the preparation time by requiring the advanced copy to be submitted to the Chief of Naval Operations by 18 working days after close of the report period. The F-14/PHOENIX project office transmitted the SAR on July 19, 1972. Reviews of the SAR took place prior to release by the Navy to DOD on August 17, 1972. Thus, more time elapsed in reviewing the SAR after preparation than was permitted for the preparation itself.

PHOENIX missile

We believe that certain data should be added to the PHOENIX SAR to make it more informative, and that certain items in the SAR should be revised to make the report more meaningful.

Suggested additions

Operational Evaluation Testing - We noted that the Navy Operational Evaluation Testing was not included in the SAR as a milestone on the PHOENIX program. While this testing is not directed at the PHOENIX missile itself, the Navy is to launch a significant number of the missiles during this testing.

The Navy Deputy Project Manager advised us that he did not know why this testing was not a DOD approved milestone. He stated he would inquire into the matter and consideration would be given to including this item in future SAR's.

Cumulative Test Results - The SAR reported the results of recent test launches but nowhere in the report was there a figure reflecting the results of all launches from inception to date. The Deputy Project Manager advised us that such figures are shown in many other reports and because of this, the Navy did not believe they need to be in the SAR. He added that such information is

meaningful and consideration would be given to including it in future SAR's if directed by DOD.

Suggested revisions

Additional Program Costs - In the June 30, 1971, SAR, the Navy reported an estimate of \$11 million for modifications and \$15.4 million for replenishment spares. These amounts were reported under a section titled Additional Procurement Costs but were not included in total program costs.

In the June 30, 1972, SAR, the Navy's estimate for modifications increased by \$1.5 million, to \$12.5 million and the \$15.4 million estimate for replenishment spares was totally deleted from the SAR. The \$1.5 million increase for modifications was attributed to a new price-out of the program based on the 1974 Program Objective Memorandum. The \$15.4 million for replenishment spares was deleted from the SAR based on the direction of the Office of the Secretary of Defense.

GAO believes the \$15.4 million for replenishment spares should be reincorporated into the SAR. Additionally, we believe this \$15.4 million plus the \$12.5 million for modification should be included in the program cost estimate. The addition of this \$27.9 million would show a program cost of \$1,141.6 million.



Missile Reliability - The 90-percent reliability performance objective in the SAR does not refer to the launch success probability but rather refers to the probability that any missile shall pass all checks required to prepare it for launch. The reliability objective for the systems which perform the launch readiness checks is 92 percent and, when combined with the 90 percent figure, gives a ready to launch probability for a missile selected at random of about 83 percent, before considering other factors affecting the probability of a successful launch. We suggest that **more meaningful** figures should be provided in the SAR.

## CHAPTER 3

### TEST AND EVALUATION

Because certain Navy test phases including BIS have not begun or have recently started, the technical and operational performance of the F-14 weapon system cannot be completely assessed.

#### NAVY PLANS AND ACCOMPLISHMENTS

##### F-14A/PHOENIX Project Management Office

The Naval Air Systems Command (NAVAIR) established the F-14A/PHOENIX Project Management Office (PMO), to manage the F-14 weapon system program. PMO involvement in test and evaluation primarily concerns the monitoring of the contractor demonstration test program. In addition, it coordinates, through the use of an Operational Test and Evaluation Working Group, the development of Navy tests for the F-14A program.

PMO personnel are assigned to key areas of concern for monitoring responsibilities. These areas include the

airframe, AWG-9/PHOENIX, and other Government-furnished equipment. In addition, there is a specific individual responsible for monitoring the overall Test and Evaluation program. The PMO does not have as one of its functions the management of the engine program. This task has been delegated to the NAVAIR propulsion group. PMO advised us, however, that it monitors the engine program.

Navy preliminary evaluations

NPEs are used to: 1) determine at the earliest possible opportunity, the combat potential and deficiencies of the airplane, 2) highlight the need for and to allow early correction of deficiencies, 3) evaluate changes incorporated, 4) identify deficiencies, and 5) determine when the airplane is suitable for Board of Inspection and Survey (BIS) trials.

The first NPE was conducted during the period December 2-16, 1971. The Navy's reports stated that the F-14A exhibited outstanding potential for the fighter mission and noted 34 favorable items. They reported, however, 43 deficiencies which required corrective action prior to the second NPE and BIS trials. Of these deficiencies, 30 were satisfactorily corrected prior to NPE II.

The remaining 13 deficiencies received corrective action but remained as deficiencies. Eleven are now to be corrected prior to NPE III and two are to be corrected prior to BIS trials.

The second NPE was conducted at two locations. The West Coast evaluation was held at the Naval Missile Center, Point Mugu, during the period July 6 to August 9, 1972. The East Coast evaluation was held at the Grumman flight test facility at Calverton, Long Island by a Naval Air Test Center team during the period July 12 to August 15, 1972.

The purpose of the second NPE was to: 1) re-evaluate characteristics affected by changes in airplane since NPE I; 2) evaluate items not tested during NPE I; 3) evaluate the items of NPE I at critical combinations of airplane weight and center of gravity; and 4) evaluate the airplane for the expanded envelope and further investigation of characteristics not fully evaluated previously.

The West Coast preliminary report stated that the integrated F-14A Avionics and Weapon Control System displayed outstanding performance characteristics and potential to accomplish the air superiority fighter and fleet air defense missions. However the report also

noted 33 deficiencies to be corrected prior to NPE III and BIS trials. Of these deficiencies, nine were to be corrected prior to NPE III and 24 prior to BIS trials.

The East Coast report stated the F-14A continued to exhibit outstanding potential for the fighter mission within the expanded flight envelope available for NPE II. Additional characteristics which enhance the capability of the F-14A airplane to perform the fighter mission are performance of the M-61A1 gun, and the direct lift control. Both of these characteristics, as stated by the report, should be incorporated in future designs.

There were, however, 29 deficiencies noted during NPE II. Of these deficiencies, 9 should be corrected prior to NPE III and 20 should be corrected prior to BIS trials.

NPE III was scheduled for November and December 1972. The scope of the final phase NPE should consist of an evaluation to determine whether the airplane is ready for Navy Board of Inspection and Survey trials. As noted previously, the project office told us that current plans are to conduct a continuous or running NPE instead of a specific NPE phase.

### Board of Inspection and Survey trials

The Board of Inspection and Survey (BIS) is scheduled to conduct acceptance trials beginning February 1973. Originally, BIS trials were scheduled to begin June 1972. This slippage was caused primarily by the loss of aircraft number 1 on December 30, 1970. The objectives of the BIS trials are to determine whether the aircraft, with its support equipment, is capable of performing its basic mission and is suitable for service use. BIS will also recommend to the Secretary of the Navy whether to accept the F-14A weapon system. Additionally, BIS will note defects and determine if there has been contract and specification compliance.

### Operational test and evaluation program

#### Concurrent evaluation

Navy test phases are based on a Concurrent Evaluation concept known as CONEVAL. CONEVAL combines a technical (TECHEVAL) and operational (OPEVAL) evaluation into a single project which provides for simultaneous evaluation of those efforts and tests which are common to both phases. The program also employs a coordinated control for demonstration witnessing effort to minimize redundant testing by integrating contractor test programs into the Navy's test and evaluation program.

The concept of concurrent testing is an attempt to introduce OPEVAL into the testing program at an earlier stage. This is in conformance with a 1971 DOD memorandum which stressed that initial operational test and evaluation be accomplished as early as possible in the acquisition cycle. A comparison of the standard test and evaluation type program and the concurrent evaluation type program is included in Appendix II.

Operational Test and Evaluation, as defined by the Assistant Secretaries for Research & Development of the three services is the test and analysis of specific weapons systems, organizations, or equipment conducted under operating conditions for the purpose of determining 1) its ability to meet operational performance requirements, 2) its suitability for service use, 3) the determination and promulgation of such tactics and doctrines as required for service use, and 4) the re-evaluation of the weapon systems or equipment in order to insure that it continues to meet operational needs and retains its effectiveness in a new environment or against a new threat.

The overall coordination responsibility for all F-14A government test and evaluation belongs to the Operational Test and Evaluation Working Group. The Working Group was

established by the F-14 PMO which is charged with its responsibility by the Chief of Naval Operations and the Secretary of the Navy. There are representatives from all involved Navy activities within the Group which was originated to initiate this Operational Test and Evaluation Program.

#### Navy technical evaluation

A Navy Technical Evaluation or TECHEVAL is the test and analysis required by the developing agency to determine whether a weapon system and its support systems meet the design specifications. The TECHEVAL is also required to determine if the systems are functioning in a technically acceptable manner and are suitable for an Operational Evaluation (OPEVAL). The TECHEVAL for the F-14 program was planned to run from July 1972 through December 1973 except for a few months during the first half of 1973 when BIS trials would be conducted.

Various Navy agencies are involved in the TECHEVAL. The Naval Air Test Center located at Patuxent River, Maryland, has three areas of responsibility in this evaluation phase. The Flight Test Division is responsible for the technical evaluation and reporting of flying qualities and performance, carrier suitability and control systems. The Weapon System Test Division is responsible



for technical evaluations and reporting of the F-14A avionics, weapon control system, and stores compatibility, and the Service Test Division evaluates and reports on the technical aspects of engine performance, all weather flight capability, human factors, and various other aircraft system performance.

The Naval Missile Center located at Point Mugu, California, is responsible for the technical evaluation and reporting on the performance of the AWG-9/guided missile interface, guided missile/airframe interface, all guided missiles, and support of Weapon System Test Division by flight and ground tests.

The Naval Air Development Center located in Johnsville, Pennsylvania, has been delegated the responsibility for providing coordinated analysis and simulations as required to support the TECHEVAL and OPEVAL flight and ground test activities.

#### Navy operational evaluation

OPEVAL is the test and analysis of a technically acceptable weapon and support system under service operating conditions. Its main purpose is to determine the ability of the system to meet its operational performance requirements and to develop tactics for the utilization of the weapon system within its capabilities.

The Navy's OPEVAL was scheduled to be conducted during October 1972 to December 1973.

The Commander, Operational Test and Evaluation Force under the command of the Chief of Naval Operations was assigned responsibilities as an independent test agency for the required operational test and evaluation. The VX-4 Squadron is responsible for performing the Navy's OPEVAL including development of the Navy's tactical manual.

Delay in initiating concurrent evaluation concept

Although TECHEVAL was due to commence in July 1972 this did not occur. F-14A aircraft numbers 15 and 16 had not been delivered on time by Grumman. A Navy report stated that late incorporation of aircraft change directives, non-availability of vendor and in-house manufactured parts, difficulties in AWG-9 system integration and hydraulic system contamination contributed to the late delivery of these aircraft. In addition, aircraft number 17, scheduled to begin TECHEVAL in September 1972, was converted to carrier suitability to replace aircraft number 10 which crashed on June 30, 1972.

As with the delay of TECHEVAL, we were informed that OPEVAL, scheduled for October 1972, also would be delayed due to late delivery of aircraft to the Navy. The reasons

for the delayed deliveries in TECHEVAL were also responsible, in part, for the delayed deliveries in OPEVAL which is being rescheduled to February 1973. A "mini" OPEVAL, which included only seven flights, was held at Point Mugu during September-October 1972 according to Grumman. In addition, Navy project office personnel said that TECHEVAL was considered to have begun on November 13, 1972.

Replacement air wing and  
initial operating capability

In addition to the test milestones already mentioned, the F-14 program has scheduled a Replacement Air Wing and an Initial Operating Capability phase. A Replacement Air Wing phase, which covers the training of pilots and crew members, was scheduled to begin about November 1972. The Initial Operating Capability comes about when the Navy expects to operate the first fleet squadron. It is scheduled for July 1973.

Observation on concurrency of the  
Navy test and evaluation program

The F-14A PMO through the Operation Test and Evaluation Working Group, has planned a concurrent Navy Test and Evaluation Program. This CONEVAL concept has been established to preclude redundancy in testing. Various test and evaluation plans have been and are to be

submitted to the PMO by Navy agencies involved in the F-14A program. These plans, in most instances are very detailed for accomplishing their respective tests and evaluation. Submission of interim test and evaluation status reports from the various contractors involved in the F-14 program has also occurred. However, the PMO has received few formal contractor demonstration reports on the F-14. The PMO recognized this shortcoming and requested Grumman to explain why no formal demonstration data had been submitted through August 1972. As of September 22, 1972, Grumman had submitted final demonstration data only for the navigation portion of the avionics part of the overall test requirements. We were informed by Navy representatives that no demonstration test witnessing has been accomplished.

As part of the BIS and OPEVAL test phases the Navy requires the use of a Versatile Avionics Shop Test system. It is a general purpose support system being developed by PRD Electronics, Inc., Syosset, New York, which will be compatible with several types of Navy aircraft including the F-14, S-3A, and E-2C. It appears that the system will not have selftest capability in time to support BIS and OPEVAL; therefore, PRD contractor engineers/technicians will be required on site to insure station operability.

In addition, Grumman is responsible for developing Test Program Sets that will support approximately 51 percent (December 1971 estimate) of the contractor and government furnished avionics systems. They are, however, having developmental problems with six of these systems. Since Grumman is experiencing these developmental problems the Navy contends it will be incumbent upon the contractor to provide whatever support is necessary to insure the operational capability of the F-14 avionics systems. Grumman pointed out that the versatile shop tester was not intended to support the AWG-9 system which uses its own test equipment. The Navy contends that Grumman is committed to supporting the Navy test phases.

#### CONTRACTOR PLANS AND ACCOMPLISHMENTS

##### Airframe

The schedule and assignment of the 12 F-14A flight test aircraft to the elements of the test program are shown in Appendix III. The only difference since March 31, 1972 is that aircraft number 10, which crashed on June 30, 1972, has been replaced by aircraft number 17.

##### Flight test program

During the period December 1970 to November 12, 1972, a total of approximately 806 flights and 1,567 hours had been flown. Five weapon system test aircraft were flying at the Naval Missile Center, Point Mugu, including the two

F-14's being tested by Hughes. Four aircraft were in performance testing at Grumman, Calverton, New York and one aircraft was undergoing carrier suitability testing at Naval Air Test Center Patuxent River, Maryland.

The status as of August 1972 of certain key technical performance characteristics shows 16 out of 24 of these characteristics were below their respective target specifications while four have attained specification compliance. Data was not reported for the remaining four characteristics. An example of performance below target specification is the combat radius escort mission.

Project office personnel pointed out that the F-14A was able to meet or exceed the specified combat radius if the full existing capacity of internal fuel were used.

The detailed specification was changed in December, 1970 to increase the internal fuel capacity of the aircraft. At the same time the external fuel capacity was decreased resulting in a net increase in fuel capacity. We noted, however, that the aircraft weights were not revised to reflect this change. During our review, Grumman had advised us that aircraft performance should be based on specification values. We believe that if the revised fuel capacity is

used to assess combat radius performance, other technical characteristics like take-off weights, wind over deck requirements and other related factors should also be based on revised calculations. One characteristic which had attained specification compliance was the cruise ceiling with the maximum number of PHOENIX missiles, wherein the target specification had been surpassed.

#### Ground test program

Major airframe ground testing includes structural tests, performed on two static test airframes and one fatigue airframe, wing pivot development tests, wind tunnel tests, and systems integration tests. Static tests involve the exertion of force without motion on the structure and/or a component alone to evaluate the stress levels. Fatigue tests involve dynamic stressing of the structure to isolate any structural tendencies to weaken or break.

Five structural tests satisfactorily demonstrated sustaining at least 100 percent design ultimate load without failure for the period June 2 through August 25, 1972. The status of F-14A structural tests as of September 15, 1972, indicated that ultimate design and failing load tests were 96 percent and 38 percent complete, respectively. Fatigue tests were 23 percent complete.

it had been corrected by adding external strips.

#### F-14B engine

The F-14B advanced technology engines known as the F401-PW-400 engine is scheduled to start its Preliminary Flight Rating Test during December 1972. This test will evaluate the prototype engine to see if it will meet flight certification standards. The Qualification Test which is used to establish a production baseline engine, is scheduled to begin during June 1973.

At the time of our review there was a two-phase performance demonstration test taking place at the Naval Air Propulsion Test Center in Trenton, New Jersey. The first phase of the test demonstrated the compatibility of the prototype engine and the Grumman air inlet. This phase has been completed with no stalls being experienced. The second phase, which Grumman told us was completed, tested-altitude performance. NAVAIR had earlier indicated that progress was proceeding satisfactorily.

#### PHOENIX missile and AWG-9

##### Test program

The primary responsibility for testing of the AWG-9 and PHOENIX rests with the Hughes Aircraft Company and the Navy. GRUMMAN provides test support to Hughes and the Navy, primarily in the form of aircraft maintenance.



On August 4, 1972, the outer panel of the fatigue article right wing was severely damaged and determined unrepairable. The accident occurred during the off-loading of simulated fuel upon completion of 2000 equivalent flight hours and was not associated with actual tests being conducted. A resident Navy engineering official believed the accident would not cause any delay in the next series of wing tests scheduled for January 1973. This date, however, reflects a 7-week slippage in wing fatigue test when compared with the latest revision of the test schedule status prior to the accident. Grumman will use the recovered outer panel from aircraft number 10, we were told, to meet this revised schedule.

Drop tests, which determine the limits of the aircraft landing gear, and its supporting structure, in simulated carrier landings under various conditions were reported to be 100 percent complete as of September 15, 1972.

Structural problems requiring laboratory  
and flight test solution

A meeting between Grumman and NAVAIR was held on September 14, 1972, to discuss 13 structural problems which require laboratory and flight test solution. The problems included both airframe and engine performance. In the case of one of these problems, rudder buzz, Grumman told us that

### Accomplishments

Both the AWG-9 and PHOENIX missile have demonstrated certain capabilities which are superior to those of other radar systems and missiles in the Navy inventory. Also, Hughes and the Navy project office have stated that the radar and missile development are ahead of past air-to-air system developments for this point in the acquisition process.

AWG-9 superior capabilities include the following:

- Increased versatility afforded by having multiple modes of operation;
- Greater maximum detection ranges;
- Capability to track multiple targets while maintaining a search and detect capability over the battle area;
- Rapid target acquisition during air combat maneuvers in "dogfight" situations;

Both Hughes and the Navy have indicated the Electronic Counter Countermeasures (ECCM) capability for the AWG-9 has had more development and testing than any other system at the same stage of development. The Navy has given particular praise to the state of development of the ECCM capability. ECCM for the PHOENIX has been extensively tested and has been successful.

Superior performance capabilities for the PHOENIX

include:

- Long-range capability which, for most situations, is considerably greater than that of its closest competitor, the long-range version of the SPARROW missile which is still under development;
- Larger lethality radius afforded by a larger warhead;
- Multiple modes of operation including (a) one which allows the missile to guide to a target using its own radar, (b) another in which the launch aircraft provides radar guidance data for the missile, and (c) a home-on-jam mode which allows the missile to guide on electronic jamming signals emitted by a target;
- Designed in ECCM capability;
- Fully independent target detection and fusing system.

The missile firings, throughout the development and test prototype phases of the test program, are considered by the contractor and the Navy to have been unusually successful - 73 percent of all test launches. Included in the successes are launches against small targets, high speed, high altitude targets, maneuvering targets, and medium speed targets at high and low altitudes. The last four missile launches were from the F-14 aircraft. Three were successful - two from single launch tests and one of two launched in a multiple launch test.

#### Hughes Aircraft Company testing

The Hughes test program consists of laboratory and flight testing. The most significant laboratory testing is performed

in the Hughes "roofhouse" where Hughes engineers, utilizing a full AWG-9 system (1) supplement flight test data through simulation of flight test mission profiles, (2) investigate hardware and software problems detected in flight tests, (3) evaluate design changes to ensure maintenance of performance capabilities prior to incorporation of the changes in flight test systems.

Hughes developmental flight testing of the AWG-9 and PHOENIX on the F-14 aircraft began in late January 1972, shortly after they received their first F-14. Development flight testing had been conducted for several years, prior to this time, using F-111B and TA-3B aircraft.

Hughes conducts its flight test program under a development and evaluation test plan which has been approved by the Navy. The original test plan was submitted in June 1971, and two subsequent updates to the plan were submitted in January 1972 and May 1972. The May 1972 plan was approved by the Navy.

The test plan appears to be comprehensive with the testing being broken down by AWG-9 modes of operation and by missile functions that interface with the AWG-9. The plan also presents, in general terms, flight profiles for planned missile launches. The detail plans for missile launches are submitted to the Navy for approval about 30 days prior to the

launch.

Upon completion of the development test program, Hughes is to start the formal contractor demonstration phase of the test program. This phase was scheduled to begin in October 1972 and end in May 1973, and is to demonstrate whether the AWG-9 and PHOENIX are ready for final Navy evaluation.

The results of the Hughes flight testing are submitted to the resident Navy Technical Representatives (NTR) on a daily basis and to the PHOENIX project office on a weekly basis. The weekly reports contain a brief description of tests performed, problems noted, status of work to resolve AWG-9 problems noted by the Navy in its NPE, and a brief description of tests to be performed during the next period.

#### Navy testing

The Navy, in addition to monitoring Hughes testing activities, conducts its own AWG-9 (F-14) and PHOENIX missile flight testing at Point Mugu, California. The Navy flight test program, as planned, consists of three NPE's, an OPEVAL, TECEVAL and BIS trials.

The NPE's conducted at Point Mugu are primarily evaluations of the AWG-9 (NPE's for the F-14 aircraft are discussed elsewhere in this report) at various stages of its development. The basic objectives of the NPE's are to assess the AWG-9's capabilities and problem areas, estimate its ability to

accomplish its intended mission, and establish a baseline for recommending further development and flight test efforts. NPE's I and II have been conducted on the AWG-9 system, and NPE III is scheduled for December 1972. NPE I, held in August and September 1971, tested the AWG-9 on a TA-3B aircraft. NPE II, held in July and August 1972, tested the AWG-9 with the F-14 and included the launching of two PHOENIX missiles in a multiple shot mode, one of which was successful.

The TECHEVAL is to determine whether the AWG-9, PHOENIX and their support systems meet design specifications, function in a technically acceptable manner in an operational environment, and are technically suited for an OPEVAL. It is at this point that the Navy begins its comprehensive testing of the PHOENIX. TECHEVAL for these systems began with laboratory testing at Naval Missile Center, Point Mugu, in July 1972. The flight test portion is scheduled to begin in November 1972 and continue through September 1973.

OPEVAL is to test the technically acceptable AWG-9, PHOENIX and their support systems and is to develop and promulgate tactics for utilization of the systems within their capabilities. This testing is conducted by using command personnel under fleet operating conditions. OPEVAL for the

AWG-9 is presently scheduled for the period April 1973 to December 1973.

The formal Navy acceptance testing for the AWG-9 and PHOENIX is BIS. The objectives of BIS are to determine whether the systems are capable of fulfilling their basic missions and are suitable for fleet use. BIS for the two systems is presently scheduled for the period March 1973 to May 1973.

Relative to the two NPE's that have been conducted, the NPE team at Point Mugu orally reported test results and problems noted to Hughes within 72 hours after test completion. The oral report was later followed up with a letter report to Hughes which set out in general terms the problems noted. In addition, the NPE team submitted a preliminary report on NPE results to the F-14/PHOENIX project office within 7 days after test completion.

Project office use of test data

The project office uses test result data primarily to evaluate technical progress on the program. This is

accomplished by comparing the test demonstrated capabilities against the contractually specified capabilities.

The test result data are also used by the project office to analyze problems noted in the testing and to determine possible solutions to the problems or trade-offs that may have to be made in system capabilities. Additionally, the data are used to plan future testing or possibly revise existing plans for future testing.

Areas of concern - PHOENIX missile and AWG-9

While we found the planning, conduct, and reporting of tests to be generally adequate, we did note several matters of concern which were noted earlier in this chapter and are discussed in detail below.

Concurrency in development and production

Several GAO reports as early as August 17, 1970 report on the F-14 program's (including the AWG-9 and PHOENIX) high degree of overlap in development and production. Since that date, the degree of concurrency has increased because test schedules have slipped while option exercise dates for production units have remained firm.

The AWG-9 and PHOENIX are in the development and evaluation testing phase which is to extend into early 1973. However, the Navy has already exercised options for 136 production-type AWG-9's, the latest option for 48 units was

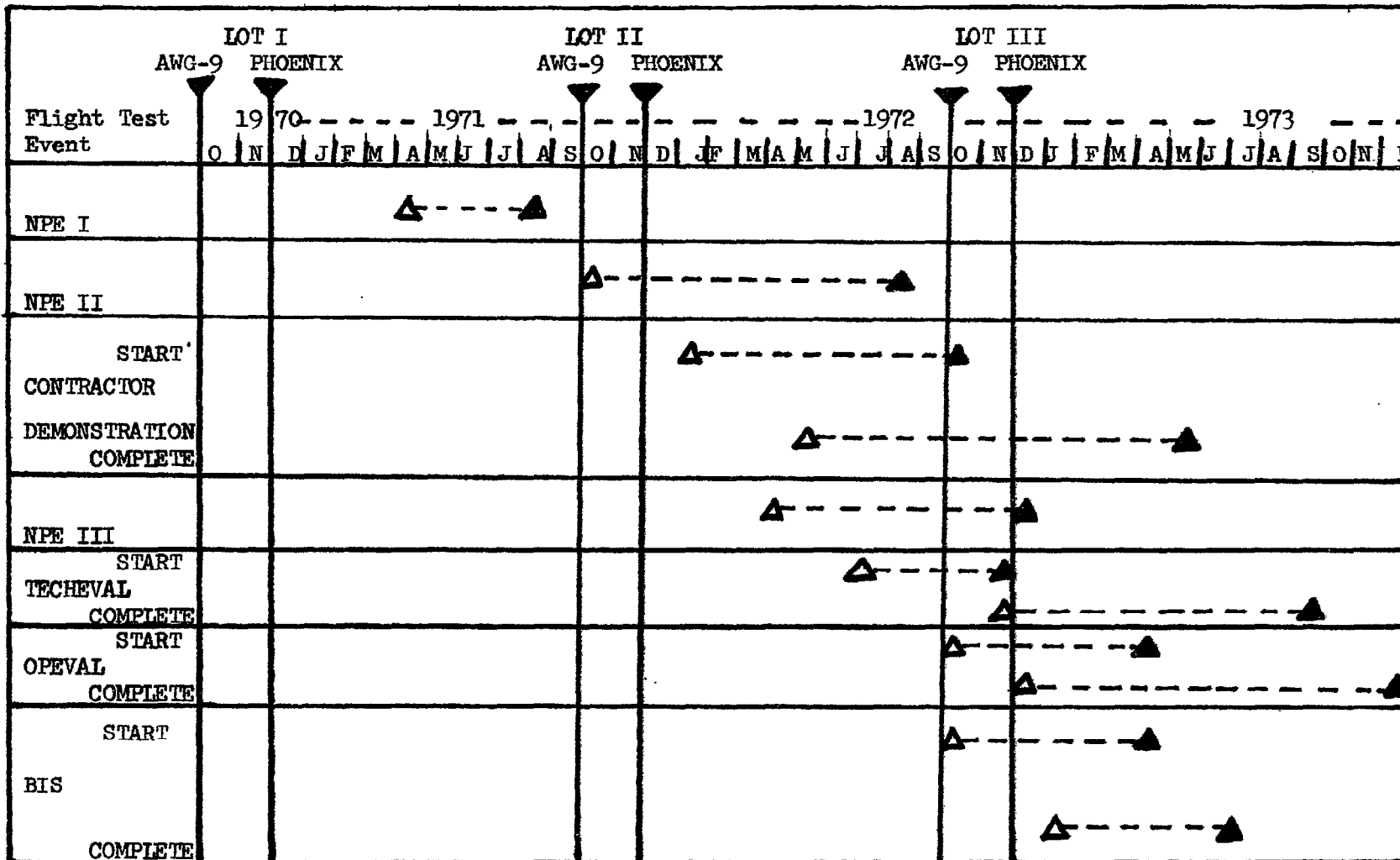


exercised on September 29, 1972. The Navy has also exercised options for 309 pilot and regular production PHOENIX missiles and is to exercise its fiscal year 1973 option for a minimum of 180 units by December 1, 1972. The quantities are intended to fulfill the aircraft requirements through Lot V.

Presented below is a comparison of the sequence of testing and procurement events as planned in 1970 and as actually occurred or planned at September 22, 1972:

# BEST DOCUMENT AVAILABLE

## AWG-9 AND PHOENIX SEQUENCE OF TESTING



▲ 1970 PLAN  
 ▲ ACTUAL OR CURRENT PLAN  
 --- SLIPPAGE

Through the time that the Lot II production options were exercised, there was no significant difference between the amount of testing planned in 1970 and the amount actually performed. However, it should be noted that the 1970 plan called for NPE I testing of the AWG-9 in an F-14 aircraft, whereas the testing was actually conducted in a TA-3B aircraft. As a result, the AWG-9 was not tested with the F-14 until after the Lot II production option for the AWG-9 had been exercised.

The major difference between the 1970 test plan and current test plan is the amount of testing prior to exercise of the Lot III option. The 1970 plan called for NPE's I, II, III, and contractor demonstration to be completed, plus TECHEVAL was to be well underway. When the option was exercised, only NPE I and II were completed, TECHEVAL had just begun, and NPE III and contractor demonstration were scheduled to begin within the following month.

Slippage in the testing coupled with fixed option dates created a situation whereby less data were available for making decisions at the key decision points. Flexible option exercise dates dependent on demonstrated performance would have allowed management greater latitude in scheduling in order to minimize retrofit costs.

Go-no-go decision points

An important function of management is the establishment of goals, along with general and specific criteria to be used in measuring progress. Discussions with Navy program and testing personnel at Point Mugu revealed that they have not been asked to test any specific performance capabilities or parameters of the AWG-9 and PHOENIX for the purpose of providing input to program management on "go-no-go" type performance characteristics.

By setting out critical "must have" performance capabilities and parameters to Navy technical and test personnel for evaluation, the program management would have early and progressive evaluations of the system's development. With this approach, problem areas could be identified early and decisions regarding the future course of the program could be made at the most cost-beneficial point in time.

Progress from NPE II to NPE III  
in testing capabilities

In its series of NPE's the Navy is to test the capabilities of the AWG-9 as it progresses in development. However, as

of October 1972, the Navy was planning to use an earlier configuration in NPE-III and possibly in BIS trials than was tested in NPE II.

Each new configuration of the AWG-9 is assigned a block number and by contract specifications each production unit of an earlier configuration is to be retrofitted to conform to the latest configuration. Hughes is now developing a Block III configuration and the Navy, in NPE II, tested a Block II configuration AWG-9 with several of the Block III modifications incorporated into it. For NPE III, and possibly BIS, the Navy plans to use a "straight" Block II AWG-9.

The Navy Deputy Project Manager for the PHOENIX program stated that the Navy wants to test the latest F-14 aircraft configuration in NPE III, but at the same time, he indicated that at the scheduled date for NPE III, such aircraft would not yet have the latest configuration AWG-9's. He indicated that Hughes would not have sufficient time prior to NPE III to retrofit the AWG-9's in the latest configuration F-14's to the Block III configuration and provide adequate support. These F-14's were Block II configuration when used in NPE II.

It appears that if NPE III is conducted as scheduled, the Navy will have to:

1. Test the latest configuration F-14 aircraft with an earlier configuration AWG-9 that has already been tested.

2. Test the latest configuration AWG-9 on an older configuration F-14.
3. Conduct independent, separate tests of the latest configuration F-14 aircraft and AWG-9 which would not be a test of the fully integrated weapon system, as was the case in NPE's I and II.

We discussed this matter with the Navy Deputy PHOENIX Project Manager who concurred with our assessment. He advised us that the Project Office would have to look more closely at these three approaches and consider a fourth approach which would be delaying NPE III until such time as the latest configurations of the F-14 and AWG-9 can be integrated.

#### Testing in an operational environment

The tactical capabilities of the AWG-9 and PHOENIX in the "ultimate user" or "fleet" environment are to be assessed during Navy OPEVAL. A "mini-OPEVAL" consisting of seven flights was conducted from September 25, 1972, to October 20, 1972, by Navy operational test personnel at Point Mugu. Formal full-scale OPEVAL testing is scheduled to begin in April 1973, at which time 136 AWG-9's and 309 PHOENIX pilot or full production missiles will have been ordered.

Prior to exercise of the Lot III production options for both the AWG-9 and PHOENIX, almost all testing was or will be performed in an engineering environment where all test parameters are known to all test personnel. In the development

flight test program, all live launches of the PHOENIX are preceded by a number of "dry runs." Such conditions do not test human limitations which can be expected with a system as complex as the AWG-9 and therefore do not determine the operational suitability or usefulness of the system in a tactical or operational environment.

Until formal OPEVAL, program management knows only what a system can do technically or "on the drawing board." Being at the end of the development and, in this case, after one pilot production contract was awarded and two production options have been exercised, the formal OPEVAL comes too late to have any significant influence on major program decisions or weapon system design.

Capability of PHOENIX missile to hit  
targets under multiple launch conditions

The PHOENIX missile is to be capable of hitting up to six separate targets when launched in rapid succession (every 3.2 seconds). Through September 1972, there had been five multiple launch tests with the maximum number of missiles launched being two. Subsequently in late December 1972 after our review was completed, a four missile launch test was successfully accomplished with all missiles scoring as hits.

Of the first five tests, there was only one - the first test of this capability on March 8, 1969 - in which both missiles scored hits on their targets. Additionally, the

minimum time interval between launches on all multiple missile launches (including the four missile test in December) has been about 6 seconds or about double the desired minimum interval. On the latest test the shortest interval was 10 seconds.

Because the multiple launch capability is the most significant feature of the PHOENIX missile over other air-to-air missiles, and in light of past failures it seems apparent that continued emphasis is needed to ensure that this capability is achieved. Additionally, demonstration is needed with time intervals between launches at or near the desired minimum of 3.2 seconds.

Testing of PHOENIX missile  
with live warhead

Navy officials have stated that the effectiveness of a warhead is affected by the angle and velocity of the missile/target interception. There has been only one test of a PHOENIX with a live warhead, and it was successful. Navy and contractor officials stated, however, that this test was set up for the maximum likelihood of success.

In all other missile firings a telemetry unit was carried in place of the warhead. The unit relays data on the operation of the missile in flight to the range control officer, and such data has been deemed to be less costly



than demonstration of the missile warhead's performance.

The Navy indicates that its ground testing of the warhead is proof of its capability, and that telemetry data on the target detection and fusing mechanisms are sufficient to provide assurance as to the overall performance of the armament system without flying a lot of live warhead missiles. Present Navy plans call for testing of missile warhead performance during TECHEVAL and OPEVAL.

## CHAPTER 4

### PROGRESS MEASUREMENT

Our review of progress measurement was directed toward understanding how the F-14/PHOENIX PMO and its contractors measure program progress, and evaluating whether the system provides management with credible information for decision making.

An effective progress measurement system is an important management tool. Information in terms of cost, schedule, and performance can provide a measurement of work completed against work that was expected to be completed for the same amount of resources spent. Thus, management can have early indications of potential cost increases, schedule slippages, and performance degradations so that action can be taken to correct the problems.

#### F-14/PHOENIX PROJECT MANAGEMENT OFFICE

The F-14/PHOENIX PMO was established in October 1969, as an outgrowth of the prior VFX Aircraft/PHOENIX Weapon System Project to manage the weapon system program. It is headed by a Project Manager who reports to, and is organizationally responsible to, the Naval Air Systems Command.

The Project Manager has direct authority for program planning, direction, control, and utilization of resources. His primary mission is to provide to the Navy a fully supported F-14/PHOENIX Weapon System which will satisfy approved operational requirements. A chart showing the PMO organizational relationship in the Navy is included as Appendix IV.

#### PROGRESS MEASUREMENT SYSTEM

The progress measurement system used by the PMO on the F-14 weapon system for the most part has not been formally expressed in writing, therefore, the information which follows identifying and describing the techniques and practices used was primarily based on discussions with Navy officials and from the correspondence and reports provided.

#### Grumman

Under the terms of its contract for the F-14 aircraft, Grumman is required to maintain a management information system similar to the criteria set forth in Department of Defense Instruction 7000.2 titled Performance Measurement for Selected Acquisitions. Accordingly, Grumman submits monthly Project Profile Manual (PPM) reports to the PMO which include for the aircraft under contract the

estimated costs expected to be incurred at completion and the estimated cost overrun or underrun in comparison to contractual targets and ceilings. These reports cover only aircraft on order. Comparisons of estimated costs at completion with contract values do not include dollar amounts for ground support equipment, spare parts, and publications.

Our March 1972, F-14 Staff Study reported that Grumman's performance measurement system was providing some visibility over contract cost to the PMO, however, certain problems were discussed which were limiting this system's effectiveness as a management tool. We concluded at that time that the system could be enhanced by:

- providing information for use in projecting the results of effort currently under contract for future anticipated procurements to better assess and anticipate the impact of current activity on the total program;
- maintaining a budget baseline at target cost and reporting properly related variances between established plans and accomplishments;
- highlighting and tracking the use of management reserves for better program visibility;

--conducting a proper and vigorous surveillance program which is coordinated with the PMO.

Our follow-up on these matters disclosed that information is still reported only for the aircraft under contract. A flexible budget baseline is still used to measure performance against current budgets and variance reporting has been discontinued with Navy concurrence. The requirement for management reserve reporting has been deleted in a revised DOD 7000.2 instruction. A more vigorous surveillance program has been initiated which is providing considerably more visibility to the PMO.

Regarding the use of estimates of cost for aircraft under option, PMO officials told us that legally they cannot obtain estimates for option lots of aircraft which had not been exercised. They added that Grumman had, in the past, furnished its estimates for out-lots when requested by the Navy.

We noted that the contractor is using three different methods for computing performance measurement.

In contract Lot I for six research and development aircraft a milestone technique employing over 10,000 milestones was approved by the Navy.

For Lot II for six additional aircraft a work package budget oriented technique was approved.

For Lot III, which is for 26 production aircraft, the contractor is using an improved milestone tracking system, pending Navy approval.

The use of three different approaches and methods to measure performance has hampered the Navy's surveillance efforts and complicated obtaining meaningful performance measurement. Grumman said that the nature of the work on the different lots was sufficiently different to necessitate the use of differing methods of measurements.

#### Pratt and Whitney

PMO told us that it did not have management responsibility for the F-14 engine program and that the Naval Air Systems Command had retained this function. We did not perform a specific review of Pratt and Whitney's progress measurement system. We noted, however, that Pratt and Whitney submitted a report highlighting program schedules and major milestones to accomplish the program. It also provided trend charts depicting progress by indicating the weeks that a milestone is ahead or behind schedule.

Pratt and Whitney does not provide a PPM-type report to the PMO on the F-14A engine. When the P-412 engine progressed from the development stage to the product support stage in July 1969, PPM reports were no longer required. Instead, Pratt and Whitney submits a quarterly problem-oriented report covering the P-412 and other engines in this phase.

Hughes implementation

The AWG-9 and PHOENIX progress measurement system for Hughes and the Navy is based on the Hughes internal management system. Although the system results in concise factual reports which tie into both the contractor's accounting system and the contracts, we have been informed that they basically document history and that management draws from the system real time information for progress measurement.

The first step required in implementation of the progress measurement system was development of a Work Breakdown Structure (WBS) identifying all the work tasks needed to achieve contract objectives. The WBS used on the AWG-9 and PHOENIX contracts is patterned after and ties directly into the Hughes internal management system for budgeting and accounting. As such, cost data relative to the WBS can be readily traced to the Hughes cost accounting system.

For the AWG-9 and PHOENIX contracts Hughes employs a standard WBS that is primarily product-line oriented. For each contract lot, WBS's are set up starting at level one and continuing through subdivisions down to manageable units of work. The lowest level of each WBS may vary between tasks depending on their complexity.

At all levels within the WBS, tasks are authorized by Work Authorization and Delegation documents which set out the budget, statement of work, and schedule of the task to be performed. The authorizations are considered to be contracts between the manager who is delegating the task and the manager who is accepting the responsibility for the task.

The Hughes internal management system measures actual cost, schedule, and technical progress against established plans. This is accomplished by having task managers report their progress to the PHOENIX Program Manager on a weekly basis in addition to daily telephone calls.

The weekly cost and schedule data are summarized every 4 weeks for work on the production options and every 8 weeks for work on the flight test program. The summarized data are submitted to the Navy (project office and resident technical representative) in the form of a



Program Management Information System (PMIS) report.

PMIS report

The PMIS report follows the WBS and groups cost and schedule information by WBS element. The report also provides the following summary reports:

(1) Program Description, (2) Current Status, (3) Threshold Condition Matrix, (4) Critical Condition Action Item List, (5) Cost Performance Measurement Report, (6) Summary of Cumulative Deviations from Budget, (7) Summary of Changes to Target Price, (8) Contract Funds Status Report, (9) Summary of Funding Requirements, (10) Provisioned Items Summary, (11) Recap by Fiscal Year, (12) Schedule Chart, (13) Financial and Manpower Chart, (14) Class I Engineering Change Proposal Report, and (15) Change Proposals Approved/Outstanding.

The PMIS reports on the production and flight test contracts provide cost and schedule progress measurement information but do not cover technical progress. Technical progress was reported in the PMIS reports for the development contract for adapting the AWG-9 to the F-14 aircraft, but the Navy decided that this information was not needed on later contracts because the Navy would be doing its own testing by that time.

NTR officials stated that there still is technical tracking on the AWG-9 and PHOENIX, and that such tracking is accomplished through daily person-to-person contact with the contractor. Additionally, NTR indicated that it informally receives reports, such as daily flight test and mission operations status reports, and weekly AWG-9 status reports. Data from these reports are extracted and included in a daily status report to the Navy project office.

The mechanism used to focus management attention on particular WBS elements that deviate from pre-established limits is called "thresholding." For the AWG-9 and PHOENIX, thresholds are set at WBS levels one and two (with level three added for further visibility where contractually specified on certain key tasks).

Three threshold conditions are established for cost, schedule, and technical data (where monitored), as described below:

1. Green - Within established limits.
2. Yellow - Outside established limits but not critical to program accomplishment, a condition requiring management attention at the next higher level.
3. Red-Critical, outside established limits and of sufficient gravity to potentially affect program accomplishment.

The tasks classified as red are tabulated on the "Critical Condition Action Item List," which is a summary report in the PMIS. This list shows the corrective action to be taken, identifies the responsible manager and indicates the date the task entered the critical condition. Once on the list, the task is to be recorded on succeeding critical condition lists until the problem is corrected.

On contract N00019-71-C-0187, for which separate PMIS reports are prepared on the options for fiscal years 1971 and 1972, we noted that the report variance analyses compared actual costs to a flexible baseline, even though a fixed baseline was available for comparison. Hughes officials agreed that a comparison to a fixed baseline was more meaningful, and effective April 1972, the reports were changed to compare expenditures against the fixed baseline.

While variance analyses comparing actual costs to a fixed baseline are more meaningful than comparisons against a flexible baseline, comparison of the percentage of budget expended with percentage of work physically completed would provide an even better tool for detecting potential overruns. In the PMIS reports for the AWG-9,

Hughes presents the data necessary to make such comparisons for two key tasks. These data are presented as figures called "earned value" and are based on an analysis of actual work performed versus previously established standards to perform the tasks. At any point in time, comparison of the "earned value" figures with related budgeted cost at completion should yield the percentage of the task physically completed.

The Navy recognizes the usefulness of the "earned value" figures and had Hughes submit a cost estimate for incorporating them into the PHOENIX missile production PMIS reports. Hughes estimated that it would cost \$200,000 to implement and \$280,000 annually to provide these figures in the PMIS reports for PHOENIX. The Navy decided this price was too much to pay and decided not to have them on the current PHOENIX contracts.

#### Project Profile Manual

The Project Profile Manual (PPM) is a compendium of reports prepared by Hughes and submitted to the Navy. The manual which is updated monthly provides cost, schedule, and technical data by contract for the total AWG-9 and PHOENIX program.

The following required reports had not been incorporated into the PPM: (1) Summary of Changes to Target Price, (2) Cost Performance Measurement Report, (3) Threshold Condition Matrix, and (4) Critical Condition Action Item List. The contractor acknowledged that the omitted reports should have been included and subsequently added them to the PPM.

Management reserves

In tracing costs with the WBS, we found no account entitled management reserve within the system. We found an account entitled "Unallocated work to be released," which represents the difference between the contract price and the sum of all budgeted costs. This money is applicable to Navy orders and is to be assigned to task budgets, returned to the Navy, or utilized for changes which are anticipated but not fully defined or budgeted.

Hughes officials stated that funds can be taken from a task which is running under budget and applied to a task which is running over budget. Such a transfer of funds would not affect the fixed budget baselines.

Correlating contract  
line items to the WBS

The DOD requires the contractor's accounting records to summarize direct cost and overhead allocations for elements of the WBS identified as priced items.

A review of the cost accounts showed that costs are generally accumulated on a task basis. Each task is identified with a contract line item through a matrix. Hughes officials stated that the tasks are summarized by line item at proposal submittal, at contract definition, and at the completion of each contract. This, they stated, is a simple task involving insignificant effort and negligible cost.

We agree that correlating the WBS task to the line items involves insignificant effort and cost with the Hughes cost information system.

Navy implementation

Program management uses data presented in formal and informal reports as a basis for making decisions relative to the course of the program. If program management is to make decisions with any degree of confidence, they should have some form of assurance that the reported data are accurate and complete.

The resident NTR is the Navy Project Manager's representative at the contractor's plant and receives data from Hughes both on a formal and informal basis. The formal reports are furnished generally as PPM or PMIS reports which are generated by the Hughes internal management program. Additionally, NTR receives data on an informal basis through daily AWG-9 and PHOENIX reports and personal contact between NTR and Hughes officials. These data are summarized in a daily report furnished to the F-14 Project Manager. NTR officials stated that the daily report not only serves to keep the Project Manager informed of technical developments, but also serves as the AWG-9 and PHOENIX program history.

The Navy project office indicated that the office measures progress primarily with the daily reports and by telephonic or face-to-face discussions with Hughes management, NTR, and Naval Missile Center personnel. The project office also indicated that the data furnished through formal reports were 30 to 60 days old when received, and that the office is aware of the vast majority of the data prior to its receipt. However, the project office stated that reports are necessary because they put the contractor on record, reinforce informal report data, and provide a historical record in terms of cost, schedule, and technical performance.

The Air Force Plant Representative's Office (AFPRO) is required to maintain surveillance over progress measurement systems under its administration--at Hughes, this includes those for the AWG-9 and PHOENIX--to ensure that all requirements are being met. No formal surveillance plan was implemented by the AFPRO or the Navy on the AWG-9 and PHOENIX contracts until September 29, 1972--about 3-1/2 years after the first contract was issued with the PMIS requirement.

The NTR at Hughes acknowledged that surveillance is needed to systematically verify the accuracy and reliability of data presented in the PMIS reports. During our review, the Navy approved a formal surveillance plan on August 4, 1972, and the AFPRO approved the plan on September 29, 1972, with plans for implementation during October 1972.

#### Schedule

Basically, the PMO uses project master schedules from Grumman, Pratt and Whitney, and Hughes to keep informed of the current status of the respective programs. These schedules are periodically updated and provide the most current contractor program information. We were advised that the PMO does not maintain an overall schedule showing the status of the total program or utilize a Program Evaluation Review Technique system.



### Performance

The PMO is informed of program performance and problems through contractor and staff meetings and briefings, formal reports, and daily contacts with its representatives at contractor and testing sites.

### Reports

Grumman submits bi-weekly action reports to the PMO citing problems they are having with the Navy. This report is channeled to the responsible Navy functional group and feedback is provided to the PMO along with problems the Navy is having with the contractor.

Another source of information is provided in the Maintenance and Surveillance report prepared by resident Navy personnel at the Grumman, Bethpage location. This report identifies problems and what action is being taken to resolve them in such areas as engineering, production, quality control, and Government furnished material.

Finally, as previously discussed, Grumman submits a monthly PPM report which includes (in addition to cost and schedule data) information regarding the technical progress being achieved on the aircraft.

### Meetings

The PMO staff meets approximately three times a week to discuss problems that they may be experiencing. Monthly meetings are held with Grumman, Hughes, and Pratt and Whitney program directors to identify and resolve matters impacting the program.

Process used in preparing  
current program estimates

Basically, the PMO uses data from the Naval Air Systems Command functional groups to prepare the current program estimates. These data, in the form of reports, schedules and worksheets are updated by the Naval Air Systems Command and analyzed by the PMO. The data then becomes the basis for SAR reported current program estimates. We were advised that PMO officials obtain clarifying information regarding cost changes through discussions with cognizant Naval Air Systems Command personnel before the changes are incorporated into the SAR. As discussed in Chapter 2, we found that the basis for changes to current estimates were not adequately supported.

CONCLUSIONS

The practices and techniques used by the PMO to measure program progress on the F-14 weapon system have not been formally expressed in writing. Based on discussions with PMO representatives, and from the correspondence and reports provided, the system in effect is geared toward keeping current on program status and providing current costs, schedule and performance information which can be used in the decision-making process.

The Grumman performance measurement information furnished to the PMO has certain weaknesses which limit its effectiveness to provide meaningful measurements of work completed against the work that was expected to be completed for the same amount of resources expended. These weaknesses were reported in our March 1972 staff study and for the most part still are present in the existing system.

The progress measurement system at Hughes is meeting its objective to provide visibility to the Navy over contract cost and schedule on the AWG-9/PHOENIX programs. We believe that the system will be strengthened by corrective action that has been taken on minor weaknesses that were noted.

#### RECOMMENDATIONS

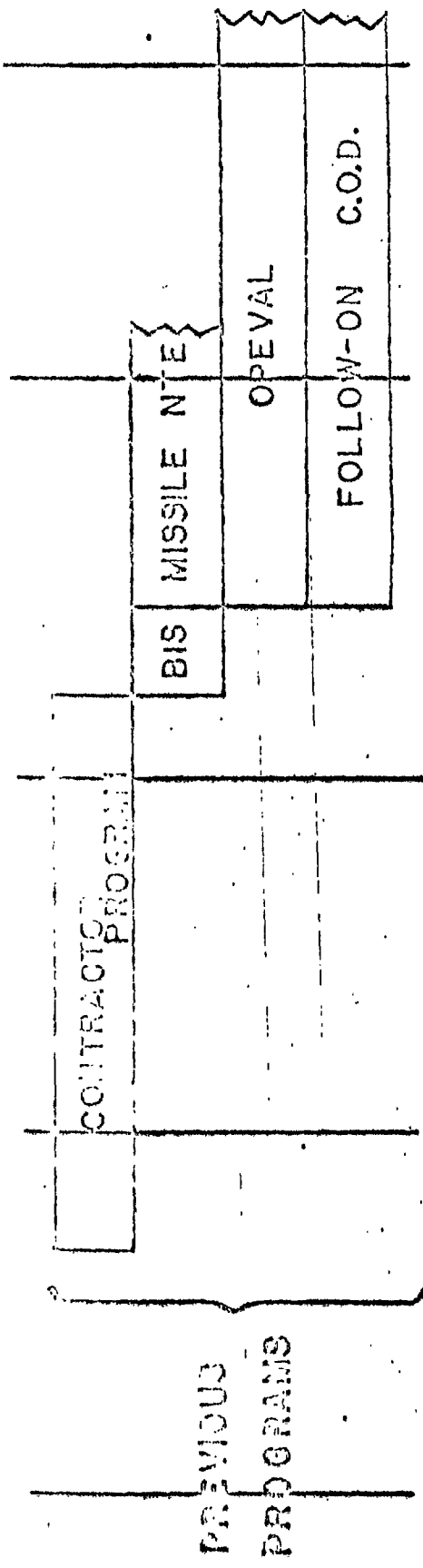
The following recommendations relate to those weaknesses noted in the performance measurement system at Grumman and Hughes.

The PMO should continue to require Grumman to furnish estimated costs to produce aircraft under option, as well as those on order. This provides information as to the costs the contractor expects to incur in relation to the prices established for the program and visibility as to the cost growth being experienced and anticipated in the performance of the program.

The Navy should evaluate the merits and shortcomings of each of the systems in use in calculating aircraft performance measurement and decide on one method which will provide accurate and meaningful data for decision making.



CONCURRENT EVALUATION CONCEPT  
ON THE F-14 PROGRAM



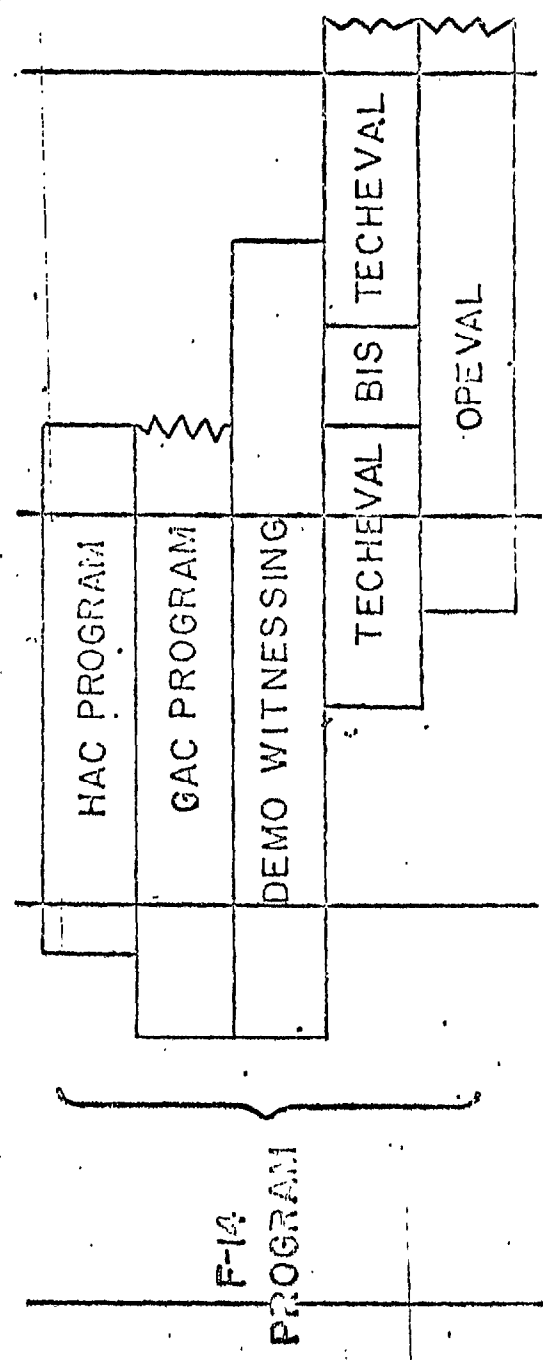
1974

1973

1972

1971

BEST DOCUMENT AVAILABLE



HAC - Hughes Aircraft Company

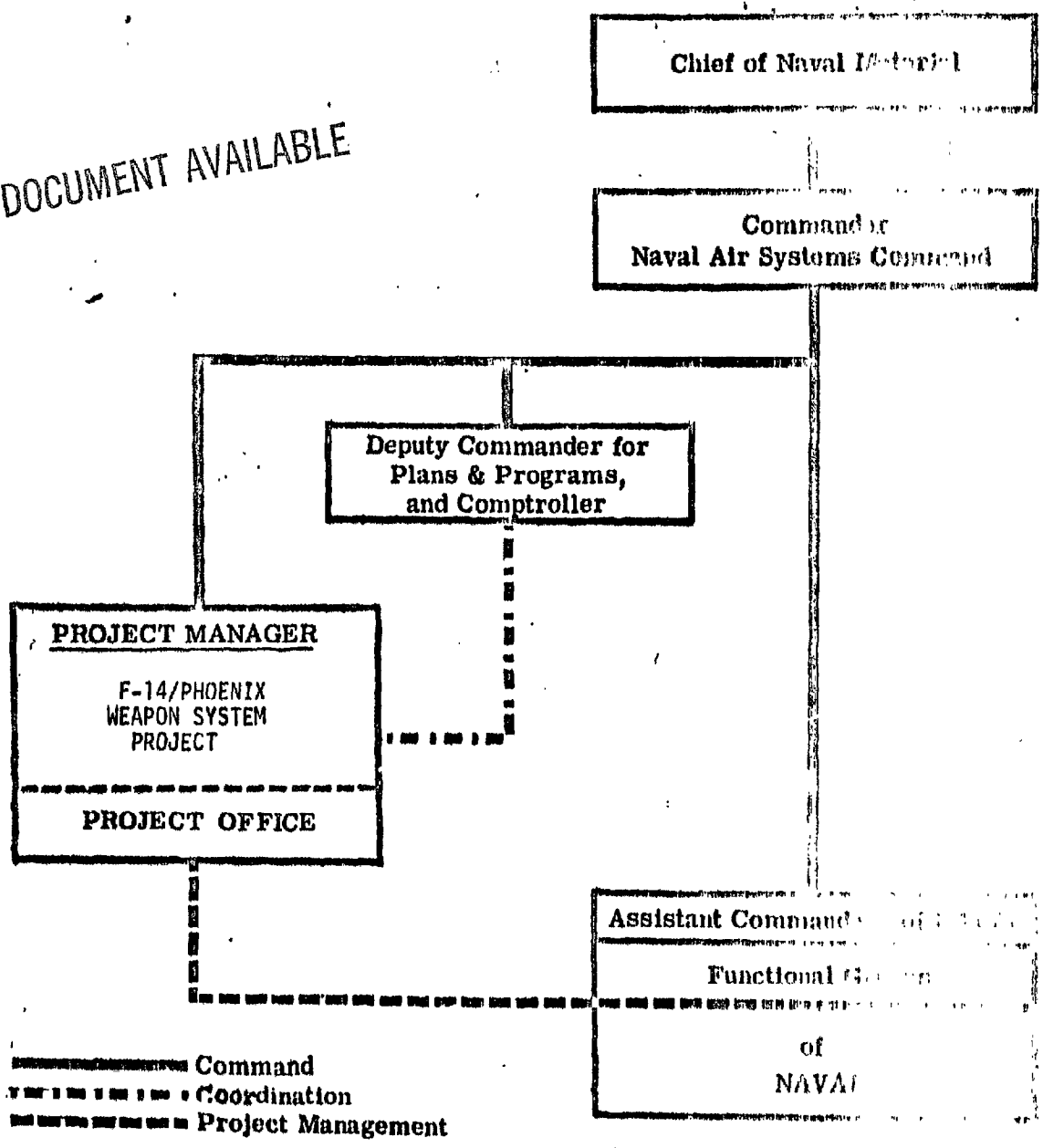
GAC - Grumman Aircraft Corporation

F-14A Contractor Flight Test Program  
(Status as of December 5, 1972)

<u>Aircraft No:</u>	<u>Test</u>	<u>Scheduled to</u>	
		<u>Begin</u>	<u>End</u>
1-X	High speed performance, flying qualities	August 1971	October 1973
2	Low speed performance, flying qualities	May 1971	August 1973
3	Structural calibration and demonstration	September 1971	November 1973
4	Hughes Airborne Weapon Control System evalua- tion and demonstration	October 1971	January 1974
5	Grumman Airborne Weapon Control System evaluation and demonstration	November 1971	July 1973
6	Missile separation/equip- ment demonstration	November 1971	December 1973
8	Aeronautical performance demonstration	December 1971	December 1973
9	Hughes Airborne Weapon Control System evalua- tion and demonstration	December 1971	October 1973
11	Grumman Airborne Weapon Control System evalua- tion and demonstration	March 1972	December 1973
13	Functional compatibility	April 1972	November 1973
14	Reliability/maintenance demonstration	May 1972	November 1973
17	Carrier suitability demonstration	July 1972	January 1974

PROJECT ORGANIZATIONAL RELATIONSHIPS

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BIBLIOGRAPHY OF RECENT GAO REPORTS  
ON F-14 PROGRAM

<u>Report date</u>		<u>B number</u>
2-6-70	Report to the Congress on "Status of the Acquisition of Selected Major Weapon Systems" appendix V	B-163058
8/17/70	*Report to the Chairman, Preparedness Investigating Subcommittee, Senate Committee on Armed Services, on "Analysis of the F-14 Aircraft Programs"	B-168664
2-17-71	*Followup letter on the report dated August 17, 1970	B-168664
2-71	Staff study (supporting report dated March 18, 1971) entitled "The F-14 Weapon System, Department of the Navy"	B-163058
3/18/71	Report to the Congress on "Acquisition of Major Weapon System"	B-163058
4-27-71	*Letter report to the Honorable John C. Stennis, Chairman, Senate Committee on Armed Services	B-168664
6-1-71	*Letter report to the Honorable John C. Stennis, Chairman, Senate Committee on Armed Services	B-168664
9-3-71	Report to the Joint Economic Committee, "Review of F-14 Aircraft Costs, Department of the Navy"	B-168664
2-15-72	*Report to the Senate Committee on Armed Services, "F-14 Aircraft Program Cost Analysis, Department of the Navy"	B-168664
2-26-73	Report to the Congress on the Status of the Procurement of the F-14 Weapon System as of June 1, 1972.	B-168664

\* These reports have been furnished to the Committees indicated and have not been released by these Committees.

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