Audit Report

OFFICE OF THE INSPECTOR GENERAL

MILESTONE REVIEW PROCESS FOR THE ADVANCED FIELD ARTILLERY TACTICAL DATA SYSTEM

Report No. 94-115 May 27, 1994

Department of Defense

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Acronyms

ACAT	Acquisition Category
AFATDS	Advanced Field Artillery Tactical Data System
AMSAA	Army Materiel Systems Analysis Activity
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Continuity of Operations
CRLCMP	Computer Resources Life-Cycle Management Plan
FDT&E	Force Development Testing and Experimentation
IFSAS	Initial Fire Support Automation System
IOT&E	Initial Operational Test and Evaluation
LCU	Lightweight Computer Unit
MCCRMG	Mission-Critical Computer Resources Management Guide
ORD	Operation Requirements Document
OSD	Office of the Secretary of Defense
RISC	Reduced Instruction Set Computer
TACFIRE	Tactical Fire Direction System
TCU	Tactical Computer Unit
TEMP	Test and Evaluation Master Plan
USAFAS	United States Army Field Artillery School

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202-2884

May 27, 1994

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND TECHNOLOGY

SUBJECT: Audit Report on Milestone Review Process for the Advanced Field Artillery Tactical Data System (Report No. 94-115)

We are providing this report for your review and comments. This report is the second in a series of reports resulting from our audit of the milestone review process for Component-managed acquisition programs. We requested comments on a draft of this report; however, comments were not received.

As required under DoD Directive 7650.3, "Followup on General Accounting Office, DoD Inspector General, and Internal Audit Reports," September 5, 1989, all audit recommendations must be resolved promptly. Therefore, you must provide final comments on the recommendations by July 26, 1994. The recommendations are subject to resolution in accordance with DoD Directive 7650.3 in the event of nonconcurrence or failure to comment.

We appreciate the courtesies extended to the audit staff. If you have any questions on this report, please contact Mr. Jack D. Snider, Project Manager, at (703) 693-0402 (DSN 223-0402). Appendix G lists the distribution of this report. Audit team members are listed inside back cover.

David K. Steensma

David K. Steensma
Deputy Assistant Inspector General
for Auditing

Office of the Inspector General, DoD

Report No. 94-115 **May 27, 1994**
(Project No. 3AE-0061.01)

MILESTONE REVIEW PROCESS FOR THE ADVANCED FIELD ARTILLERY TACTICAL DATA SYSTEM

EXECUTIVE SUMMARY

Introduction. The Army's Advanced Field Artillery Tactical Data System (AFATDS) is an integrated battlefield management and decision support system. The system is one of five battlefield automation systems of the Army Tactical Command and Control System. The AFATDS utilizes evolving commercial computer technology from the Army Tactical Command and Control System hardware and software procurement. The AFATDS Program has three versions of software, of which Version 1 is scheduled for a Milestone III, Production Approval, decision in December 1994 to approve entry into the production and deployment phase of the acquisition process.

Objective. The overall audit objective was to evaluate the effectiveness of the milestone review process for Component-managed acquisition programs. The AFATDS was one program selected as part of the overall audit. We are reporting our finding and recommendations separately because management needs to take prompt corrective action. This audit assessed the adequacy of the information provided to DoD Component milestone decision authorities in support of major milestone and program reviews and evaluated internal controls related to the objective.

Audit Results. The AFATDS Program is not ready to proceed into the production and deployment phase of the acquisition process. The AFATDS software to be deployed lacks critical capabilities necessary to fulfill user requirements, including communication with other user systems. Subsequent versions of AFATDS software, potentially capable of meeting user requirements, do not have a dedicated engineering and manufacturing development phase to achieve production hardware and software configurations suitable for deployment. As a result, the Army could spend $187.2 million for hardware that does not meet requirements, spend $4.6 million for an initial operational test and evaluation that will not prove the AFATDS ready for fielding, experience further delays in the development of software, field software that does not meet user requirements, and support two systems to accomplish the same mission.

Internal Controls. The audit did not identify material internal control weaknesses. Internal controls assessed are summarized in Part I of this report.

Potential Benefits of Audit. Potential monetary benefits are $191.8 million of procurement and operational test and evaluation funds put to better use, of which $76.9 million will occur from FYs 1994 through 1999. Implementation of the recommendations will provide decisionmakers all available information to make fully informed decisions concerning whether the AFATDS Program is ready to proceed into production or more advanced stages of development and whether program plans for subsequent stages are consistent with sound acquisition management practices (Appendix E).

Summary of Recommendations. We recommended designating the AFATDS Program as an acquisition category ID program, canceling the Milestone III decision and hardware procurement for the initial version of software, reporting the schedule baseline breach, requiring a Defense Acquisition Board program review of alternatives for meeting user requirements, updating the AFATDS Operational Requirements Document, requiring revision of the Test and Evaluation Master plan to reflect the minimum operating requirements, and requiring that a cost and operational effectiveness analysis is completed before the recommended Defense Acquisition Board program review.

Management Comments. We requested comments on a draft of this report from the Under Secretary of Defense for Acquisition and Technology; however, comments were not received. As a result, we request comments on this final report by July 26, 1994.

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Part I - Introduction

Background

This report discusses the adequacy of the information provided to the Army milestone decision authority in support of a Milestone III, Production Approval, decision[1] for the Advanced Field Artillery Tactical Data System (AFATDS).

Decision Authority. The DoD Instruction 5000.2, "Defense Acquisition Policies and Procedures," February 23, 1991, states that the Under Secretary of Defense for Acquisition and Technology shall be the acquisition program milestone decision[2] authority for all acquisition category (ACAT) I[3] programs. However, the Under Secretary can delegate decision authority to the cognizant DoD Component head, who may delegate authority to the DoD Component acquisition executive. ACAT I programs administered by the Under Secretary and the DoD Component head are titled ACAT ID and ACAT IC programs, respectively.

Advanced Field Artillery Tactical Data System. The Army's AFATDS, an ACAT IC Program, is to provide an integrated battlefield management and decision support system, designed to overcome the size, vulnerability, high sustainment cost, limited functionality, central processing, and training limitations of the Tactical Fire Direction System (TACFIRE).[4] The AFATDS Program is one of five battlefield automation systems of the Army Tactical Command and Control System. The AFATDS will automate 27 fire support functions, grouped in five fire support operational requirements: fire support execution, fire support planning, movement control, field artillery mission support, and field artillery fire direction operations. The AFATDS will utilize the evolving commercial computer technology selected for the Army Tactical Command and Control System architecture. The AFATDS Program is comprised of three versions:

o Version 1 was intended to be interoperable with TACFIRE and to provide division and corps-level initial functionality to include attack by cannon, missile, or rocket; naval gunfire; mortars and air attack systems employment.

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[1]Appendix A discusses the specifics of a Milestone III, Production Approval, decision.

[2]The point when a recommendation is made and approval sought regarding starting or continuing (proceeding to next phase) an acquisition program. Milestones are 0 (Concept Studies Approval), I (Concept Demonstration), II (Development Approval), III (Production Approval), and IV (Major Modification Approval).

[3]An ACAT I designation is issued to all major Defense acquisition programs that have an eventual total expenditure for research, development, acquisition, and evaluation of more than $300 million in FY 1990 constant dollars or an eventual total expenditure for procurement of more than $1.8 billion in FY 1990 constant dollars.

[4]TACFIRE has been provided to all heavy divisions and corps of the active force. TACFIRE consists of two types of central computers, providing field artillery fire planning and tactical fire control, and a remote terminal, providing communications with the central computers. Tactical fire control includes evaluating targets, selecting units to fire, munitions, and volume of fire.

o Version 2 will replace TACFIRE in FY 1996 and will be fielded in two increments, increasing automation to provide enhanced capabilities in target generation and prioritization, attack system analysis, naval gunfire, and close air support. It will also provide improved fire support planning and increased interoperability. To satisfy higher echelon operational considerations, system software will have greater flexibility for continuity of operations (CONOPS) alternatives.

o Version 3 is the objective system and will fully automate the AFATDS system. It will provide computerized maps, integrate chemical and conventional schedule of fires, provide advanced guidance development, provide technical fire direction, and replace the Fire Direction Data Manager system.[5]

The December 31, 1992, AFATDS Selected Acquisition Report estimated a total acquisition cost of $876.8 million in then-year dollars of which $394.2 million has been appropriated through FY 1994:

o $300.8 million for research, development, test, and evaluation and

o $93.4 million for procurement.

The FY 1994 procurement appropriation of $12 million was $12 million less than the budget request of $24 million.

Under cost-plus-award-fee contract DAAB-90-C-E708, valued at $69.9 million, Magnavox Electronic Systems Company, Fort Wayne, Indiana, is developing AFATDS Version 1 software. Under an option to the contract, Version 2 software is being developed for $43 million. The AFATDS Version 1 software is scheduled for a Milestone III, Production Approval, decision in December 1994.

Objective

The overall audit objective was to evaluate the effectiveness of the milestone review process for Component-managed acquisition programs. The audit also assessed the adequacy of the information provided to DoD Component milestone decision authorities in support of major milestone and program reviews and evaluated internal controls related to the objective. The AFATDS was one program reviewed during the audit. We determined that management attention was needed on the AFATDS Program as it proceeded toward a

[5]The Fire Direction Data Manager system (the system) improves the Multiple Launch Rocket System Fire Direction System by increasing the fire direction system processing, storage, and communications capability. The system provides tactical fire control of rockets not possible with TACFIRE. The system will be deployed in FY 1994.

Milestone III, Production Approval, decision and before the completion of our overall audit work. Therefore, we are reporting this issue separately before the conclusion of our overall audit.

Scope and Methodology

We conducted this program audit from May 1993 through January 1994 and reviewed data dated from September 1986 through January 1994. To accomplish the objective, we:

o discussed issues relating to the effectiveness of the milestone review process for the AFATDS Program with Office of the Secretary of Defense and Army personnel;

o determined the adequacy of the information that the Army provided to the decision authorities in support of major milestone and program reviews;

o evaluated the effectiveness of the milestone review and program review processes for the AFATDS Program;

o reviewed AFATDS Program decision documents as well as selected acquisition reports, Defense acquisition executive summary reports, and various contract cost management reports; and

o examined contract DAAB-90-C-E708, valued at $69.9 million, with Magnavox Electronic Systems Company, Fort Wayne, Indiana.

The audit was made in accordance with auditing standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD, and accordingly included such tests of internal controls as were deemed necessary. We did not rely on computer-processed data to support the finding and recommendations in this audit report. Appendix F lists the organizations visited or contacted.

Internal Controls

Internal Controls Evaluated. We evaluated internal controls related to the effectiveness of the milestone review process and the adequacy of the information provided to the milestone decision authorities in support of major milestone and program reviews for the AFATDS Program. The DoD Instruction 5000.2, "Defense Acquisition Policies and Procedures," February 23, 1991, and DoD Manual 5000.2-M, "Defense Acquisition Management Documentation and Reports," February 23, 1991, specify those controls and procedures. We also assessed implementation of the requirements

of DoD Directive 5010.38, "Internal Management Control Program," April 14, 1987, including performance of vulnerability assessments and management control reviews.

Internal Control Weakness Not Identified. The audit did not identify any material internal control weakness, as defined by DoD Directive 5010.38. Existing internal controls, if properly implemented, were sufficient to preclude the deficiencies noted in this report. In the AFATDS FY 1993 Statement of Internal Management Control, August 20, 1993, no internal control deficiencies were identified. As a part of this audit, we did not examine the effectiveness of implementation of the DoD Internal Management Control Program for DoD Component-managed programs because our objectives were limited to AFATDS program management. Our summary report on the overall audit will include our assessment of the internal controls for Component-managed programs.

Prior Audits and Other Reviews

Since 1988, the Office of the Inspector General, DoD, issued one report that included the AFATDS Program. However, we did not follow up on the prior audit report because it did not contain findings or recommendations related to our objective.

Other Matters of Interest

On March 11, 1994, the Army issued Magnavox Electronic Systems Company a stop work order. The order stated that the Government was not satisfied with the contractor's progress in completion of AFATDS Version 1 software. The order required that all work on Version 2 software stop on or before April 1, 1994, and expected the contractor to deliver Version 1 in accordance with the requirements of the contract. The order also stated that because of the software development delays and an anticipated contractor inability to deliver an acceptable product in time for a July 1994 initial operational test and evaluation (IOT&E) (Appendix D), the Army reduced the operational testing for FY 1994. A separate AFATDS IOT&E to validate fire support functionality will be scheduled during FY 1995. In preparation for that test, complete Version 1 software must be delivered to the Army for technical testing by June 20, 1994. Based upon the contractor's performance on Version 1, the Army will make a final decision on Version 2.

Part II - Finding and Recommendations

Proceeding Into Production and Deployment

The AFATDS Program is not ready to proceed into production and deployment. The Version 1 of AFATDS software scheduled for a Milestone III, Production Approval, decision in December 1994 lacks critical capabilities necessary to fulfill user requirements, including communication with other user systems. Subsequent versions of AFATDS software, potentially capable of meeting user requirements, do not have a dedicated phase of engineering and manufacturing development needed to achieve production hardware and software configurations suitable for deployment. The lack of readiness to enter production and deployment was caused by the Army decision to deploy Version 1 of AFATDS instead of Version 2 after schedule slippage resulting from Version 1 software development problems. As a result, the Army could:

o spend $187.2 million for hardware that does not meet requirements,

o spend $4.6 million for an initial operational test and evaluation that will not prove whether the AFATDS is ready for fielding,

o experience further delays in the development of Version 2 software, and

o support two systems to accomplish the same mission.

Background

The DoD Instruction 5000.2 states that computer resources are hardware, firmware,[6] software, documentation services, support services, supplies, and spare parts. (Appendix B further discusses computer resources.) The Defense Systems Management College's Mission-Critical Computer Resources Management Guide further states that:

o computer resources are integral to weapon systems because software is critical for weapon system development;

o software development costs can exceed initial budget estimates by 50 percent to 100 percent;

o the performance of modern weapon systems is largely dependent on the quality of computer resources; and

[6]Software that is stored on a fixed system, such as the read-only memory of the system.

o when software falls behind schedule, development lead times cannot be shortened by applying more resources. Therefore, only more time can help fix schedule problems.

Assessing Acquisition Strategy

The AFATDS Version 1 software lacks critical capabilities necessary to fulfill user requirements, including communication with other user hardware. The AFATDS Version 2 software, potentially capable of meeting user requirements, does not have a dedicated phase of engineering and manufacturing development needed to achieve production hardware and software configurations suitable for deployment. Until AFATDS can fulfill user requirements, the Army and the Marine Corps are fielding an alternative system.

Capabilities. The AFATDS Program Office hopes to gain permission, through the Milestone III, Production Approval, decision, to buy hardware and designate the Program Executive Officer, Command and Control Systems, (Appendix C) as the decision authority on future versions of the software. Therefore, a favorable milestone decision will remove the AFATDS Program from the oversight of the Assistant Secretary of the Army (Research, Development and Acquisition) even though the AFATDS Program will not have demonstrated that it will satisfy requirements.

Acquisition Documentation. The acquisition documentation did not fairly state the position of the AFATDS Program. The Version 1 software will not deliver the command and control functionally needed to satisfy user requirements. Specifically,

o The Version 1 software does not provide sufficient artillery target intelligence, close air support, and naval gunfire functionality.

o The AFATDS Version 1 software is run on a tactical computer unit (TCU) and a lightweight computer unit (LCU); however, the Version 1 software will not allow the TCU and LCU to share the same local area network.

o The acquisition strategy does not permit the user to provide feedback for the Version 2 software development.

o The test and evaluation strategy is inadequate.

o The computer hardware may not possess sufficient speed and memory.

Artillery Target Intelligence. The AFATDS Operational Requirements Document (ORD) does not specify whether or when artillery target intelligence[7]

[7] Artillery target intelligence is the ability of the software to locate a target from various sensor readings.

should be a part of the fielded AFATDS software; however, the Unites States Army Field Artillery School (USAFAS) (Appendix C) states artillery target intelligence would improve AFATDS fire support functionality. The DoD Manual 5000.2-M states that the ORD shall clearly specify the operational capability or level of performance necessary to declare initial and full operational capability. The AFATDS Version 1 software will not have artillery target intelligence capability; however, the AFATDS Program Office documented that it will be a feature of either Version 2 or 2.1. Artillery target intelligence offers needed functionality that is currently available from other automated fire support programs. Accordingly, to enhance fire support capability, AFATDS must offer improvements over fielded systems. Therefore, the ORD should be updated to reflect the need for artillery target intelligence.

Close Air Support and Naval Gunfire. Version 1 of the AFATDS software will not be able to effectively utilize all fire support assets available to the commander as the ORD requires. Specifically, the Marine Corps stated that the Version 1 software will not be able to perform sufficient close air support and coordinate naval gunfire. The AFATDS ORD requires that close air support and naval gunfire functionality be available on the fielded software; however, the AFATDS Program Office stated that the Version 2 software will specifically address this requirement. The Marine Corps stated that adding those functions to the Version 2 software will allow it to evaluate the system for fielding. Additionally, Version 1 does not offer sufficient functionality to employ Air Force aircraft in close air support roles. Therefore, the design of the Version 1 software will not satisfy the requirements of managing all available fire support assets through a single system. Naval gunfire and close air support functionality are necessary to provide significant additional capabilities over TACFIRE and the Initial Fire Support Automation System (IFSAS) Program; therefore, it would be inappropriate to field the AFATDS software until the AFATDS Program has undergone sufficient engineering and manufacturing development to ensure that this functionality is available.

Memory. The AFATDS hardware may not possess sufficient memory (Appendix B) capacity to satisfy mission requirements. The DoD Instruction 5000.2 states that a program office will not finalize computer hardware resource decisions until the software design is mature enough to minimize the risk that the computer selected has inadequate speed and memory capacity; however, it does not provide a quantitative means to measure this requirement. The Mission-Critical Computer Resources Management Guide does quantify this requirement by stating a computer should not use more that 50 percent of speed and memory to accommodate a system's growth over its life cycle. Speed and memory are interrelated in that insufficient random access memory[8] can lead to the need for frequent exchanges between internal and secondary memory, which reduces the effective speed of the computer. The Project Office states that the LCU must have a minimum of 32 megabytes of random access memory;

[8]Random access memory is semiconductor-based memory that the computer can read and write to.

however, the Reduced Instruction Set Computer (RISC)[9] TCU must have considerably more than 32 megabytes of random access memory due to its design. Currently, the TCU and LCU have 32 megabytes of random access memory.

Memory Capacities. The AFATDS Program Office estimated that current random access memory capacities can probably support the additional software without further increase in memory if performance requirements are not increased and large Common Army Tactical Command and Control System Support Software[10] applications are not added. For example, if the Terrain Evaluation Module Software is added, current processing capacity will not be sufficient to perform intensive calculations concurrently on the same computer that is performing AFATDS fire mission-type processing. The Army stated that the speed and complexity of tomorrow's battlefields will continue to increase and that a higher degree of automation is required to plan, direct, and execute combat operations effectively. Versions 2 and 3 of the AFATDS software are expected to increase by 25 and 10 percent, respectively; however, the Version 1 computer will not be able to accommodate those increases without compromising functionality. Specifically, if the user identifies additional functionality necessary to enhance mission effectiveness, the current capacity will not allow the change without eliminating existing functionality or degrading system performance. These conditions exist because the AFATDS ORD does not specify what minimum speed and memory reserves are necessary to field the software. Additionally, the acquisition strategy does not provide sufficient time for the user to evaluate the completed software on the target computers before the Milestone III, Production Approval, decision. The Marine Corps stated that more developmental tests of the AFATDS Program with actual user operational units is necessary to determine whether AFATDS meets the users' requirements.

Hardware. From 1994 through 2004, the AFATDS Program plans to purchase 2,272 TCU and 380 LCU computers for approximately $179 million and $8.2 million in then-year dollars, respectively, with an estimated 10-year useful life. The Army plans to buy 1,803 additional LCU computers identical to the AFATDS LCUs for the IFSAS and Fire Support Ada Conversion Programs because, once it is fielded, AFATDS is intended to replace the IFSAS and Fire Support Ada Conversion Programs. At 32 megabytes of random access memory, neither the RISC TCU nor the LCU will have a random access memory reserve.

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[9]The RISC is a microprocessor design based on the premise that most instructions that a computer decodes and executes are simple; therefore, RISC chips limit the number of instructions built into a microprocessor but optimizes each for rapid execution. The RISC chips are slower than general purpose complex instruction set chips when complex instructions must be executed.

[10]Common Army Tactical Command and Control System Support Software incorporate generic command and control support functions found in all Army Tactical Command and Control System Battlefield Functional Area Control Systems. The support software consists of common system support software and application software, including Movement Control Module, Digital Mapping Module, and Terrain Evaluation Module.

Additional Memory. The AFATDS Program Office is considering adding an additional 48 megabytes of random access memory to the TCU, upgrading the LCU from 25 to 66 megahertz for additional speed, or adding a RISC-based LCU with 128 megabytes of memory. However, a formal plan has not been established, life-cycle cost estimates do not reflect these changes, and the proposed hardware has not been tested to determine whether it will satisfy a 50-percent margin requirement. Since the AFATDS Program must have sufficient capacity to meet current and future requirements, the AFATDS Program Office must verify that the hardware does not hamper system growth. Specifically, procurement of TCU and LCU computers should be postponed until, at a minimum, Version 2 software is available and fully tested on representative hardware platforms. Further, the decision must first be made as to whether the AFATDS software should even be fielded and, if so, what version should be fielded, based on the results of the ongoing cost and operational effectiveness analysis (COEA) scheduled for completion in November 1994. Thereafter, the acquisition strategy, life-cycle cost estimates, the test and evaluation master plan (TEMP), and the ORD should be updated to reflect those requirements before proceeding with procurement actions.

AFATDS Architecture. The design of the AFATDS Version 1 software architecture will not satisfy mission requirements. The DoD Instruction 5000.2 states a program may not enter full-rate production unless the milestone decision authority confirms that performance objectives and thresholds have been validated and test results and low-rate initial production reasonably assure that the design is stable, operationally acceptable, and logistically supportable. The AFATDS Project Office is developing versions of the software with a heterogeneous architecture;[11] however Version 1 is designed on a homogeneous architecture[12] that allows the system to send messages at the bit level, ones and zeros, rather than messages, for speed in execution. The Army Materiel Systems Analysis Activity (AMSAA) (Appendix C) stated that AFATDS software was originally intended to run only on the TCU computer. However, as the AFATDS Program progressed, the AFATDS Program Office added the LCU through an engineering change proposal. The user stated that those computers have different processors and will not be capable of sharing the same data via the local area network or performing CONOPS procedures for each other; therefore, information must be shared by radio or other communication devices. The heterogeneous architecture will allow TCU and LCU operational facilities to share automated information and provide CONOPS support for each other. The lack of a heterogeneous architecture for Version 1 software is a significant operational shortfall; however, the AFATDS Project Office has not planned to address this problem. The AFATDS

[11]Heterogeneous architecture allows communication between computers by sending messages with the information. The messages tell the other computer how to read the information; therefore, this process allows computers with different processors to be part of the same local area network.

[12]Homogeneous architecture requires all computers within the local area network to have identical computer processors from the same manufacturer; however, the AFATDS will have two processors, the TCU and LCU.

architecture should reflect known requirements, especially when seeking a production approval decision. Also, the ORD should state those requirements explicitly before a decision is made to field software.

Alternative System. The Army has an urgent need for the replacement of TACFIRE; however, AFATDS acquisition documentation could lead decisionmakers to allow premature fielding of AFATDS Version 1 software. The DoD Instruction 5000.2 states that documentation is the primary means for the functional staff and the program manager to provide the milestone decision authority with the information needed for a milestone decision. In addition, in a November 18, 1991, memorandum to the Army Acquisition Executive, the Under Secretary of Defense for Acquisition required that OSD staffs continue to monitor the Army Tactical Command and Control System Programs through Defense acquisition executive summary reports to maintain visibility in the Army Tactical Command and Control System Programs. In its mission description section, the AFATDS Defense Acquisition Executive Summary report stated that AFATDS software is to replace TACFIRE and shows that Version 1 will be fielded to the total force. However, the report did not inform decisionmakers that the Army and Marine Corps have fielded the IFSAS Program. Additionally, the AFATDS ORD and TEMP do not adequately disclose that the Army has fielded IFSAS to overcome TACFIRE limitations pending the availability of AFATDS.

Initial Fire Support Automation System Capabilities. The IFSAS Program consists of a C software language version of TACFIRE that can run on the AFATDS LCU, while only utilizing 3 megabytes of the 32-megabyte random access memory. The IFSAS Program has more functionality than TACFIRE and was developed by the Field Artillery Tactical Data System Project Office (Appendix C) at the request of the Commandant, USAFAS, to provide a means to replace Battalion TACFIRE quickly and economically. The IFSAS Program will be capable of performing artillery target intelligence; however, it does not perform close air support and naval gunfire functions adequately. The IFSAS Program is not intended to provide the level of automation that would be expected from the objective AFATDS system, but it has been designed to provide immediate relief for TACFIRE and can accommodate additional functionality. Therefore, the Army has achieved through the IFSAS Program a level of automation that will relieve pressure temporarily to field AFATDS software.

Cost and Operational Effectiveness Analysis. According to Army Training and Doctrine Command officials, the IFSAS Program will remain in the Army inventory whether or not AFATDS is fielded. The Training and Doctrine Command is preparing the AFATDS COEA using three alternatives planned to satisfy objective system requirements in the year 2004. The three alternatives, which all include IFSAS, are:

- stop AFATDS development and field IFSAS to the entire Army,

- stop further AFATDS development and field Version 1 to selected units with IFSAS to the remainder of the Army, or

o continue AFATDS development and field Version 3 to selected units with IFSAS to the remainder of the Army.

Initial Fire Support Automation System Fielding. The Marine Corps is utilizing portions of the TACFIRE program but intends to field the IFSAS Program in the fourth quarter of FY 1994 or until the AFATDS Version 2 software demonstrates that it will satisfy requirements. The Army and Marine Corps deployment of IFSAS Program will directly impact AFATDS requirements as well as AFATDS test and evaluation; however, the AFATDS ORD and TEMP do not address the effects of the combined fielding of IFSAS and AFATDS. To adequately assess the AFATDS software for fielding, the AFATDS test and evaluation program must consider the increased fire support capabilities offered by IFSAS rather than TACFIRE performance alone. Therefore, the recent fielding of IFSAS indicates that the fielding of AFATDS software must noticeably improve fire support functionality, which will require additional engineering and manufacturing development. Also, decisionmakers must have timely access to all available information on the IFSAS Program through the ORD, TEMP, and COEA to make fully informed decisions on automated fire support systems. The AFATDS Version 1 software should not be fielded and a dedicated phase of engineering and manufacturing development would be required to provide a version of AFATDS software that satisfies user requirements. Additionally, the ORD and the TEMP should be revised to reflect the impact of IFSAS on fielding AFATDS.

Cause for Program Position

The AFATDS Project Office has based acquisition decisions on schedule considerations at the expense of functionality. The DoD Directive 5000.1, "Defense Acquisition," February 23, 1991, states that a program shall follow an event-based acquisition strategy; however, management decisions concerning development, test, and evaluation and IOT&E were based on schedule concerns. Additionally, the AFATDS documentation does not provide the decisionmaker with the necessary information to make fully informed decisions.

Acquisition Oversight. The OSD recognizes that the AFATDS Program is critical to future fire support operations and has attempted to provide guidance to the AFATDS Program by monitoring the AFATDS Program's Defense Acquisition Executive Summary reports; however, OSD oversight has not been sufficient to prevent the AFATDS Program from following a schedule-driven acquisition strategy. By monitoring only the AFATDS Program's Defense Acquisition Executive Summary reports, OSD did not obtain sufficient information to determine that the Version 1 software design will not meet user requirements, the Force Development Testing and Experimentation (FDT&E) will not be accomplished with the target computers or the complete software, and the IOT&E has a high risk of failure. Additionally, monitoring the Defense Acquisition Executive Summary reports alone does not disclose that after a Milestone III decision on the Version 1 software all future fielding decisions would be made by the Program Executive Officer, Command and Control

Systems. The OSD should revise the AFATDS Program acquisition strategy to include elevating the Program to ACAT ID status to verify that the AFATDS Program satisfies user requirements. The new acquisition strategy would base decisions on events and the elevated acquisition category would verify that sufficient information was made available to OSD officials to support the decisions.

Assessments. The Version 1 software is to provide functionality greater than TACFIRE. However, the Army Fire Support Command, Control, and Communications Automation Plan, December 1992, states Version 1 will only have functionality equivalent to TACFIRE and that Version 2 will replace TACFIRE and possess superior functionality. The USAFAS, the Army combat developer and user representative, and the Marine Corps System Command, the Marine Corps materiel developer, have assessed the AFATDS Program as essential for providing integrated fire support functionality to the battlefield; however, both agree that the AFATDS Version 1 software will not satisfy their requirements. The AFATDS Version 2 Program has not had a dedicated phase of Engineering and Manufacturing Development to achieve production hardware and software configurations suitable for deployment. The USAFAS stated that the Version 1 software was only intended to be fielded to the test unit for a year and then replaced with Version 2. Additionally, USAFAS stated that Version 1 does not offer sufficient functionality to warrant fielding past the test unit and needs an additional 9 months of development before its scheduled IOT&E. The Marine Corps will not field the AFATDS Version 1 software because Version 1 does not adequately address its fire support needs. The Marine Corps has assessed that the AFATDS Program needs an additional year of development before it will be ready for IOT&E. The AMSAA stated that the AFATDS Program faces a significant risk of IOT&E failure if the development schedule is not extended by at least 6 months. A dedicated phase of engineering and manufacturing development should address the lack of functional maturity in the AFATDS Program. The objective should be to develop a version of software capable of satisfying user requirements.

Schedule Breach. The AFATDS Program Office has not reported a schedule breach or revised its acquisition strategy. The DoD Instruction 5000.2 states that a current estimate that fails to meet a cost, schedule, or performance threshold constitutes a reportable program deviation. Further, the Instruction states that the program manager should immediately issue a program deviation report to the Under Secretary of Defense for Acquisition and Technology when the program will encounter a schedule delay of 180 days or more. The AFATDS Program must hold its Milestone III, Production Approval, decision no later than December 31, 1994, or breach its baseline schedule. The AFATDS Milestone III decision was originally scheduled for June 1994 and rescheduled for December 1994; however, the AFATDS Program will not be mature enough for a Milestone III decision in December 1994, due in part to a lack of functionality. The key event in adhering to the schedule is holding the IOT&E in July 1994 to prove the system is mature enough to proceed into production. The USAFAS, the Marine Corps, and AMSAA have stated that the AFATDS Program needs from 6 to 12 months of additional development before the AFATDS Program will be ready for an IOT&E. Additionally, due to the lack of functionality, the AFATDS Program cannot pass an IOT&E unless the

test is designed to assess what the system can do rather than what it should do. However, the AFATDS Program Office:

o will hold the IOT&E on a release of the Version 1 software that did not go through developmental testing,

o will conduct the IOT&E on hardware that does not represent the system to be tested due to the lack of availability, and

o will conduct the IOT&E on a software design that does not meet user requirements.

Therefore, the scheduled AFATDS IOT&E will not provide a valid estimate of the operational effectiveness and suitability of the AFATDS Program because the Version 1 software lacks the functionality to replace TACFIRE or satisfy user requirements. As a result, a deployable version of AFATDS software will not be available before December 31, 1994.

By the Army not reporting the breach, the Under Secretary's ability to provide guidance is impaired. Additionally, the software design will not satisfy user requirements and the conditions that caused the schedule slippage may continue and delay the fielding of a software version capable of satisfying user requirements. Further, the $4.6 million spent on the IOT&E would be wasted. The AFATDS Program Office should submit a program deviation report to the Under Secretary of Defense for Acquisition and Technology. After the Army reports the breach, the Under Secretary should convene a Defense Acquisition Board[13] review of the AFATDS Program to ascertain the cause of the breach and what corrective actions must be taken.

Development Test and Evaluation Programs. The AFATDS developmental test and evaluation program is based on satisfying schedule concerns rather than ensuring that the AFATDS Program is sufficiently mature to enter operational testing. The DoD Instruction 5000.2 requires that a program's developmental test and evaluation program verify that the system is ready for operational test and evaluation. Key developmental tests for the AFATDS Program are the FDT&E and the formal qualification test (Appendix D); however, the tests do not prove the AFATDS Program is ready for operational test and evaluation.

[13]The DoD Instruction 5000.2 states that the Defense Acquisition Board is the senior advisory body to Under Secretary of Defense for Acquisition and Technology to advise the Under Secretary in enforcing policies and procedures governing the operations of the DoD Acquisition System. The Defense Acquisition Board is the primary forum to advise the Under Secretary on mission needs approved by the Joint Requirements Oversight Council, possible Concept Exploration or Definition study efforts, and Milestone I through IV decision point reviews and program reviews of major Defense acquisition programs subject to Defense Acquisition Board review. The reviews ensure that a program is ready to proceed into more advanced stages of development or production before receiving Milestone approval and that proposed program plans for subsequent stages are consistent with sound acquisition management practices. Three Defense Acquisition Board committees support the Defense Acquisition Board review process.

Force Development Test and Experimentation. The FDT&E, a developmental test, began in February 1994 with contractor personnel who are providing the user with essential training that will be used in the IOT&E. The AFATDS Program Office will allow the AFATDS Program to transition from software development to FDT&E without assuring that key events were successfully completed. Specifically, the software will be incomplete and the target computers will be unavailable for the testing. Magnavox provided the AFATDS Program Office with functionality matrices on August 5, 1993, stating that the CONOPS and other software functionality would not be available for testing with Version 1 software at the FDT&E. CONOPS software offers new and essential functionality that will allow AFATDS operational facilities to automatically take over processing capabilities for each other due to movement or catastrophic loss. Additionally, the AFATDS software will not have been written for the target computers in time for the FDT&E. The AFATDS Program Office does not have enough target computers to run the FDT&E. Specifically, the FDT&E will be conducted using the 382 TCUs and no LCUs.

The FDT&E will not satisfy its objective of certifying the system as ready to enter the IOT&E. Not allowing the AFATDS software and hardware to mature before the FDT&E contributes to the risk that the AFATDS Program could fail the IOT&E. Specifically, AMSAA stated that the FDT&E for the Version 1 software has a high risk of not achieving its objective of certifying that the AFATDS Program is ready for IOT&E because the CONOPS functionality will not be tested at the FDT&E. Further, AMSAA stated that the risk of failing the IOT&E would be greatly reduced if all required AFATDS Version 1 software functionality was written for the target computers and tested at an FDT&E. AMSAA believes that the FDT&E will provide good user feedback to enhance the engineering and manufacturing development of the AFATDS Program.

Formal Qualification Test. The formal qualification test will not be done in accordance with the AFATDS Statement of Work, which requires the test to be on the target computers to be fielded. The formal qualification test will be done on the final release of the software to the extent it is different from prior releases and errors are known to exist; however, the AFATDS Software Development Plan states that the formal qualification test should occur on the entire release of software to be fielded. A full formal qualification test on the final version of software is required to verify that no catastrophic errors exist in the software. The AFATDS Program Office has not allowed sufficient time for the formal qualification test to verify that all catastrophic errors are found and corrected. Therefore, if the software is not tested properly during engineering and manufacturing development, the software could experience avoidable mission failures.

Initial Operational Test and Evaluation. Functionality called for in the AFATDS ORD will not be available in the Version 1 software. However, in July 1994, the AFATDS Program Office intends to begin IOT&E for Version 1 software that will involve from 1 to 2 months of testing. The IOT&E is estimated to cost $4.6 million. The DoD Instruction 5000.2 states that operational test and evaluation programs shall be structured to determine the operational effectiveness and suitability of a system under realistic combat

conditions and to determine whether the minimum acceptable operational performance requirements as specified in the operational requirements document have been satisfied. Without required functionality, the Army will not meet the ORD requirements during the IOT&E.

The Version 1 software will not offer the minimum performance requirements as stated in the ORD such as close air support and naval gunfire. The IOT&E will be conducted on computers that are not representative of the AFATDS computers to be fielded because the AFATDS Program Office did not allow enough time to purchase the target computers. The IOT&E will be conducted using 58 computers consisting of 28 RISC TCUs (48 percent), 23 382 TCUs (40 percent), and the 7 LCUs (12 percent). The 28 RISC TCUs represent all RISC TCUs available, with the exception of 2 spares. The lack of RISC TCUs forces the AFATDS Program Office to use the 382-TCU for 40 percent of total computers to meet the IOT&E date; however, the 382-TCUs will not be fielded. The OSD Director, Operational Test and Evaluation, will evaluate the IOT&E results. Personnel from the Office of the Director, Operational Test and Evaluation, stated that the degree to which the 382-TCUs are used could nullify the tests, depending on the extent to which using the 382-TCUs may obscure the test results. Further, AMSAA has rated the IOT&E as a high-risk event due to the lack of necessary FDT&E testing on the AFATDS target computer and completed Version 1 software.

Documentation. The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) expressed concern that the managers of the Army Tactical Command and Control Systems need to keep OSD decisionmakers informed on the Systems' progress. However, the AFATDS Program Office did not prepare or did not adequately prepare acquisition documentation that would allow decisionmakers to assess the AFATDS Program properly. The computer resources life-cycle management plan (CRLCMP) (Appendix B), COEA, ORD, and TEMP do not adequately reflect the status of the AFATDS Program.

Computer Resources Life-Cycle Management Plan. The AFATDS Project Office did not complete and maintain a CRLCMP. The DoD regulations require the preparation of a CRLCMP to adequately detail the major decisions made in the acquisition of computer resources. The AFATDS Program Office made performance decisions from the objective system to arrive at the Version 1 software; however, the AFATDS Program Office did not prepare a CRLCMP to document the performance decisions so that decisionmakers could assess the basis for the decisions. Further, the information to be gathered by the CRLCMP was not available to prepare milestone documents such as the COEA, TEMP, ORD, integrated program summary, and integrated logistics support plan. In January 1994, the AFATDS Program Office started preparing a CRLCMP.

Cost and Operational Effectiveness Analysis. The Army Training and Doctrine Command began updating the AFATDS COEA in November 1993 and will deliver it on November 30, 1994, providing the decisionmaker with the document approximately 1 month before the Milestone III decision meeting. Continued development of the IFSAS Program is not detailed in the COEA

alternatives. The IFSAS Program is intended to provide fire support automation pending AFATDS' delivering desired fire support functionality. However, all COEA alternatives require the IFSAS Program to have enhanced capabilities to satisfy mission requirements because AFATDS' development could be stopped at Version 1 or would require additional years to develop a fieldable system. The AFATDS' COEA assumes that IFSAS is a proven system that can satisfy requirements; however, it does not alert the decisionmaker that additional development is necessary to convert the software into Ada[14] programming language and will require additional software code to satisfy mission requirements such as coordinating close air support and naval gunfire. Therefore, each alternative should also disclose what further development will be required of IFSAS so that decisionmakers can determine whether the Army must field two fire support systems. If the alternatives regarding IFSAS are not disclosed fully, the decisionmakers may not consider the most technologically or economically feasible solution to fire support automation, given the limited time available to review the COEA.

Operational Requirements Document. The ORD specifies what minimum requirements are necessary to field the objective version of the AFATDS software. However, the ORD does not specify the requirements for fielding Version 1, such as:

o what minimum fire support functionality or what minimum hardware speed and memory requirements must be available to field AFATDS,

o what type of software architecture is desirable, and

o what are the time-frame availability or contingency issues. For example, the ORD does not consider the availability of IFSAS on the requirements for AFATDS.

The present ORD does not provide the decisionmaker with a comprehensive set of requirements to determine whether the AFATDS Version 1 software is suitable for fielding for other than evaluation and feedback. The testers cannot design an IOT&E to adequately assess the AFATDS Program for fielding because the artillery target intelligence, naval gunfire, close air support, hardware speed and memory, and system architecture are undefined in the ORD. As a result, the IOT&E is only a test of what functionality AFATDS Version 1 software has, not an evaluation of ORD requirements. The ORD should be updated to reflect minimum requirements for fielding AFATDS.

Test and Evaluation Master Plan. The AFATDS TEMP does not identify potential operational and technical limitations of the alternative concepts and the design options being pursued or support the decision to certify the AFATDS Program as ready for operational testing. The DoD Instruction 5000.2 states that minimum test planning must address all system components that are critical to the achievement and demonstration of contract technical performance specifications and minimum acceptable operational performance

[14]Ada is the only programming language to be used in new Defense systems and major software modifications of existing systems regardless of size, cost, or functional application.

requirements specified in the operational requirements document. The TEMP designs a testing plan for the Version 1 software even though the software by design cannot meet minimum operational requirements. For example, the ORD requires that, at a minimum, the AFATDS Program provide close air support and naval gunfire functionality. The AFATDS Version 1 software cannot adequately meet this requirement, yet the TEMP is an attempt to design a test plan that would result in fielding the AFATDS Version 1 software. The TEMP does not test the ability of the system to meet ORD requirements. Rather, the TEMP focuses on the functionality designed into Version 1. The TEMP should be updated to verify that it is compatible with the updated ORD.

Effect of Milestone Decision

Decisionmakers will not have all information to make fully informed decisions, which could result in cost and performance problems.

Decision Authority. After completing the Milestone III review, the Army plans to transfer decision authority for subsequent reviews to the Program Executive Officer, Command and Control Systems, before the AFATDS Program is mature. The DoD Instruction 5000.2 states that the lowest level decision authority for an Army ACAT IC program shall be the Army Acquisition Executive. However, in view of the AFATDS Program deficiencies, the Milestone III decision should be made by the Under Secretary of Defense for Acquisition and Technology.

Acquisition Strategy. The Army's acquisition decisions are being made to adhere to schedule considerations, which increase the risk that the AFATDS Program will not satisfy user needs. The acquisition strategy will not allow the user sufficient time to evaluate the system before final decisions are made. Further, the user will not be able to add functionality once the AFATDS Program is fielded because of computer speed and memory constraints. As a result, the fielded AFATDS Program will not provide the needed functionality, causing the Government significant cost, schedule, and performance problems. Specifically, the Government could prematurely procure hardware that does not meet requirements. Deferring computer procurement until definite decisions on fielding the AFATDS Program, including which version, will permit $72.3 million (Appendix E) to be put to better use over the succeeding 6-year period.

Initial Fire Support Automated System. The Army's failure to adequately disclose that IFSAS is a recently fielded alternative to TACFIRE, pending AFATDS showing the desired functionality, could cause decisionmakers to make less than fully informed decisions. The decision to rush AFATDS into the field would cause the Army to support two new systems for the same mission.

Test and Evaluation. The Army's failure to adequately perform developmental tests on all portions of the AFATDS Version 1 software would lead to the

decision to send the software to operational testing prematurely. As a result, technical errors overlooked at developmental testing may not be discovered until the system is fielded because operational testing is not designed for this activity. Errors discovered at operational testing could cause the system to fail the IOT&E, which would inefficiently use the $4.6 million dedicated for the test, require an unknown amount of development funds to correct errors, and delay schedule. The Army not conducting the IOT&E with production-representative computers may cause the decisionmakers to pass or fail the system incorrectly, which would also impact cost, schedule, and performance.

Capabilities. The Army not adequately addressing the minimum capabilities necessary to field the AFATDS Version 1 software in its acquisition documentation hinders the decision authority in making a fully informed decision. The fielding of the Version 1 software would result in a lack of functionality in regard to artillery target intelligence, close air support, and naval gunfire. Additionally, the inadequate memory and system architecture would hamper system performance, such as communications through the CONOPS software. As a result, the Army would have to spend more funds to correct those problems than if the requirements were adequately defined and performed as early as possible.

Conclusion

The lack of functionality necessitates cancellation of the December 1994 planned Milestone III, Production Approval, decision and the planned procurement of computers until the AFATDS software has reached a sufficient level of maturity. The schedule baseline breach should be reported in the program deviation report, Defense Acquisition Executive Summary, and the Selected Acquisition Reports because the software has not reached a level of maturity suitable for fielding and, therefore, has a reportable breach. After reporting the breach, a Defense Acquisition Board program review should be held to assess alternatives for meeting user requirements, which would include subsequent versions of the AFATDS, and approve a restructured acquisition strategy with a dedicated engineering and manufacturing development phase for any developmental solution. Further, the AFATDS ORD should be updated to address minimum acceptable operational requirements, interoperability with the IFSAS Program, and Marine Corps requirements. The TEMP should be revised to reflect the minimum operating requirements as reflected in the ORD. Also, the COEA should contain alternatives that reflect the impact of IFSAS on the AFATDS Program and be completed before the recommended Defense Acquisition Board program review.

Recommendations for Corrective Action

We recommend that the Under Secretary of Defense for Acquisition and Technology:

1. Redesignate the Advanced Field Artillery Tactical Data System as an acquisition category ID program.

2. Cancel the Army System Acquisition Review Council Milestone III, Production Approval, decision planned for Version 1 of the Advanced Field Artillery Tactical Data System.

3. Cancel procurement plans for hardware to support Version 1 of the Advanced Field Artillery Tactical Data System.

4. Direct the Army to report the schedule baseline breach.

5. Conduct a Defense Acquisition Board program review of alternatives for meeting user requirements, including subsequent versions of the Advanced Field Artillery Tactical Data System, and approval of a restructured acquisition strategy including a dedicated engineering and manufacturing development phase for any developmental solution.

6. Require the Advanced Field Artillery Tactical Data System Operational Requirements Document be updated to address minimum acceptable operational requirements, including interoperability with the Initial Fire Support Automation System and with the Navy, the Air Force, and the Marine Corps.

7. Revise the Test and Evaluation Master Plan to reflect the minimum operating requirements in the updated Operational Requirements Documents.

8. Complete the Cost and Operational Effectiveness Analysis before the recommended Defense Acquisition Board program review.

Management Comments and Audit Response

Management Comments. We did not receive comments from the Under Secretary of Defense for Acquisition and Technology to a draft of this report issued March 17, 1994. The comments were required by May 16, 1994.

Audit Response. The DoD Directive 7650.3 requires that all audit recommendations be resolved promptly. Therefore, we request that the Under Secretary provide comments on the final report.

Part III - Additional Information

Appendix A. Milestone III, Production Approval, Decision

The DoD Instruction 5000.2, "Defense Acquisition Policies and Procedures," February 23, 1991, states that a program may not enter full-rate production and deployment unless the milestone decision authority confirms that:

o the system threat assessment and performance objectives and thresholds have been validated;

o test results and low-rate initial production provide reasonable assurance that the design is stable, operationally acceptable, logistically supportable, and capable of being produced efficiently;

o potential environmental consequences of the program have been analyzed and appropriate mitigating measures have been developed;

o projected life-cycle costs and annual funding requirements are affordable in the context of long-range investment or similar plans; and

o adequate personnel and funds have been programmed to support production, deployment, and support.

At Milestone III, the milestone decision authority decides on entry into the production and deployment phase of the acquisition process. The objectives of this phase are to:

o establish a stable, efficient production and support base;

o achieve an operational capability that satisfies the mission need; and

o conduct follow-on operational and production verification testing to confirm and monitor performance and quality and verify the correction of deficiencies.

Appendix B. Computer Resources

Computer Resources Life-Cycle Management Plan. The DoD Instruction 5000.2, "Defense Acquisition Policies and Procedures," February 23, 1991, states that a computer resources life-cycle management plan (CRLCMP) documents the management approach, decisions, and plans associated with computer resources. Further, the CRLCMP identifies and addresses critical issues, objectives, risks, methodologies, and evaluation criteria. The CRLCMP also structures development, test, quality assurance, and support processes to provide data that permit quantitative assessment of the impact of computer resources on weapon system cost, schedule, and performance.

The Defense Systems Management College defines the CRLCMP in its Mission-Critical Computer Resources Management Guide (MCCRMG) as one of the most important documents to reduce software life-cycle costs. It further states that the CRLCMP:

o is to be developed early in the acquisition cycle to ensure that all issues and resources relevant to weapon system acquisition, testing, and support are accounted for properly;

o defines the criteria for measuring progress and identifies the resources needed to develop, test, acquire, and support computer resources, such as facilities, personnel, hardware, software, training, funding, and tools; and

o should be updated whenever the software is modified or at least annually.

Cost of Software Fixes. The MCCRMG stated that the costs of fixing software errors early in the development of the software is insignificant compared to the costs of finding and correcting the error once the software has been delivered. Specifically, the MCCRMG estimated that the costs to correct software problems increases as a system proceeds from requirements analysis through design and test to deployment.

Hardware Decisions. The DoD Instruction 5000.2 states that a program office will not finalize computer hardware resource decisions until the software design is mature enough to minimize the risk that the computer selected has inadequate speed and memory capacity, which is usually measured by the amount of random access memory. Additionally, software design and hardware design schedules must be closely linked. The MCCRMG stated that the hardware at delivery should have at least a 50 percent speed and memory reserve.

Memory. Memory is an electronic circuit that allows for the storage and retrieval of information. Memory can also refer to external data storage systems such as disk drives or tape drives; however, "memory" usually refers to the storage of random access memory that is directly connected to the computer's processor. Random access memory is semiconductor-based memory that can be read and written to by the computer or other access devices. The

data in random access memory is lost when the power is disconnected from the system. Usually the software program that operates the computer is stored in random access memory to increase speed in operation.

Software Development. At the beginning of the software development process, the software developer does not use as much code and associated paperwork. However, as the software begins computer-based testing, major resources such as computers, weapon system hardware, technicians, and systems analysts are involved and costs can escalate quickly.

Software Impact. The MCCRMG stated that, as of 1980, software is 50 percent of system design effort; therefore, software is no longer just a part of a system but is a system in its own right, having the integration function for various subsystems of a weapon. During the past 30 years, the computer hardware-to-software ratio as a percentage of computer resource cost has reversed from 80 percent to 20 percent hardware-to-software to 20 percent to 80 percent hardware to software. The software cost estimate also reflects software support, which accounts for as much as 60 percent of the cost. The MCCRMG estimated that by 1995 DoD software costs will approach $35.7 billion, up from $11.4 billion in 1985. The rise in the cost of software can be attributed to the fact that software design and support are labor intensive. Although software allows automation of many tasks, very few machines can generate computer programs from a set of requirements; therefore, software development and support require programmers and other technical specialists.

Appendix C. Acquisition Community

Members of the Advanced Field Artillery Tactical Data System (AFATDS) acquisition community include:

o the Program Executive Officer, Command and Control Systems, who is responsible for all Army Tactical Command and Control System activities and reports directly to the Army Acquisition Executive;

o the Project Manager, Field Artillery Tactical Data Systems, who is responsible for the management of the AFATDS Program;

o the U.S. Army Field Artillery School (USAFAS), the combat developer, acts as the user representative for AFATDS;

o the Marine Corps Systems Command, the materiel developer for Marine Corps Fire Support Command and Controls Systems, is responsible for the Marine Corps' participation in the AFATDS Program;

o the Army Materiel Systems Analysis Activity (AMSAA), the AFATDS independent technical evaluator; and

o the U.S. Army Operational Evaluation Command, the independent operational evaluator.

Appendix D. Test and Evaluation

Developmental Test and Evaluation. The DoD Instruction 5000.2, "Defense Acquisition Policies and Procedures," February 23, 1991, states that developmental test and evaluation programs shall:

o identify potential operational and technological limitations of the alternative concepts and design options being pursued,

o support the identification of cost performance trade-offs,

o support the identification and descriptions of design risks,

o substantiate that contract technical performance and manufacturing process requirements have been achieved, and

o support the decision to certify the system is ready for operational test and evaluation.

Developmental test and evaluation of software can be accomplished by force development testing and experimentation and formal qualification testing.

Force Development Testing and Experimentation. For the AFATDS Program, the force development testing and experimentation is a training exercise to prove the system is ready for an initial operational test and evaluation. The user, user representatives, contractor, and other interested parties participate in the exercise.

Formal Qualification Testing. A formal qualification test is a contractor-conducted developmental test, witnessed by Government representatives, intended to show that the software meets the contract specifications. The Defense Systems Management College personnel stated that a full formal qualification test should be run on software to detect possible catastrophic errors in the software created by combining computer software configuration items.

Initial Operational Test and Evaluation. The DoD Instruction 5000.2 states that an Initial Operational Test and Evaluation consists of all operational tests and evaluations conducted on production or production-representative articles to support a decision to proceed beyond low-rate initial production. An Initial Operational Test and Evaluation is conducted to provide a valid estimate of expected system operational effectiveness and operational suitability.

Operational Test and Evaluation. The DoD Instruction 5000.2 states that operational test and evaluation programs shall determine the suitability of a system under realistic combat conditions and whether the minimum acceptable operational performance requirements as specified in the operational requirements document have been satisfied. Specifically:

o threat-representative forces shall be used when possible;

o typical users shall operate and maintain the system, simulating combat stress and peacetime conditions; and

o production or production-representative articles shall be used for the dedicated phase of operation test and evaluation that supports the full-rate production decision.

Appendix E. Summary of Potential Benefits Resulting From Audit

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
1.	Program Results. Will provide a sufficient level of OSD oversight to ensure requirements are achieved.	Nonmonetary.
2.	Program Results. Will delay the Milestone III, Production Approval, decision and related Initial Operational Test and Evaluation until the Program is mature.	$4.6 million[1] of Initial Operational Test and Evaluation funds will be put to better use from FYs 1994 through 1999.
3.	Program Results. Will delay the procurement of hardware until the software is complete.	$72.3 million[2] in hardware procurement funds will be put to better use from FYs 1994 through 1999.
4.	Program Results. Will report the baseline breach and allow OSD decisionmakers the opportunity to provide direction to the Program.	Nonmonetary.
5.	Program Results. Will determine Program direction.	Nonmonetary.
6.	Program Results. Will update the Operational Requirements Document to adequately reflect Program requirements.	Nonmonetary.

[1]Funds put to better use by fiscal year (Research, Development, Test and Evaluation, $ in millions):

1994	1995	1996	1997	1998	1999	Total
$4.6	$0.0	$0.0	$0.0	$0.0	$0.0	$4.6

[2]Funds put to better use by fiscal year (Other Procurement, Army, $ in millions):

1994	1995	1996	1997	1998	1999	Total
$7.2	$21.5	$18.9	$24.7	$0.0	$0.0	$72.3

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
7.	Program Results. Will update the Test and Evaluation Master Plan to adequately reflect Program requirements.	Nonmonetary.
8.	Program Results. Will update the Cost and Operational Effectiveness Analysis to adequately reflect Program alternatives.	Nonmonetary.

Appendix F. Organizations Visited or Contacted

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology, Washington, DC
  Director, Acquisition Program Integration, Washington, DC
Assistant Secretary of Defense (Command, Control, Communications and Intelligence), Washington, DC
Director, Operational Test and Evaluation, Washington, DC

Department of the Army

Assistant Secretary of the Army (Research, Development and Acquisition), Washington, DC
  Program Executive Office, Command and Control Systems, Fort Monmouth, NJ
    Project Manager, Field Artillery Tactical Data Systems, Fort Monmouth, NJ
    Project Manager, Common Hardware and Software, Fort Monmouth, NJ
Director of Information Systems for Command, Control, Communications and Computers, Washington DC
  Director, Modernization and Integration, Washington, DC
Army Materiel Command, Washington, DC
  Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD
Army Operational Test and Evaluation Command, Alexandria, VA
Army Training and Doctrine Command, Fort Monroe, VA
  U.S. Army Training and Doctrine Command, Analysis Command, White Sands Missile Range, NM
  U.S. Army Field Artillery School, Fort Sill, OK
    Director of Combat Development, Fort Sill, OK

Department of the Navy

Commandant of the Marine Corps, Washington, DC
  Marine Corps Systems Command, Quantico, VA
    Program Manager, Command and Control, Quantico, VA
  Marine Corps Combat Development Command, Quantico, VA
    Director of Requirements Division, Quantico, VA
Space and Naval Warfare Systems Command, Arlington, VA
Naval Sea Systems Command, Arlington, VA
  Deputy Commander for Ship Design and Engineering, Arlington, VA

Defense Agencies

Defense Logistics Agency, Alexandria, VA
  Defense Contract Management Command, Alexandria, VA
    Defense Plant Representative Office, Magnavox, Fort Wayne, IN
Defense Systems Management College, Fort Belvoir, VA

Contractor

Magnavox Electronic Systems Company, Fort Wayne, IN

Appendix G. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology
  Principal Deputy Under Secretary of Defense (Acquisition and Technology)
    Director, Acquisition Program Integration
    Director, Tactical Systems
  Assistant Secretary of Defense (Economic Security)
Assistant Secretary of Defense (Command, Control, Communications and Intelligence)
Comptroller of the Department of Defense
Director, Operational Test and Evaluation
Assistant to the Secretary of Defense (Public Affairs)
Director, Program Analysis and Evaluation

Department of the Army

Secretary of the Army
Assistant Secretary of the Army (Research, Development and Acquisition)
  Program Executive Office, Command and Control Systems
    Project Manager, Field Artillery Tactical Data System
Army Materiel Command
  Army Materiel Systems Analysis Activity
Army Operational Test and Evaluation Command
Army Training and Doctrine Command
  U.S. Army Training and Doctrine Command, Analysis Command
  U.S. Army Field Artillery School
    Director of Combat Development
Auditor General, Department of the Army

Department of the Navy

Secretary of the Navy
Commandant of the Marine Corps
  Marine Corps Systems Command
    Program Manager, Command and Control
  Marine Corps Combat Development Command
    Director of Requirements Division
Assistant Secretary of the Navy (Financial Management)
Assistant Secretary of the Navy (Research, Development, and Acquisition)
Comptroller of the Navy
Auditor General, Naval Audit Service

Department of the Air Force

Secretary of the Air Force
Assistant Secretary of the Air Force (Acquisition)
Assistant Secretary of the Air Force (Financial Management and Comptroller)
Auditor General, Air Force Audit Agency

Defense Agencies

Director, Defense Contract Audit Agency
Director, Defense Logistics Agency
  Commander, Defense Contract Management Command
    Defense Plant Representative Office, Magnavox, Fort Wayne, IN
Inspector General, Defense Intelligence Agency
Inspector General, National Security Agency
Commandant, Defense Systems Management College
Director, Defense Logistics Studies Information Exchange

Non-Defense Organizations

Office of Management and Budget
U.S. General Accounting Office, National Security and International Affairs Division, Technical Information Center

Chairman and Ranking Minority Member of the Following Congressional Committees and Subcommittees:

Senate Committee on Appropriations
Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
House Committee on Armed Services
House Committee on Government Operations
House Subcommittee on Legislation and National Security, Committee on Government Operations

Audit Team Members

Donald E. Reed	Director, Acquisition Management Directorate
Russell A. Rau	Audit Program Director, Systems Acquisition Division
Jack D. Snider	Audit Project Manager
Eric L. Lewis	Senior Auditor
Cris M. Helfrich	Auditor
Scott A. Marx	Auditor
Mary Ann Hourclé	Editor
Teresa D. Bone	Administrative Support