U. S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

THE F-14 AIRCRAFT

DEPARTMENT OF THE NAVY

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CONTENTS

ABBREVIATIONS

AMCS	Airborne Missile Control System
BIS	Navy Board of Inspection and Survey
Grumman	Grumman Aerospace Corporation
NPE	Navy Preliminary Evaluation
SAR	Selected Acquisition Report
VAST	Versatile Avionics Shop Tester

SUMMARY

F-14 AIRCRAFT WEAPON SYSTEM

SYSTEM DESCRIPTION

The F-14 weapon system is a carrier-based aircraft capable of performing air-to-air and air-to-surface attack missions. It is intended to replace the F-111B in its intended fleet defense mission role and to phase-out the F-4J in other fighter roles. It is concurrently in the development and production life cycle phases. The F-14A is being developed by the Department of the Navy. The F-14B will use an advanced version of the F-14A engine to be developed jointly by the Navy and the Air Force. Grumman Aerospace Corporation (Grumman) is the prime contractor.

COMING EVENTS

--April 1, 1972 - Long lead funding to Grumman at 2 percent of the ceiling price of next year's procurement.

--July 15, 1972 - Same as above at 6 percent

--October 1, 1972 - Date of expiration of option to buy an additional 48 aircraft (Lot V).

COST

The estimated cost progression of the program is as follows:

Date	Quantity	Estimate	Unit Cost
Jan. 13, 1969*	469	$6,166 million	$13.1 million
June 30, 1969	469	$6,373 million	$13.6 million
June 30, 1970	722	$8,279 million	$11.5 million
June 30, 1971	313	$5,212 million	$16.6 million

* Date given in SAR for Planning & Development Estimates.

Most of the total net cost reduction is due to the change in quantity planned for production. The increases in estimated costs were primarily attributed to inflation, the crash of the first aircraft, and development problems on the advanced technology engine. The unit cost has risen primarily due to the development cost being appropriated over fewer aircraft.

In addition to the $5,212 million estimated to be needed for the 313 aircraft, there are additional costs estimated at $37.8 million for replenishment spares and $65.0 million for modification (retrofit).

Program funding through June 30, 1971, is as follows:

	RDT&E	PAMN	($ in thousands)
Appropriated	$1,032.6	$ 695.7	
Obligated	$1,018.2	$ 584.3	
Expended	$ 974.9	$ 179.9	

The escalation rate used in the above estimates of total cost are approximately 4% for production and 5% for R&D.

CONTRACT DATA

The principal contractors on this program are Grumman Aerospace Corporation, Hughes Aircraft Company, and Pratt and Whitney Aircraft.

Grumman, the airframe manufacturer, has alerted the program office that the execution of Lots IV through VIII under the terms of the contract was "commercially impracticable" under existing terms and conditions. The Lot IV option was exercised for 48 aircraft, the minimum quantity, before the October 1, 1971, option expiration.

PERFORMANCE

During fiscal year 1971, there were some minor reductions in the performance estimates. None of these was based on flight test data. The program office considers these adjustments a normal part of the development program. At this time only limited flight testing has been performed by the contractor. Navy flight testing began in November 1971.

The Navy's original plan was to buy only 66 F-14A's, with the rest being F-14B's. It now plans to defer buying F-14B's until engine development problems are resolved. The Navy is continuing its participation with the Air Force in developing the new engine; however, it wants more testing of the new engine before it commits the F-14B to production.

PROGRAM MILESTONES

Testing milestones have slipped three to eight months. The F-14B buy has been deferred, the first Navy Preliminary Evaluation has slipped seven months; and second NPE, 8 months; and the start of the Navy Board of Inspection and Survey (BIS) trials 8 months to February 1973. The latter will cause another production contract option, Lot V, to be exercised or expire, before the final results of all flight testing are known. During BIS, the Navy will test whether the aircraft meets maintainability reliability, and performance specifications of the contract.

RELATIONSHIP TO OTHER SYSTEMS

The F-14A aircraft is intended 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 an all-weather capability for delivery of the Phoenix and Sparrow missiles using a modification of the AN/AWG-9 airborne missile control system, and will depend on the Versatile Avionics Shop Tester (VAST) for maintenance and repair. As we have reported in our VAST staff study, it appears questionable whether the VAST will be able to fully support the F-14A by the required date due to extensive work remaining to be accomplished on the VAST and the likelihood of compatability problems.

The Navy has stated that it is possible that some airborne systems may not be integrated and be ready for VAST testing at the time of BIS trials and fleet introduction. If this situation occurs, factory test equipment will be utilized to fill this void until VAST integration can be completed. The factory test equipment used for this task will be used later for production buildup in the plant at Grumman.

SELECTED ACQUISITION REPORTING

We repeat our recommendation of previous years that the program office include appropriate performance and schedule data for the airborne missile control system in the Selected Acquisition Report (SAR). With this exception, we acknowledge the suitability of the SAR format to fulfill the objectives of the SAR system.

COST EFFECTIVENESS

The Navy concluded in its Navy Fighter Study (NFS) that the F-14 aircraft was cost effective for purposes of proceeding into Contract Definition. This study was prepared by the Navy Program Planning, Systems Analysis Division to supplement the analysis of the F-111B Requirements Study and compared alternative aircraft in fulfilling two missions, fleet air defense and other fighter roles. In our opinion, this study was biased by the limited number of alternative aircraft considered.

We do not believe the study conclusion that the F-14 was generally superior to the F-4J aircraft in other fighter roles was demonstrated conclusively. We believe that updated effectiveness analysis should have been conducted for the Phoenix missile system development.

PERFORMANCE MEASUREMENT

In our review of selected cost aspects of the F-14 contract performance measurement system to evaluate its effectiveness, we found that, although it is providing some contract cost visibility, the problems noted during our review limit this system's potential effectiveness as a DOD and Navy management tool. The problems to which we refer have to do with their use of flexible budget baseline and the low cost visibility associated with the contractor's use of a management reserve of funds for application to selected aspects of the program in need of emergency assistance.

MATTERS FOR CONSIDERATION

Due to the crash of the first aircraft there has been a slippage of BIS trials causing another option to come due before these trials begin.

This brings the total aircraft on order to 134 before the final results of all flight testing will be known.

The Navy has deferred buying the F-14B, the advanced version of the F-14. It will buy 301 rather than 66 F-14A's. To the extent that the introduction of the F-14B into the fleet is delayed, the Navy will not have this increased capability.

Funds must be appropriated by the Congress if the Navy is to exercise the option for Lot V aircraft. The option expires on October 1, 1972. Should this option expire, future options will lapse which could result in the renegotiation of established contract ceiling prices.

AGENCY REVIEW

A draft of this staff study was reviewed by Navy officials associated with the management of this program and comments were coordinated at the Headquarters level. The Navy's comments are incorporated as appropriate. As far as we know, there are no residual differences in fact.

CHAPTER 1

INTRODUCTION

HISTORY OF THE WEAPON SYSTEM

The F-14 aircraft (formerly designated the VFX) with the Phoenix missile system is an evolutionary outgrowth of the Eagle-Missileer Weapon System originally proposed in the 1950's. The Missileer was to be a subsonic, long endurance aircraft with a large, high-powered pulse doppler radar that had track-while-scan multi-shot capabilities and was to carry six long-range Eagle missiles. It was subsequently judged to be too single purpose (fleet air defense only) and too slow, and was canceled in the early 1960's. The Missileer aircraft was replaced by the F-111B which was also canceled and replaced by the F-14, and the Eagle missile eventually evolved into the Phoenix missile.

The VFX concept was initiated in November 1967, when Grumman Aircraft Engineering Corporation submitted an unsolicited aircraft proposal to the Navy. Subsequently, the Chief of Naval Operations recommended a study be made to determine the feasibility of the VFX design. The Navy Fighter Study (NFS) concluded that the new fighter design was feasible and the Navy obtained authority in June 1968 to proceed with Contract Definition. Five companies submitted formal proposals. In January 1969, final evaluation of the proposals was completed and the contract for the F-14A, the designation given to the first development aircraft, was awarded to Grumman in February 1969.

The F-14 aircraft is an all-weather, carrier-based, airborne weapon system capable of performing air-to-air combat and air-to-surface attack missions. It is a twin-engine, two place variable sweep wing,

supersonic fighter capable of engaging multiple targets simultaneously. It will replace the F-111B for fleet air defense and replace the F-4J in other fighter roles in the 1973-80 time frame. It is intended to have an all-weather capability for delivery of the Phoenix and Sparrow missiles using a modification of the AN/AWG-9 airborne missile control system which can acquire and track multiple targets, and conduct multiple missile attacks. The aircraft will also employ an internal gun and Sidewinder missiles for close-in air-to-air combat. The program is concurrently in the development and production life cycle phases.

On December 30, 1970, the first aircraft crashed during its second flight.

The Navy recently exercised the fiscal year 1972 option for 48 Lot IV aircraft on October 1, 1971. The total number of aircraft on order is 86.

SCOPE

Information on the F-14 aircraft program was obtained by reviewing plans, reports, correspondence, and other records and by interviewing officials at contractor plants and the F-14 system program office. We did not make detailed analyses or audits of the basic data supporting program documents nor attempt to: (1) assess the military threat or the technology, (2) develop technological approaches, or (3) involve ourselves in decisions while they were being made.

CHAPTER 2

WEAPON SYSTEM STATUS

SYSTEM COST EXPERIENCE

Production estimate

The major change in the F-14 program since the June 30, 1970, SAR has been the reduction of planned production aircraft quantities from 710 aircraft to 301.

Development estimate

The program development cost estimate has increased from the $974 million estimated baseline to $1,393 million since establishment of the development estimate baseline. Of this $419 million increase, $81 million occurred since June 30, 1970. The F-14A development program estimate was increased by $40 million as a result of the crash of the first aircraft which necessitated a stretching of the test program. The F-14B development cost estimate also increased by about $41 million due chiefly to development problems in the advanced technology engine.

In addition to the above, the Air Force told the Navy on July 16, 1971, that an additional $55 million will be required from the Navy for "B" engine development. Although the June 30, 1971, SAR cost estimates exclude this amount, this change is highlighted in the narrative section concerning changes. Also, these costs are included in the September 30, 1971, SAR and are discussed in the highlights section thereof.

Construction estimate

The current cost estimate includes $4.9 million for military construction. The development estimate did not include anything for military construction because the inclusion of this type cost was not originally necessary for planning purposes.

Inflation

Inflationary growth is incorporated in the F-14 SAR. Basically, production costs are escalated at approximately 4 percent and research and development costs are escalated at approximately 5 percent.

Grumman financial problems

Grumman, the airframe manufacturer, has alerted the program office that the execution of Lots IV through VIII under the terms of the contract was "commercially impracticable" under existing terms and conditions. The Lot IV option was exercised for 48 aircraft, the minimum quantity before the October 1, 1971, option expiration.

We are currently reviewing the cost projections prepared by Grumman to ascertain the validity of and reasons for projected cost growth.

Funding

Through fiscal year 1971, $1,032.6 million was appropriated for F-14 development and $695.7 million for production. Of the RDT&E funds appropriated, $1,018.2 million have been obligated and $974.9 million have been expended, $584.3 million of the PAMN funds have been obligated and $179.9 million have been expended.

SYSTEM SCHEDULE EXPERIENCE

Significant schedule slippages have occurred in the program since June 30, 1970, primarily because of the crash of the first development aircraft in December 1970.

Flight test schedule slippages

The beginning of the fist Navy Preliminary Evaluation (NPE) was postponed 7 months to November 1971. The start of the second NPE was also postponed 8 months to June 1972. The Navy has also deferred the start of its Board of Inspection and Survey trials until February 1973 a slip of 8 months. The program office attributes these slippages primarily to the crash of F-14A aircraft number one.

F-14B development slippage

The Navy previously planned to buy a "B" version of the F-14 aircraft starting with the 67th plane. During fiscal year 1971, this was changed. The present plan (July 1, 1971) is to buy 301 F-14A's, and to defer buying F-14B's until "B" engine development problems are solved. The Navy is continuing its participation with the Air Force in developing the new engine, however, it desires more testing of the new engine before committing the F-14B to production.

Development - production concurrency

We previously reported that the Navy would be buying a number of production run aircraft before BIS trials. With a eight month slippage projected in the BIS trials, development-production concurrency increases. The BIS trials were scheduled to begin in June 1972 and are now scheduled to start in February 1973. Thus, an additional contract option, Lot V, due to be exercised on October 1, 1972, for an estimated 48 production aircraft's, will be due before BIS trials commence. This could bring the total aircraft on order to 134 before the final results of Navy tests of

performance, maitainability, and reliability are known.

SYSTEM PERFORMANCE EXPERIENCE

Technical characteristics

Up to this last fiscal year, little change had occurred in the aircraft's technical characteristics as reported by the F-14 project office. This is also generally true for fiscal year 1971. We noted, however, that 14 out of 20 characteristics degraded whereas only four improved. Two remained the same. We asked the deputy program manager if this degradation were significant and were advised that these measurements were based on available data such as wind tunnel tests, not flight tests, and were normal changes which occur during a development program.

F-14B engine program

The acquisition of the improved engine for the F-14B is being managed by a Joint Engine Project Office at Wright-Patterson AFB, Ohio. The reason for joint management is to obtain a high degree of coordination between the Air Force and Navy in their engine contracts with Pratt & Whitney. (The F-14B engine has a high degree of commonality with the engine being obtained for the Air Force F-15 aircraft.)

Separate contracts were written with Pratt & Whitney by the Air Force and Navy on March 1, 1970, in satisfaction of their respective needs. As of April 1, 1971, these contracts, as amended, called for 1,928 engines (5 experimental, 33 prototype, and 1,890 production, including option quantities). The Navy canceled its planned FY 72 buy of 176 of these new engines following a decision by the Deputy Secretary of Defense on July 1, 1971, to buy 301 F-14's and defer the purchase of F-14B's

However, the Secretary of Defense directed the Navy to complete the joint development of the Advanced Technology Engine (ATE) for possible installation of the F-401 versions in the F-14 aircraft when development status and final considerations warrant. The Navy is proceeding with this direction.

The Navy will be denied the operationally improved "dogfight" capability of the F-14B in its fleet operation by the extent to which this deferment is in effect.

Further study

The GAO is continuing its investigation into program technical performance and its impact on the weapon system's capability to accomplish its mission. We are also attempting to identify and evaluate, to the extent possible, current and potential problems in the development, testing, and production of the weapon system.

SELECTED ACQUISITION REPORTING

During our two previous reviews, we found that the airborne missile control system (AMCS) was not being reported on the SAR. The program office indicated that the Department of Defense had not established this as a reporting requirement. Our current review disclosed that AMCS data was still not being reported on the SAR. We are repeating our previous recommendation as part of this staff study.

We also found a number of instances where the Selected Acquisition Report (SAR) did not identify the information sources. In several cases, the program office had difficulty identifying the information source. In our first review of the SAR, we recommended that the program office maintain better documentation in support of data shown on the SAR. Improvements have been noted but a better cross-referencing of the SAR

and supporting data would measurably facilitate the preparation of subsequent reports. Otherwise, the SAR format is acceptable.

The Navy has stated that the difficulty in identifying information sources arose solely from the pressure of other high priority work which did not permit key personnel full time participation in the report effort.

We feel this provides further support for our recommendation. If there were better cross referencing of the SAR and supporting data, this data would be more readily available and it would not be necessary to waste key personnel's valuable time in providing it.

CHAPTER 3

PERFORMANCE MEASUREMENT

We reviewed selected cost aspects of the performance measurement system applied to the F-14 aircraft contract at the Grumman Aerospace Corporation, (Grumman) Bethpage, New York, to evaluate its effectiveness and potential. A performance measurement system is an internal management control system which should provide an adequate basis for responsible decisionmaking by both contractor management and DOD components. This system must provide data which (1) indicate work progress, (2) properly relate cost, schedule and technical performance, (3) are valid, timely, and auditable, and (4) supply DOD managers with a practicable level of summarization. Specifically, we inquired into the system implementation, the accuracy and reliability of reported cost information, and its use by Government and contractor representatives to manage the program.

The DOD Performance Measurement Instruction, DODI 7000.2, seeks to encourage DOD contractors to accept and install management control systems and procedures which are most effective in meeting their requirements. It also has as one of its objectives providing an adequate basis for responsible decisionmaking by both contractor management and DOD.

IMPLEMENTATION PROCEDURES

In the Request for Proposal (RFP) dated June 21, 1968, and in the F-14 contract a requirement was included for a management control system. This system would provide visibility of schedule, budget and cost. It would be used by both the contractor and the Government and would assure that summary type reporting established for the Government would be

supported by the detailed system. Although not in specific terminology the RFP required essentially the system for Performance Measurement for Selected Acquisition as covered by DOD Instruction 7000.2, of December 22, 1967.

Addendum No. 1, dated February 18, 1969, to the F-14 contract covers program management control system requirements and reports, and establishes the basic reporting system for project management.

A demonstration review of the contractor's system was performed by a Navy team in August 1969, for approximately five weeks. The team was composed of members from the Naval Air Systems Command (NAVAIR), the Naval Plant Representative Office (NAVPRO), Bethpage, and the Defense Contract Audit Agency (DCAA). The team concluded that the contractor had an effective system of management control, was using the same system for internal management control, and had an effective system for the control of changes. However, the review disclosed a few major discrepancies. Therefore, the same team conducted a redemonstration review on July 20-23, 1970, to review these discrepancies and the corrective action taken.

The Navy team concluded that based upon the changes made, the contractor now meets the criteria of addendum No. 1 relating to the performance measurement system. It should be noted that the changes began with contract Lot II.

PROBLEMS FOUND IN CONTRACTOR IMPLEMENTATION OF THE PERFORMANCE MEASUREMENT SYSTEM

Flexible budget baseline

The DOD Instruction criteria requires that the contractors' systems retain the original budgets for those elements at the lowest level of the

DOD Project Summary Work Breakdown Structure as a traceable basis against which contract performance can be compared.

Addendum No. 1 also requires that original budgets for those elements at the control package level of the contract (level 6) be maintained.

In the Cost Schedule Control Systems Criteria (Joint Implementation Procedures) August 26, 1970, the need to maintain a performance measurement baseline within the contract target cost to ensure that actual cost deviations from plan are visible is emphasized. Contract target cost is defined as the sum of all internal direct and indirect budgets and management reserve. In brief, the importance of a rigid baseline to the success of the performance measurement system can hardly be over-emphasized. However, when comparing actual to planned costs, we found the contractor is using a flexible budget baseline which reflects the latest revisions to budget. As a result, cost variances being reported are not related to the contractor's original budget which has the effect of minimizing the extent of reported cost variances.

An effective performance measurement system requires the computation of work accomplished in terms of the original budget (planned value of work accomplished PVWA). However, on the F-14, the contractor does not compute work accomplished in terms of the original budget but in terms of the current, revised budget. By comparing work accomplished, based upon current budget to actual costs, the contractor reports a cost variance which reflects only the difference between current budget and actual cost instead of original budget and actual cost.

Our discussions with F-14 program planning and control personnel indicate that they consider the flexible budget baseline presently in use to be a more realistic measurement of performance. They do concede, however, that a dual baseline (one at target cost and one at current budget) could be maintained. We believe the use of only the flexible baseline is improper and that the use of a rigid baseline (contract target cost plus the estimated cost for Government authorized changes which have not been priced) would more appropriately meet the requirements of DOD performance measurement criteria by comparing established plans with related work accomplishment.

The Navy advised us that a flexible budget baseline was permitted with the stipulation that records be maintained assuring visibility and traceability to the original budgets. The Navy indicated that an original baseline is maintained at the airframe level and is traceable to lower levels through the system if and when supporting data is required. In addition, the Navy believes that the contractor's need to develop and to measure performance against current budgets should be recognized as the only feasible way of establishing realistic estimates at completion.

Variance reporting in Project Profile Manual Cost Account and Summary Status Report

The contractor, in the Project Profile Manual (PPM) Cost Account and Summary Status Report (CASSR), cited current variances for each of the major contract cost elements. The manner in which current variances are determined does not adequately show the relationship between the contractor's actual and planned performance since the contractor compares the planned value of work scheduled (PVWS) with the actual cost of work

accomplished. This comparison is not a true measure of variance because it represents neither a schedule variance nor cost variance. A valid schedule variance could be determined by comparing the planned value of work scheduled versus the planned value of work accomplished (PVWA). Likewise, a valid cost variance could be determined by comparing the planned value of work accomplished with the actual cost incurred to complete this same accomplished work.

For example, assume that the contractor scheduled $50 worth of planned work but only accomplished $30 worth of this planned work at an actual cost of $100. In this case, an unfavorable cost variance of $70 (actual costs - PVWA) and an unfavorable schedule variance of $20 (PVWS - PVWA) would result. However, in the CASSR this condition would be reflected as an unfavorable current variance of only $50 (actual costs - PVWS).

Further distortion would arise if PVWS and actual costs were the same. For example, if PVWS is $100, PVWA is $30, and the actual cost for this work is $100, then the current variance as reported in the CASSR would be zero (PVWS - actual costs), while there should be both a $70 unfavorable cost variance (actual costs - PVWA) and a $70 unfavorable schedule variance (PVWS - PVWA).

We therefore believe that the current variances as cited in the Cost Account and Summary Status Report are not meaningful.

The Navy agrees that the CASSR only tracks current budget status and therefore does not present valid variances in terms of the original budget. However, the Navy maintains that variance reports in the Project Profile Manual present valid variances at summary levels of reporting.

Visibility of management reserve

The DOD Instruction criteria requires that management reserves be identified, if used. Management reserve is defined as the difference between the contract price and the sum of all budgeted costs. The contract also requires that management reserves, wherever used, shall be visible to the Government.

One of the minor deficiencies noted by the Navy demonstration team was that contractor management reserve was not identified by an account number, and was only visible to the Government as the difference between the total allocated corporate budget and the total contract cost. In addition, and more importantly, the PPM does not highlight the use or application of management reserves.

We believe that visibility could be more effective if management reserve was highlighted in the PPM and its use reported.

Method of computation of planned value of work accomplished

To measure the value of work accomplished the contractor initially selected certain events which were believed to be significant indicators of contract performance. The Navy demonstration review team recommended that the contractor's method be changed to include the consideration of all work packages in the computation of the value of work accomplished. The recommended change was agreed to.

Total program visibility

The PPM and its reports on cost, schedule and technical performance only report information on lots currently under contract. The contractor only reports "estimates of cost at completion" of work contractually authorized.

We found that trend data is available in the contractors performance measurement system on labor rates, labor hours, overhead rates, material costs and other costs, and can be provided to the Navy for projecting costs to future lots. This information has not been made available by the contractor basically because it never had been requested to do so.

We believe that the inclusion of information in the PPM about the impact of current effort on future program costs would enhance the Navy's visibility over the program and provide the means to better project and anticipate cost growth.

The Navy has informed us that they are currently conducting discussions with the contractor concerning data similar to that mentioned in this report for use by the Navy in projecting the costs of future aircraft lots.

Subcontractor performance measurement systems

The responsibility for review and approval of subcontractor performance measurement systems has not been clearly defined in the DOD Instruction. Consequently, neither the prime contractor nor the Government have assumed the responsibility for evaluating subcontractor performance measurement systems to assure that accurate, timely, and effective integration of subcontractor data can be made into the prime contractor system.

The DOD Instruction provides that subcontracts, excluding those that are firm-fixed price, will be selected for application of the performance measurement criteria by mutual agreement between prime contractors and the contracting DOD component.

The Navy states that the subcontracts on the F-14 are all firm-fixed price and, therefore, are not required to have performance measurement criteria evaluations. However, the prime contractor has imposed performance measurement criteria on selected subcontractors and the Navy has conducted a review of one major subcontractor.

MAINTENANCE AND SURVEILLANCE ACTIVITIES

The NAVPRO has the responsibility for performing maintenance and surveillance (M&S) reviews of the F-14 performance measurement system. The M&S NAVPRO team leader has assigned specific functional areas for review to the team members, based on the requirements of Addendum No. 1 to the contract. No formal surveillance programs have been prepared by NAVPRO. The team reports directly to the Project Office, NAVAIR, at least every quarter. We were informed that limited guidance has been received from NAVAIR concerning the type of effort to be performed by NAVPRO.

Since the team members maintained limited or no formal documentation of their surveillance efforts, we had to rely primarily on discussions with them to assess their efforts. These discussions indicated that verification of contractor reports has been limited. Thus, we believe that the M&S efforts at NAVPRO for the most part have been limited and ineffective in monitoring the contractor's performance measurement system and in assuring the accuracy and reliability of reported information.

The Navy stated that the NAVPRO surveillance team performs surveillance of the F-14 management system in accordance with approved procedures. The Navy is presently training personnel in the surveillance function and all NAVPRO team members are presently scheduled to attend a training course in the subject.

CONCLUSIONS AND RECOMMENDATIONS

We believe that the performance measurement system at Grumman is providing some visibility to the Navy over contract cost. However, we believe that the problems noted during our review limit this systems' potential effectiveness as a DOD and Navy management tool.

We believe that the effectiveness of 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.

-providing for Navy review and approval of major subcontractor performance measurement systems.

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

By incorporating these suggested changes, we believe that the continued use of the performance measurement system and its related reports will provide a better means for monitoring weapons system progress.

CHAPTER 4

COST EFFECTIVENESS

The Navy concluded in its Navy Fighter Study (NFS) that the F-14 aircraft was cost effective and eligible for matriculation into Contract Definition. Such authority was granted the Navy in June 1968. The NFS, which preceded this authorization, was prepared by the Navy Program Planning, Systems Analysis Division, to supplement the analysis of the F-111B Requirements Study and compared alternative aircraft in fulfilling two missions, Fleet Air Defense (FAD) and Other Fighter Roles (OFR). Our review indicated that certain conclusions presented in these analyses were not demonstrated conclusively.

Evaluation of the effectiveness of the F-14 system for FAD

The NFS compared the alternatives first on the basis of FAD performance, and if a choice could not be made on that basis, then on the capabilities in OFR.

The NFS found that the F-14 was the most cost effective aircraft for FAD; however, we noted that certain alternative aircraft were not considered in the study.

Alternative aircraft

The NFS group initially restricted their analysis to three aircraft capable of carrying the Phoenix missile: F-111B, F-14 and the A-6 MOD IIA. Subsequently, the F-4J alternative was also examined. The study group, however, did not consider other alternatives such as the VFAX with Sparrow missiles, the VFAX with Phoenix missiles, or the new improved

F-4J (designated F-4 (FV)) which were included in the F-111B Requirements Study.

The VFAX aircraft was conceived as a small, highly maneuverable multi-mission fighter attack aircraft with all-weather air-to-air and air-to-ground capabilities, new avionics, an advance technology FX(F-15)/ VFAX engine, and was to have the capability of carrying a variety of conventional and nuclear weapons. The VFAX with Sparrow was an alternative aircraft considered for use in FAD and OFR in the F-111B Requirements Study. The F-4(FV) was to be a modified swing-wing version of the F-4J, and would carry Sparrow and Sidewinder air-to-air missiles. While the other alternatives were evaluated in the F-111B Requirements Study, they were not, except for the VFAX with Sparrow, mentioned in the NFS.

The Navy advised that the NFS was a refinement of the F-111B Requirements Study and as such only compared those type of aircraft found to be cost effective from the F-111B Requirements Study.

Evaluation of F-14
in OFR missions

The NFS indicated that the F-14 type aircraft was superior to the F-4J aircraft in escort and attack missions of OFR and required less deck space on the carrier.

As shown in the NFS, the generally accepted definition of the term OFR, which evolved from the F-111B Requirements Study, was as follows:

> "* * * fighter missions in support of our attack aircraft whether they be actual escort of the attack aircraft; a barrier between the attack target and the threat; or a fighter sweep ahead of the attack aircraft. OFR is intended to include all such missions including attack, but excludes fleet air defense interception missions."

The NFS compared and ranked the F-111B, F-14 and F-4J aircrafts in OFR by two analyses. The approach used for the first method was to identify certain key performance factors for OFR escort and attack missions and to rank each aircraft by its relative standings. The second method was an analysis of maneuverability in the close-in air-to-air engagement. The results of the two analyses are discussed below.

1. Key performance factors

In its analysis of key performance factors the NFS stated that of the 12 performance indicators used in ranking the three aircraft, the F-14 ranked first in eight of the categories and the F-4J ranked first in four categories (F-14 and F-4J tied in one category). The table of the rankings shown in the NFS of candidate fighters in the escort and attack roles follows:

Categories	First[1/]	Second[1/]
Specific excess power	F-4J	VFX-1
Roll rate	VFX-1	F-4J
Thrust to weight	VFX-1	F-4J
Wing loading	F-4J	VFX-1
Acceleration	VFX-1/F-4J	-
Roll acceleration	VFX-1	F-4J
Visibility	F-4J	VFX-1
Weapons flexibility	VFX-1	F-111B
Escort range	F-111B	VFX-1
Pay load range	VFX-1	F-111B
Loiter time	VFX-1	F-111B
Deck spot	VFX-1	F-4J

2. Analysis of maneuverability

For its analysis of maneuverability in the close-in air-to-air engagement, the NFS used the VEDA Air Combat Simulator to perform a comparative evaluation of the F-14 and F-111B in OFR. The study found the F-14 to be superior to the F-111B in air-to-air combat.

1/ VFX-1 now the F-14.

The NFS stated that:

> "Lack of time and pilot availability prevented inclusion of the F-4J in the comparative matrix. Comparisons with other aircraft were not conducted because adequate aerodynamic and performance data were not available in time."

Four additional simulations were conducted which matched the F-14 against the Foxbat, MIG 21F and the F-4J, and the F-4J against the Foxbat (the Foxbat and MIG 21F are Soviet fighter aircraft). We were advised by an official of the Navy Program Planning, Systems Analysis Division that the above simulations had been run but the input assumptions used had generated extreme controversy. Consequently, the simulations were not considered and the F-14 versus the F-111B simulation, in which the F-14 was shown to be superior, was used in the NFS.

In addition, the NFS' analysis of key performance factors disclosed that the maneuverability of the F-4J was superior to that of the F-14 in the projected air combat zones in the 1970s.

Thus we believe the conclusion reached in the study concerning the F-14's superiority in other fighter roles was not adequately demonstrated.

The Navy agrees that OFR was not completely treated in the NFS, however, they stated that work has been done in the OFR area subsequent to the issuance of the NFS. The results show an overwhelming superiority of the F-14 A or B over the F-4J. With regard to maneuverability, the Navy stated that the F-14 has subsequently been shown to be far superior to the F-4J.

Updating analyses

The following studies were used in evaluating the cost effectiveness of the F-14.

The F-111B Requirements Study, prepared in January 1967, concluded that the F-111B aircraft with six Phoenix missiles was best for FAD and the VFAX aircraft was best for OFR missions. However, the F-111B aircraft production was subsequently canceled by the Congress.

The NFS, prepared in March 1968, concluded that the F-14, with six Phoenix missiles was superior to the F-111B and could be used for both FAD and OFR missions, thus eliminating the need for two different aircraft. We found, however, that no updated analysis was made of the Phoenix missile system development in the NFS evaluation. Since the NFS analysis was basically restricted to those aircraft capable of carrying the Phoenix missile, we believe an updated analysis of this system should have been made.

The Navy stated that there has been no change in the projected performance and capabilities of the Phoenix missile system between the F-111B Requirements Study and the NFS. Thus, the Navy believed that an update was not necessary.

Conclusions

While cost effectiveness studies were performed for the F-14 weapon system and the basic study elements were considered we believe that:

--other alternative aircraft could have been included in the analyses.

--the conclusion that the F-14 was generally superior to the F-4J aircraft in other fighter roles was not demonstrated conclusively.

--an updated analysis of the Phoenix missile system development should have been included as part of the evaluation of the F-14 weapon system.