Audit Report

OFFICE OF THE INSPECTOR GENERAL

ACQUISITION OF THE JOINT SURVEILLANCE TARGET ATTACK RADAR SYSTEM

Report No. 94-061 March 18, 1994

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Department of Defense

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Acronyms

ASD	Assistant Secretary of Defense
C^3I	Command, Control, Communications and Intelligence
COEA	Cost and Operational Effectiveness Analysis
DFARS	Defense Federal Acquisition Regulation Supplement
E^3	Electromagnetic Environmental Effects
EMD	Engineering and Manufacturing Development
GAO	General Accounting Office
GSM	Ground Station Module
HAEMP	High-Altitude Electromagnetic Pulse
HMMWV	High Mobility Multipurpose Wheeled Vehicle
JSORD	Joint System Operational Requirements Document
LRIP	Low-Rate Initial Production
MOPP	Mission-Oriented Protective Posture
NBC	Nuclear, Biological, and Chemical
ROC	Required Operational Capability
SCDL	Surveillance and Control Data Link
STARS	Surveillance Target Attack Radar System
WAPCO	World Auxiliary Power Company

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
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March 18, 1994

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND TECHNOLOGY
ASSISTANT SECRETARY OF DEFENSE (COMMAND, CONTROL, COMMUNICATIONS AND INTELLIGENCE)
ASSISTANT SECRETARY OF THE AIR FORCE (FINANCIAL MANAGEMENT AND COMPTROLLER)
AUDITOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Audit Report on the Acquisition of the Joint Surveillance Target Attack Radar System (Report No. 94-061)

We are providing this report for your review and comments. It discusses opportunities for program improvement on issues relating to component breakout, competition, software development, and Light Ground Station Module's survivability requirements. Comments on a draft of this report were considered in preparing the final report.

DOD Directive 7650.3 requires that all recommendations be resolved promptly. Therefore, we request that the Army Office of the Deputy Chief of Staff for Operations and Plans and the Assistant Secretary of the Air Force (Acquisition) provide comments on the unresolved recommendations and monetary benefits by May 17, 1994.

We appreciate the courtesies extended to the audit staff. If you have questions on this audit, please contact Mr. John Meling, Program Director, at (703) 614-3994 (DSN 224-3994) or Mr. Michael Claypool, Project Manager, at (703) 614-1415 (DSN 224-1415). Appendix M lists the distribution of this report.

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Deputy Assistant Inspector General
for Auditing

Office of the Inspector General, DoD

Report No. 94-061 March 18, 1994
(Project No. 2AS-0065)

ACQUISITION OF THE JOINT SURVEILLANCE TARGET ATTACK RADAR SYSTEM

EXECUTIVE SUMMARY

Introduction. The Joint Surveillance Target Attack Radar System (STARS) is a joint Air Force and Army program with the Air Force designated as the lead Military Department. Joint STARS is a surveillance, battle-management, and target attack support system being developed to detect, locate, and track moving and stationary targets located beyond the forward line of our troops. The program includes 20 aircraft and 95 ground station modules that interact with aircraft. The Joint STARS has an estimated total life-cycle cost of about $24.5 billion (then-year dollars).

Objectives. The audit objective was to evaluate the overall acquisition management of the Joint STARS program. Specifically, the audit determined the adequacy of efforts to develop an economical and efficient system and to prepare the Joint STARS aircraft and ground systems for production and deployment.

Audit Results. The Air Force and Army adequately managed reliability, availability, and maintainability status; configuration control; testing; cost and schedule assessment; and production preparedness for the Joint STARS aircraft and ground systems. However, our audit identified four conditions requiring management actions.

o The Joint STARS Joint Program Office (Joint Program Office) did not consider making a comprehensive component breakout review to support the Joint STARS FY 1995 acquisition strategy. As a result, the Air Force may miss an opportunity to reduce costs an estimated $77.7 million over the Future Years Defense Program (FYs 1994 through 1999) by not breaking out nine components with stable designs and demonstrated reliability (Finding A).

o The Joint Program Office did not provide for full and open competition for refurbishing and modifying Joint STARS production aircraft. We estimated that the Air Force may miss an opportunity to reduce costs about $67.0 million over the Future Years Defense Program (FYs 1994 through 1999) by not competing the acquisition of aircraft refurbishment and modification work beginning with the sixth production aircraft (Finding B).

o The Joint Program Office has not initiated a plan to transition Joint STARS aircraft mission-critical system software[1] into Ada software programming language before the aircraft's initial operational capability date, March 1997. As a result, Joint STARS aircraft life-cycle costs for software maintenance may be as much as 30 percent higher unless the software is transitioned into Ada for use on Joint STARS aircraft (Finding C).

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[1]Mission-critical systems software is the mission application and support software for Joint STARS airborne subsystems.

o The Army established nuclear, biological, and chemical contamination survivability system requirements for the Joint STARS Light Ground Station Module that were insufficient for the effective operation of this mission-essential equipment[2]. As a result, equipment operators will experience an estimated 45 percent degradation in their ability to process and disseminate intelligence information received from the Joint STARS aircraft (Finding D).

Internal Controls. The audit did not identify internal control weaknesses. Our review of internal controls is in Part I.

Potential Benefits of Audit. The Joint Program Office could reduce costs about $144.7 million during the Future Years Defense Program (FYs 1994 through 1999) by breaking out nine aircraft components as Government-furnished equipment and by competing the aircraft refurbishment and modification effort. Potential benefits of the audit are in Appendix K.

Summary of Recommendations. We recommended that:

o Air Force perform a component breakout review to support the Joint STARS FY 1995 acquisition strategy.

o Air Force direct the prime contractor to award contracts for refurbishment and modification of Joint STARS production aircraft based upon evaluation of proposals from all potential sources.

o Air Force provide and implement an Ada software transition plan for Joint STARS aircraft mission-critical system software before the aircraft initial operational capability date, March 1997.

o Army revise the Joint STARS Light Ground Module requirements document to require the Light Shelter to include a nuclear, biological, and chemical overpressure protection system and have high-altitude electromagnetic pulse hardness protection.

Management Comments. The Air Force stated that a comprehensive component breakout review would be completed, that there was no need to compete Joint STARS aircraft refurbishment and modification work, and that an Ada transition plan was in development but it was premature to begin programming funds to transition the aircraft software to the Ada programming language. The Army agreed to revise the Joint STARS requirements document to require the Light Shelter to include nuclear, biological, chemical, and hardness protection but not to revise the requirements document for the Light Shelter. Part II contains a discussion of managements' comments to the report; Part IV contains the complete text of managements' comments.

Audit Response. We stand by our report as written. We request that the Army Office of the Deputy Chief of Staff for Operations and Plans and the Assistant Secretary of the Air Force (Acquisition) respond to the unresolved issues in this final report by May 17, 1994.

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[2]Mission-essential equipment are those items necessary to accomplish missions.

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Part I - Introduction

Background

The Joint Surveillance Target Attack Radar System (STARS) is a surveillance, battle-management, and target attack support system being developed to detect, locate, and track moving and stationary targets located beyond the forward line of our troops. Joint STARS is a joint Air Force and Army acquisition program with the Air Force designated as the lead Military Department. For program management, the Air Force Electronics Systems Center is responsible for the aircraft development and the Army Communications-Electronics Command is responsible for the ground systems development.

The Joint STARS aircraft development consists of installing radar and other subsystems into refurbished and modified Boeing 707 aircraft. The radar is to detect, classify, and process target-position data in near-real time for reception at multiple ground locations. During Engineering and Manufacturing Development (EMD)[1], two configurations of the aircraft are being developed: the E-8A test configuration and the E-8C Follow-on EMD configuration that is the baseline configuration for production. Appendix A describes the Joint STARS airborne subsystems. The Defense Acquisition Executive approved low-rate initial production (LRIP) for five aircraft on May 26, 1993.

The ground systems development is the ground station module (GSM). The GSM is a mobile, tactically deployable intelligence data-processing facility that receives, processes, and disseminates information from the aircraft. The Army is developing and fielding the GSM in successive block configurations. Appendix B describes each GSM block configuration. The Defense Acquisition Executive approved low-rate initial production for 12 Medium GSMs on August 11, 1993.

The Air Force and Army plan to buy a total of 20 aircraft and 95 GSMs. The Air Force estimates that the total life-cycle cost estimate for the aircraft is about $20 billion (then-year dollars), and the Army estimates that the total life-cycle cost estimate for the GSMs is about $4.5 billion (then-year dollars).

Objectives

The audit objective was to evaluate the overall acquisition management of the Joint STARS program. We performed the audit following our critical program management elements approach. The objectives and scope of the audit were tailored to the status of the Joint STARS program in the EMD phase of the acquisition process. We reviewed program requirements; acquisition planning; mission-critical computer resources; reliability, availability, and maintainability status; configuration control; systems integration; testing; cost and schedule assessment; contracting; production preparedness; and internal controls related

[1]Formerly full-scale development.

to those objectives. We also followed up on Air Force's implementation of the recommendations in Air Force Audit Agency reports for Project No. 0036316, "Acquisition Management of the Joint Surveillance Target Attack Radar System," November 9, 1990, and August 8, 1991.

We determined that the following five issues did not warrant additional audit work: reliability, availability, and maintainability status; configuration control; testing; cost and schedule assessment; and production preparedness (Appendix C). Two areas of concern pertaining to mission-critical computer resources and systems integration are discussed in "Other Matters of Interest" (Appendix D). Part II discusses findings and recommendations pertaining to program requirements, acquisition planning, mission-critical computer resources, and contracting; and to Air Force implementation of recommendations in Air Force Audit Agency's reports for Project No. 0036316.

Scope and Methodology

This performance audit was conducted from August 1992 through July 1993 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 reviewed data dated from June 1982 through July 1993 to accomplish our announced audit objectives. We interviewed cognizant DoD, Air Force, Army, Marine Corps, and contractor officials involved in the Joint STARS program. Computer-based data are not used in the report. Appendix L lists the organizations visited or contacted.

The Technical Assessment Division of the Office of the Assistant Inspector General for Auditing assisted our review of mission-critical computer resources, acquisition planning, testing, and systems integration.

Internal Controls

We assessed internal controls related to the critical program management elements of the Joint STARS program. We evaluated internal control techniques, such as management plans and reports, vulnerability assessments, written policies and procedures, design reviews, and mechanisms for independent reviews of the program. No material internal control deficiencies were identified as defined by Office of Management and Budget Circular A-123 and DoD Directive 5010.38.

Prior Audits and Other Reviews

Since November 1990, the Joint STARS program has been the subject of one General Accounting Office and two Air Force Audit Agency audits that were directly related to our audit objectives. The Air Force Audit Agency initially reported on the issues in our Findings A and B. Appendix E discusses the three prior audit reports.

Part II - Findings and Recommendations

Finding A. Acquisition Planning for Component Breakout

The Joint STARS Joint Program Office (Joint Program Office) did not consider making a comprehensive component breakout review to support the Joint STARS FY 1995 acquisition strategy. The Joint Program Office did not consider making a comprehensive component breakout review because it did not want to risk losing the right to hold the prime contractor accountable for total systems integration performance responsibility. As a result, the Air Force may miss an opportunity to reduce costs an estimated $77.7 million over the Future Years Defense Program (FYs 1994 through 1999).

Background

Component Breakout. Breakout is the process whereby the Government purchases components directly from the vendor and furnishes them to the end-item prime contractor as Government-furnished equipment. The Government then eliminates the prime contractor's overhead and profit on those components and achieves savings for the Government.

DoD policy is to break out components whenever the Government anticipates that prime contracts will be awarded without adequate price competition; substantial net cost avoidance can be achieved; and the component breakout decision does not jeopardize the quality, reliability, performance, or timely delivery of the system. The Defense Federal Acquisition Regulation Supplement (DFARS), Appendix D, "Component Breakout," identifies candidates for breakout as components that have an annual acquisition cost of at least $1 million. DFARS, Appendix D, further requires program managers to identify potential breakout candidates and to make and document breakout reviews.

The Air Force implemented the DoD component breakout policy and guidance in Air Force Regulation 800-22, "CFE [contractor-furnished equipment] vs GFE [Government-furnished equipment] Selection Process," August 30, 1976, and Air Force Systems Command/Air Force Logistics Command Regulation[2]

[2]Air Force Systems Command and Air Force Logistics Command merged to form Air Force Material Command July 1, 1992.

800-31, Attachment 9, "Component Breakout Process," May 31, 1985. The latter Air Force regulation requires program managers to perform component breakout reviews annually.

On August 9, 1990, the Deputy Secretary of Defense directed that program managers perform component breakout reviews as part of their system acquisition strategies. The Deputy Secretary also directed Secretaries of the Military Departments to require program managers to complete component breakout reviews as a step in acquisition strategies and to ensure that program managers have the resources and expertise to perform adequate component breakout analyses.

Prior Review. Air Force Audit Agency report for Project No. 0036316, "Acquisition Management of Joint Surveillance Target Attack Radar System," August 8, 1991, identified three components where breakout offered a potential gross savings of $683,000 per aircraft. The report recommended that the Joint Program Office implement a component breakout program with periodic component breakout reviews. Although the Secretary of the Air Force concurred with the recommendation, the Joint Program Office did not fully implement the recommendation. Specifically, the Joint Program Office conducted a preliminary review of the three components identified in the report and postponed further action until the November 1994 E-8C physical configuration audit. The Air Force stated that until E-8C system is configured, it would not be practical or in the best interest of the Government to break out components.

Component Breakout Planning

The Joint Program Office did not initiate a comprehensive component breakout review, as recommended by the Air Force Audit Agency in 1991 and directed by the Deputy Secretary of Defense in August 1990. In the 1992 amended Joint STARS acquisition plan prepared to support the Follow-on EMD phase of the acquisition process and the LRIP buy, the Joint Program Office stated that breakout of major components or subsystems was not feasible for the Follow-on EMD and LRIP systems because of Joint STARS' technical complexity. The plan also stated that the Government may risk losing the right to hold the prime contractor responsible for total systems integration performance responsibility.

Joint Program Office personnel stated that they purchased the Surveillance and Control Data Link (SCDL) Ground Data Terminal directly from the SCDL vendor and that they planned to provide five Government-owned, used Boeing 707-300 series aircraft to the prime contractor. However, the Joint Program Office did not consider 16 other components, with an annual acquisition cost of more than $1 million, for component breakout.

Component Breakout Candidates

We reviewed 9 of the 18 components, including the remaining aircraft needed for production, that met the DFARS criteria as component breakout candidates. We visited the component manufacturers to evaluate design stability, evaluate the manufacturer's delivery history in relation to contract requirements, review the frequency and nature of components being returned because of defects, and determine the efforts required of the prime contractor before assembling supplied components into the Joint STARS aircraft. Also, we interviewed Government subcontractor plant quality assurance representatives to determine the quality of components being manufactured and to obtain their opinions on whether the components could be broken out.

The nine components met the DFARS criteria for component breakout in terms of reliability, design stability, prime contractor value added, and warranty availability. Details of the nine components are in Appendix F.

Benefits From Component Breakout

Component breakout cost reductions of about $77.7 million could be achieved over the Future Years Defense Program (FYs 1994 through 1999) starting with the FY 1995 production and long-lead buys (Appendix G) because the prime contractor will add * percent to the cost of components acquired from component manufacturers. This * -percent markup includes material overhead costs and profit. Additional contractor costs connected with subcontract management could also be avoided because the prime contractor charged those costs directly to the prime contract rather than indirectly through the material overhead cost pools in the contractor's accounting system.

While we recognize costs may be added for Government contracting and technical personnel, those costs should be evaluated and compared to the potential benefits from component breakout.

* Proprietary data removed.

Conclusion

Breakout of the SCDL Ground Data Terminal and providing five Government-owned, used Boeing 707-300 series aircraft to the prime contractor will allow the Government to reduce costs through component breakout. However, the Air Force will not achieve additional benefits from component breakout unless the Air Force completes a comprehensive component breakout review. The designs and the manufacturing processes for the nine components will be sufficiently stable by the FY 1995 production and long-lead buys to enable the Joint Program Office to achieve substantial reductions in costs through component breakout.

Recommendations, Management Comments, and Audit Response

We recommend that the Program Director, Joint Surveillance Target Attack Radar System Joint Program Office:

1. Complete a comprehensive component breakout review for the nine components with an annual acquisition cost of at least $1 million to support the Joint Surveillance Target Attack Radar System FY 1995 acquisition strategy in accordance with Defense Federal Acquisition Regulation Supplement, Appendix D, "Component Breakout."

Air Force Comments. The Air Force partially concurred, stating that the Joint Program Office will complete a comprehensive component breakout review before the Joint STARS full-rate production decision planned for 4th Quarter of FY 1995. The comprehensive component breakout review will be completed in calendar year 1994.

2. Break out components if the breakout review shows that breakout will result in net savings.

Air Force Comments. The Air Force partially concurred, stating that all major components, including the components listed in the draft audit report, will be reviewed as part of the comprehensive component breakout review to be completed in calendar year 1994. The Air Force stated that the Joint Program Office will use the results of the review in developing the Joint STARS acquisition strategy in support of the 4th Quarter of FY 1995 full-rate production decision. The Air Force stated that component breakout was not considered practical and feasible during FY 1995 because the Government's best interest was to have the prime contractor retain total systems responsibility through the LRIP phase of the acquisition process. Air Force's detailed response is in Part IV of this report.

Audit Response. We consider the Air Force comments to be responsive to the intent of the recommendation. The comments were considered responsive because the Under Secretary of Defense for Acquisition and Technology endorsed the Air Force's position that the Government's best interest is to have the prime contractor retain total systems responsibility through the LRIP phase of the acquisition process. However, we still maintain that the results of our review clearly showed that technical and schedule risk is minimal with breaking out the nine components in support of the FY 1995 acquisition strategy for Joint STARS production and long-lead buys.

In response to the final report, we request that the Air Force indicate that it will provide the Office of the Inspector General, DoD, a copy of the Joint STARS comprehensive component breakout review identifying the potential monetary benefits that will be achieved through component breakout.

Management Comments on the Finding. In Appendix J, we provide audit responses to specific management comments to the draft report pertaining to the content of the four audit findings.

Finding B. Aircraft Refurbishment and Modification

The Joint Program Office did not provide for full and open competition for refurbishing and modifying Joint STARS production aircraft. This condition occurred because the Joint Program Office accepted the results of Grumman Melbourne Systems Division's (the prime contractor) June 1990 make-or-buy analysis that did not consider competitive bids from other aircraft refurbishment and modification providers. The Air Force may miss an opportunity to reduce costs an estimated $67.0 million over the Future Years Defense Program (FYs 1994 through 1999) by not competing the acquisition of aircraft refurbishment and modification work beginning with the sixth production aircraft.

Background

Refurbishment and Modification. Refurbishment and modification is the process whereby a used aircraft is overhauled and changed to meet the user's needs. Aircraft refurbishment involves corrosion control, engine overhaul, incorporation of work required by Federal Aviation Administration life-extension service bulletins and air-worthiness directives, and repairing and replacing aircraft components. Modification tasks vary depending on the user's needs. Joint STARS modification involves installation of racks, consoles, pallets, wiring, cabling, brackets, panels, assemblies, and other changes needed to bring a refurbished Boeing 707-300 series aircraft to the Joint STARS configuration.

Competition Requirement. Title 10, United States Code, "Competition in Contracting Act," section 2304, requires full and open competition in soliciting offers and awarding Government contracts. Federal Acquisition Regulation, Part 6, "Competition Requirements," prescribes policy and procedures to promote full and open competition in the acquisition process. "Full and open competition," when used in respect to a contract action, means that all potential sources are permitted to compete. Contracting without full and open competition is permitted under certain circumstances, such as the availability of only one source to perform the work and unusual and compelling urgency for the needed supplies or services.

Prior Review. The Air Force Audit Agency issued Auxiliary Report No. 063-1-1, "Acquisition Management of the Joint Surveillance Target

Attack Radar System," November 9, 1990. The report stated that the Joint STARS acquisition strategy did not consider cost savings possible through competitive procurement of the Joint STARS aircraft refurbishment and modification work. The report recommended that the Air Force evaluate competitive procurement of aircraft refurbishment and modification beginning with the fourth production aircraft. It also recommended that the Joint Program Office analyze technical data availability, technical risks, and other competition-limiting factors. Although the Assistant Secretary of the Air Force (Acquisition) concurred with the recommendation, the only action taken by the Joint Program Office was to state in the February 1993 Integrated Program Summary that competition of prime and subsystem segments would be possible during production due to the availability of level-three technical data packages.

Full and Open Competition

The Joint Program Office did not plan to provide for full and open competition for refurbishing and modifying Joint STARS production aircraft. The Joint Program Office accepted the results of the prime contractor's June 1990 make-or-buy analysis. Also, the acquisition plan in support of the Follow-on EMD program decision stated that award of a separate contract for aircraft refurbishment and modification would introduce legal and technical problems between two different contractors, which could result in each contractor blaming the other for total system performance problems.

Make-or-Buy Analysis. The Joint Program Office accepted the prime contractor's make-or-buy analysis, which allowed the prime contractor to refurbish and modify the third EMD aircraft and four additional aircraft during LRIP. However, the prime contractor's make-or-buy analysis did not consider competitive bids from other aircraft refurbishment and modification providers.

Specifically, the prime contractor's analysis compared its estimated costs at a plant in St. Augustine, Florida, with Boeing's May 1988 proposal to refurbish and modify the third EMD aircraft[3]. This comparison showed that it was more cost-effective for Grumman to refurbish and modify the third aircraft. However, we question the validity of this comparison because Boeing's bid was more than 2 years old and the prime contractor did not obtain competitive bids and quotes from other contractors capable of refurbishing and modifying Boeing 700-300 series aircraft.

In-house Cost Analysis. In June 1990, the prime contractor performed an in-house cost analysis to compare the costs and advantages of refurbishing and modifying the Joint STARS aircraft at facilities in Lake Charles, Louisiana; Melbourne, Florida; and St. Augustine, Florida. Based on its comparison, Grumman moved its aircraft refurbishing and modifying effort for the Joint

[3]Boeing Military Airplane Company refurbished and modified the first two Joint STARS EMD aircraft.

STARS program to Lake Charles. In November 1991, Grumman signed a 5-year lease for the facilities at Lake Charles, Louisiana, with four 5-year options to extend the lease up to an additional 20 years.

In April 1992, the prime contractor received Air Force approval to refurbish and modify the first two production aircraft in-house at the Lake Charles facility when the Joint STARS advanced procurement contract was awarded. In June 1993, the Air Force extended this approval to production aircraft three and four when the follow-on advanced procurement contract was awarded.

Total Systems Integration Performance Responsibility. We do not believe that the Joint Program Office's ability to hold the prime contractor accountable for total system integration and performance responsibility will be adversely affected if a separate contract is awarded for Joint STARS aircraft refurbishment and modification work. Our opinion is based on the fact that under the EMD contract for the first two E-8A aircraft, the prime contractor maintained total system integration and performance responsibility even though the aircraft refurbishment and modification work was subcontracted to Boeing Military Airplane Company. Further, the Joint Program Office has recognized that the aircraft refurbishment and modification is low risk and has so stated in the acquisition plan that supported aircraft buys for Follow-on EMD and LRIP.

Competition Feasibility

Joint STARS aircraft refurbishment and modification work beginning with procurement of the sixth production aircraft can be competitively procured. Our conclusion is based on the following considerations.

Other Sources. We identified five firms other than Boeing and Grumman that have the interest, expertise, experience, and facilities needed to refurbish and modify Boeing 707-300 series aircraft for the Joint STARS program. The five firms are AERO, Chrysler Technologies Airborne Systems, E-Systems, Lockheed Aircraft Service Company, and PEMCO Aeroplex.

Technical Data. The prime contractor and the Defense Plant Representative Office, Grumman Florida, stated that the documentation needed by another contractor to refurbish and modify used Boeing 707-300 series aircraft for Joint STARS production systems became available in March 1994.

Schedule. Competing refurbishment and modification work for the sixth and subsequent production aircraft will not impact the Air Force's ability to maintain the Joint STARS aircraft production schedule. The Joint STARS Procurement Contracting Officer estimated that procurement lead time to compete the refurbishment and modification effort is 1 year. Long-lead procurement for the sixth production aircraft is scheduled to begin in January 1995. Accordingly, the Air Force has time to compete the refurbishment and modification efforts for the sixth and later Joint STARS production aircraft.

Technical Risk. Competing the sixth and later production aircraft refurbishment and modification should not significantly increase technical risk. The Joint Program Office has recognized that aircraft refurbishment and modification is low risk. Grumman maintained total system integration and performance responsibility for the E-8A EMD systems while subcontracting for aircraft refurbishment and modification work.

Lease Commitment. Grumman is only committed to leasing the Lake Charles, Louisiana, facility through production of the fifth Joint STARS production aircraft scheduled for completion in March 1997. Accordingly, the Joint Program Office would not be liable for additional lease expenses of the Lake Charles facility if another contractor was awarded the contract to refurbish and modify the seventh and later Joint STARS production aircraft.

Benefits from Competition

The estimated cost to refurbish and modify 10 Joint STARS aircraft during Future Years Defense Program (FYs 1994 through 1999) starting with the sixth production aircraft is $267.9 million. Based upon a 25-percent[4] rule of thumb used by the Air Force Competition Advocate, the Joint Program Office could reduce costs $67.0 million (25 percent of $267.9 million) during the Future Years Defense Program (FYs 1994 through 1999) by competing the refurbishing and modifying effort for the sixth and later Joint STARS production aircraft. Our estimate does not consider costs related to future modification of EMD aircraft to the Joint STARS production configuration.

Conclusion

Competition of the Joint STARS aircraft refurbishment and modification could provide significant savings without significant technical or schedule risk. The Government has no assurance that it is receiving the best price for this work until the Joint Program Office obtains full and open competition for the Joint STARS aircraft refurbishing and modifying effort.

[4]The Air Force Competition Advocate said that actual benefits could vary and that the 25-percent factor should be used as a careful rule of thumb. Senate Report No. 98-50, "Competition in Contracting Act of 1983," March 24, 1983, stated that studies showed that between 15 percent and 50 percent can be saved through increased competition. The 25-percent factor is in the conservative end of this range.

Recommendation, Management Comments, and Audit Response

We recommend that the Program Director, Joint Surveillance Target Attack Radar System Joint Program Office, direct the Prime Contractor to award contracts for the refurbishment and modification of the sixth and later Joint Surveillance Target Attack Radar System production aircraft based upon evaluation of proposals from all potential industry sources.

Air Force Comments. The Air Force nonconcurred, stating that using another contractor to refurbish and modify Boeing 707 aircraft introduces unacceptably high technical and costs risks and that too few aircraft remain to be refurbished and modified after Grumman is contractually required to submit a complete drawing package in the 3rd Quarter of FY 1997.

The Air Force stated that all Boeing 707 aircraft are not alike because different series of the Boeing 707 aircraft exist and are being purchased for the Joint STARS program. The different airframe versions force Grumman to maintain a "running" redesign of aircraft modifications to accommodate the Joint STARS prime mission equipment. As a result, Grumman has to continually update different airframe drawing packages, thereby eliminating Grumman's ability to provide a complete drawing package to industry for competition. Also, the Air Force emphasized that Grumman was the most experienced contractor for modifying used Boeing 707 airframes and that using another airframe refurbishment company would court disaster due to cost and technical risks.

Also, the Air Force stated that the opportunity for competing aircraft refurbishment and modification comes too late in the program to be beneficial to the Government. Specifically, the Air Force stated that Grumman was not contractually required to submit the drawing package to the Government until the 3rd Quarter of FY 1997. At that point, only five aircraft would remain to be refurbished and modified, including the two EMD aircraft that previously received initial refurbishment and modification. Accordingly, the Air Force did not believe that it would be cost-effective to compete aircraft refurbishment and modification unless Congress increased the planned Joint STARS aircraft requirements.

Based on the above, the Air Force disagreed with the potential cost savings of $67 million claimed in the report. The Air Force's detailed response is provided in Part IV of this report.

Audit Response. Technical and cost risks for Boeing 707 aircraft refurbishment and modification are not high and Grumman expected to have a complete drawing package available by January 1994. Therefore, we still maintain that aircraft refurbishment and modification for Joint STARS can be competed beginning with the sixth Joint STARS aircraft. Our rationale follows.

o In the Joint STARS acquisition plan, the Joint Program Office recognized that aircraft refurbishment and modification is low risk. We agree that refurbishing and modifying different series of the Boeing 707 aircraft will

require a continuous redesign of airframe modifications and an update of drawing packages. However, this requirement is for Grumman or any other qualified contractor who performs the aircraft refurbishment and modification effort. Grumman proved that it is feasible to subcontract the aircraft refurbishment and modification work during EMD. As stated in our report, Grumman maintained total systems integration and performance responsibility for the first two EMD aircraft even though the aircraft refurbishment and modification work was subcontracted to Boeing Military Airplane Company. In addition to Boeing Military Airplane Company, the report identified five other firms that also have the necessary experience, facilities, and expertise to do the work.

o Grumman Melbourne Systems Division and the Defense Plant Representative Office stated that documentation needed to compete aircraft refurbishment and modification would be available by January 1994. Terms of the third EMD aircraft contract allow the contracting officer to direct delivery of the complete technical data package when available. Delivery of the technical data package in the 2nd Quarter of FY 1994 gives Grumman sufficient time to compete the sixth and later Joint STARS production aircraft. Therefore, we do not agree that the Air Force should wait until Congress increases the Joint STARS procurement buy before considering competition for the aircraft refurbishment and modification work.

The cost savings of $67 million is an estimate based upon information supplied by the Air Force competition advocate. However, the Government will have no assurance that it is receiving the best price for Joint STARS aircraft refurbishment and modification until Grumman solicits competitive contractor proposals.

In view of Air Force concerns over Grumman maintaining total systems integration and performance responsibility for the Joint STARS aircraft, we clarified Recommendation B. to require Grumman, instead of the Air Force, to compete the aircraft refurbishment and modification work. Accordingly, we request that the Air Force reconsider its position on the recommendation and the potential monetary benefits in response to the final report.

Finding C. Aircraft Mission-Critical System Software

The Joint Program Office has not initiated a plan to transition Joint STARS aircraft mission-critical system software into Ada software programming language before the aircraft initial operational capability date, March 1997. This condition was caused by the Joint Program Office not actively seeking Headquarters, Air Force, approval of an Ada transition plan. Because of this inaction, the Joint Program Office did not require the prime contractor to use Ada in the November 1990 Follow-on EMD contract for developing the baseline software configuration for Joint STARS production aircraft. As a result of using non-Ada software programming languages, Joint STARS aircraft life-cycle software maintenance costs may be as much as 30 percent higher than if the software is transitioned to Ada for use on the operational Joint STARS aircraft.

Background

Ada Software Programming Language. DoD established Ada as its standard software programming language in 1980. Ada is a higher-order computer programming language developed by the DoD for large system's development and maintenance. Ada programming language was designed to lower software development and maintenance costs and increase software quality. Although the Ada programming language may require more time to initially write than other software languages, Ada's rigorous software engineering approach to the development results in reduced software maintenance effort and cost. A study by TRW Incorporated showed a 30-percent savings in software maintenance costs when using Ada programming language instead of C++ software (a higher order language). The study compared development and maintenance support costs for a typical command, control, and communications system.

Public Law. Public Law 101-511, "Department of Defense Appropriations Act, 1991," Section 8092, November 5, 1990, states that, where cost-effective, all DoD software will be written in the Ada programming language unless specifically exempted by an official designated by the Secretary of Defense. In December 1991, the Deputy Secretary of Defense authorized the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) (C^3I) to serve as the official to grant special exemptions related to using Ada. In April 1992, this authority was redelegated to the Director, Defense Research and Engineering, for weapon systems development and logistics support.

DoD Policy. On June 10, 1983, the Under Secretary of Defense for Research and Engineering (now Under Secretary of Defense for Acquisition and Technology) issued the Military Departments "Interim DoD Policy on Computer Programming Languages." The interim DoD policy requested that the Ada programming language be the single, common, computer programming language for Defense mission-critical applications for all weapon systems. This policy applies to programs entering full-scale engineering development on and after July 1, 1984. The interim DoD policy was incorporated in DoD Directive 3405.1, "Computer Programming Language Policy," on April 2, 1987, and DoD Directive 3405.2, "Use of Ada in Weapon Systems," March 30, 1987. DoD Directive 3405.2 was subsequently replaced by DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures," February 23, 1991.

Air Force Policy. In August 1990, the Deputy Assistant Secretary (Communications, Computers, and Logistics) issued an action memorandum, "Air Force Policy on Programming Languages." The Air Force policy established Ada as the single implementation language for development of weapon systems. In January 1993, the Air Force policy was revised to clarify the requirement to convert to Ada if more than one-third of the subsystem or system software is modified. The revision states that for existing weapon systems, the Air Force policy requires the use of Ada when changes are planned or projected over 6 years and affect more than one-third of the existing code for an individual computer software configuration item, a subsystem, or the system. The Air Force policy stressed that Ada is a proven technology that facilitates software engineering and reduces program risk and life-cycle costs.

In July 1991, the Office of the Deputy Assistant Secretary of Air Force (Communications, Computers, and Logistics) issued an "Ada and C++ Business Case Analysis" report, which consisted of four substudies (including the TRW Incorporated study) that analyzed the life cycle cost-effectiveness of Ada versus C++, a C version higher order language. The purpose of the analysis was to determine when a waiver to DoD's Ada requirement is warranted. The report concluded that no compelling reasons exist to waive the Ada requirement to use C++. Also, the report concluded that even though the analysis was directed at information systems and command, control, and communications systems, no reason justifies a belief that the results would differ for computer programs embedded in weapon systems.

Software Language Waiver Requests. In July 1985, the Joint STARS Program Office requested a waiver to use the FORTRAN programming language instead of Ada for the radar, communications, utility, and diagnostic subsystems of the Joint STARS EMD aircraft program. The Air Force Deputy Assistant Chief of Staff (Information Systems) approved the waiver request in September 1985 and directed the Joint Program Office to continue its plans for

transitioning to Ada during Block II (phase II[5]). The Joint Program Office was also required to submit an Ada implementation plan and the life-cycle costs for consideration during the production program approval process by February 1987.

In 1986, the Joint Program Office requested a waiver to use FORTRAN programming language instead of Ada for the operations and control subsystem of the aircraft. The Office of the Air Force Deputy Chief of Staff, Command, Control, Communications and Computers, approved the waiver request in December 1986. This waiver approval document also specified that approval was contingent on the Joint Program Office budgeting necessary funds for implementation of Ada in the Joint STARS production phase.

On January 13, 1993, the Air Force Program Executive Officer for the Joint STARS program requested an exception to use C programming language rather than Ada for the advanced technology work station on the Follow-on EMD aircraft. The Air Force Deputy Assistant Secretary (Communications, Computers, and Logistics) denied the exception request on January 28, 1993, because no technical basis existed for an exception to using Ada. However, because of the program status, the Deputy Assistant Secretary authorized the Joint Program Office to proceed to flight test with the current C language implementation as a working prototype with the qualification that the software must be rewritten in Ada before the initial operational capability date. Further, the Deputy Assistant Secretary stated that the Joint STARS 1985 and 1986 Ada language waivers were not applicable to the Joint STARS EMD Follow-On Program. The C programming language is not an approved DoD programming language and was not authorized in the Follow-on EMD contract.

Magnitude of Aircraft Software. The EMD aircraft mission-critical system software consists of about 870,000 lines of code. The Follow-On EMD aircraft mission-critical systems software is being produced in three configuration modules. The three modules will consist of about 600,000 lines of code, of which 400,000 lines of code are being transferred from the EMD aircraft and 200,000 lines are new or modified software code.

Ada Implementation

The Joint Program Office has not initiated a plan to transition the software code for the mission-critical systems, including the advanced technology work station, into Ada before the Joint STARS aircraft initial operational capability date, March 1997. This condition resulted in the Joint Program Office not complying with conditions in Air Force Ada software language waivers issued in September 1985, December 1986, and January 1993.

[5]Phase II is the production phase, according to the May 27, 1983, Joint STARS Acquisition Plan.

During our review, we requested a copy of the Ada transition plan, but the Joint Program Office stated that it did not have an Ada transition plan. The Joint Program Office indicated that in 1987 an Ada transition plan was submitted to Headquarters, Air Force, for approval but Headquarters did not take action. Since 1987, the Joint Program Office has not prepared an Ada transition plan. As a result of this inaction, the November 1990 Follow-On EMD contract permitted the prime contractor to use Ada as well as non-Ada (FORTRAN and JOVIAL) programming languages in the software development.

The temporary waivers granted in 1985 and 1986 allowing the use of FORTRAN programming language instead of Ada were justified because of the lack of Ada software compilers and tool sets needed for the development of Ada software. However, validated Ada compilers were available at the time. At the present, 49 companies sponsor 574 validated Ada software compilers. The Joint Program Office is no longer justified in not requiring the prime contractor to implement Ada by the aircraft initial operational capability date, March 1997. Cost and schedule impacts to the Joint STARS program will require the Acquisition Program Baseline to be revised.

We concluded that the benefits of the Joint Program Office transitioning to Ada programming language before the aircraft initial operational capability date far outweigh the cost and schedule impacts. The specific benefit of using Ada in Joint STARS production aircraft is that life-cycle software maintenance costs may be reduced by as much as 30 percent by using Ada versus using multiple non-Ada programming languages presently being developed on the E-8C program.

Recommendations, Management Comments, and Audit Response

1. We recommend the Assistant Secretary of the Air Force (Acquisition):

a. Require the Joint Surveillance Target Attack Radar System Joint Program Office to provide an Ada transition plan for Joint Surveillance Target Attack Radar System aircraft mission-critical system software and to implement the plan before the aircraft initial operational capability, March 1997.

Air Force Comments. The Office of the Assistant Secretary of the Air Force (Acquisition) partially concurred, stating that the Joint Program Office will present an Ada transition plan to higher Air Force Headquarters in the 2nd Quarter of FY 1994.

Although comments were not solicited, the Offices of the Under Secretary of Defense for Acquisition and Technology and the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) commented on Recommendation C.1.a.

Office of the Under Secretary of Defense for Acquisition and Technology Comments. The Director for Tactical Warfare Programs was concerned that the recommended direction may have serious program cost and schedule consequences. The Director stated that the results of an analysis of the cost-effectiveness and the program impact of transitioning to the Ada programming language should be considered before directing a conversion to Ada before March 1997.

Office of the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) Comments. The Deputy Assistant Secretary of Defense (Information Management) stated that the Joint Program Office has had sufficient opportunity to show any lack of cost-effectiveness and has failed to do so over the past 6 years, in spite of specific previous direction to produce Ada transition plans. Further, the Deputy Assistant Secretary stated that the Joint Program Office awarded the follow-on contract in November 1990 that failed to comply with specific Air Force direction and DoD Ada policy.

The Deputy Assistant Secretary stated that DoD Ada policy requires that unique software developed and maintained by or for the DoD be written in the Ada programming language but does not require commercial off-the-shelf software to be written in or converted to Ada. In conclusion, the Deputy Assistant Secretary stated that the Joint Program Office should be directed to convert all non-commercial off-the-shelf software to Ada to comply with DoD policy.

Audit Response. The Air Force comments were partially responsive to the intent of Recommendation C.1.a. In response to the final report, the Air Force needs to comment on when the Joint Program Office plans to implement the Ada transition plan.

We agree with the Director for Tactical Warfare Programs that the Joint STARS Ada transition plan should include an analysis of the cost-effectiveness and the program impact of transitioning to the Ada programming language. This analysis should be considered in deciding whether the Ada programming language is transitioned to before or after the aircraft initial operational capability in March 1997.

Also, we agree with the Deputy Assistant Secretary of Defense (Information Management) that the Joint Program Office should comply with DoD policy to convert all non-commercial off-the-shelf software to Ada.

b. Provide the Joint Surveillance Target Attack Radar System Joint Program Office the funds necessary to transition the Joint Surveillance Target Attack Radar System aircraft mission-critical system software to the Ada programming language.

Air Force Comments. The Office of the Assistant Secretary of the Air Force (Acquisition) nonconcurred, stating that a decision to transition aircraft mission-critical system software to the Ada programming language is dependent on the results of the cost-effectiveness analysis to be completed as part of the

Ada transition plan. For this reason, the Air Force believes it is premature to provide the Joint Program Office the funds necessary to transition the aircraft mission-critical system software to the Ada programming language. The Air Force's detailed response is in Part IV of this report.

Audit Response. We disagree that it is premature to begin providing the Joint Program Office funds necessary to transition the aircraft mission-critical system software to the Ada programming language. DoD Ada policy requires that the Joint Program Office convert all non-commercial off-the-shelf software to Ada. Regardless of when the Joint Program Office transitions to the Ada programming language, before or after the aircraft initial operational capability in March 1997, the Air Force needs to begin programming the funds necessary to enable the transition. The Air Force's attainment of the greatest reductions in software life-cycle costs is dependent on the Air Force funding and transitioning to the Ada Programming language as soon as possible.

We request that the Air Force reconsider its nonconcurrence and comment again on this recommendation in response to the final report.

2. We recommend the Program Director, Joint Surveillance Target Attack Radar System Joint Program Office:

a. Modify the Follow-On Engineering and Manufacturing Development contract with Grumman Melbourne Systems Division to accommodate the Ada transition plan established in response to Recommendation C.1.a.

Air Force Comments. The Air Force nonconcurred, stating that contract modifications would be premature until a Joint Program Office Ada transition plan is approved and adequate funding is provided.

Audit Response. We agree that contract modifications should be deferred until the Joint Program Office Ada transition plan is approved and adequate program funding is provided for the Ada transition. However, it is not premature for the Joint Program Office to begin planning contract actions necessary to implement the Ada transition plan being developed.

We request that the Air Force reconsider its nonconcurrence and comment again on this recommendation in response to the final report.

b. Update the Acquisition Program Baseline for Defense Acquisition Executive approval to show cost and schedule impacts caused by the transition of the mission-critical systems software to Ada in accordance with Recommendation C.1.a.

Air Force Comments. The Air Force did not comment on the recommendation.

Although comments were not solicited, the Director for Tactical Warfare Programs advised that the Joint STARS Program Director is not authorized to update the Acquisition Program Baseline as recommended in the draft report but can only recommend revisions for approval by the Defense Acquisition Executive.

Audit Response. We revised Recommendation C.2.b. as suggested by the Director for Tactical Warfare Programs. We request that the Air Force provide written comments on the revised Recommendation C.2.b. in response to the final report.

Finding D. Light Ground Station Module Survivability

The Army established nuclear, biological, and chemical (NBC) contamination survivability[6] requirements for the Joint STARS Light Ground Station Module that were insufficient for the effective operation of this mission-essential equipment[7]. This condition was caused by the Army's reducing its Light Ground Station Module system's equipment survivability requirements and the system's vehicle and shelter payload weight limitations. As a result of payload limitations, the NBC overpressure protection system was not installed in the Light GSM, requiring the crew to operate in Mission-Oriented Protective Posture (MOPP)[8] gear on the battlefield. This gear will cause the crew to experience an estimated 45-percent degradation in their ability to process and disseminate radar and intelligence information to Army command, control, communications, and intelligence systems.

Background

Shelter and Vehicle. The Light GSM includes nondevelopmental equipment from the Medium GSM configuration plus other mission-essential equipment to satisfy mission requirements. The equipment is housed in two Lightweight Multipurpose Shelters (Light Shelter) mounted on two heavy High Mobility Multipurpose Wheeled Vehicles (HMMWVs) variants. The Light Shelter is a multipurpose, rigid-wall shelter similar to the Standard Integrated Command Post Rigid-Wall Shelter. The Light Shelter has a rated capacity of a 3,300-pound payload, and the Heavy HMMWV has a rated capacity of 4,401 pounds maximum payload to carry the shelter, crew, and equipment.

The Army Joint STARS Project Office cannot exceed the Light GSM shelter and vehicle weight limits because of safety concerns and increased equipment maintenance costs. Department of Army message R281430Z, "Light and Medium Tactical Wheeled Vehicle Shelter Payloads," July 1992, stated that waivers for overloaded shelters and vehicles will no longer be granted;

[6]Survivability is the capability to use the equipment after a conventional or NBC weapon(s) attack or both.

[7]Mission-essential equipment are those items necessary to accomplish missions.

[8]Mission-Oriented Protective Posture (MOPP) gear includes gas mask, hooded suit, overboots, and gloves.

vehicle load limits will dictate the allowable shelter weight; and shelters will not be loaded beyond their maximum gross weight even if the overloaded shelter does not exceed the vehicle maximum weight.

DoD Survivability Criteria. DoD Instruction 5000.2, "Defense Acquisition," Part 6, Section F, "Survivability," February 23, 1991, requires that weapon system's hardware design for nuclear, biological, and chemical contamination permit effective use of the system by people in full MOPP gear. The Instruction also requires that mission-critical electronic equipment expected to operate in a nuclear threat environment be survivable to high-altitude electromagnetic pulse (HAEMP)[9].

Army Survivability Criteria. Army Regulation 70-71, "Nuclear, Biological and Chemical Contamination Survivability of Army Materiel," May 1, 1984, requires that mission-essential equipment be survivable against NBC contamination, decontaminates, and the procedures to decontaminate equipment. Also, Army Regulation 70-60, "Nuclear Survivability of Army Materiel," November 1, 1984, requires that all Army mission-essential materiel be survivable against nuclear weapons effects.

Joint Systems Operational Requirements Document. The Joint STARS Joint System Operational Requirements Document (JSORD), February 19, 1993, and prior versions state that the GSM variants (light, medium, and heavy) are mission-essential and are required to operate in a NBC environment. For NBC contamination survivability, the JSORD requires that GSM shelters be painted with chemical agent-resistant, nontoxic paint and designed to maintain positive overpressure for collective protection or be operated by personnel in individual NBC protective clothing.

Ground Station Module Required Operational Capability (ROC) Document. The Army's GSM ROC, November 18, 1992, requires the GSM variants to be designed in accordance with NBC contamination and nuclear survivability system requirements that are compatible with those of the supported unit's vehicles and shelters. For the Light GSM, the ROC specifies that the system:

- o protection levels be provided by the shelter;
- o be designed to accept NBC protection systems; and
- o be hardened against electromagnetic environmental effects (E^3)[10].

The Army stated that the ROC did not require the Light GSM to have a NBC overpressure protection system because equipment operators would be provided MOPP gear equal to the NBC contamination protection provided to the

[9]A large electrical pulse created by high-energy electrons released by the nuclear explosion (high or low altitude), colliding with air and ground molecules.

[10]All electrical radiation made and emitted ranging from the lowest alternating current to the highest radio frequency.

supported Army light forces. Also, the ROC did not include a requirement for HAEMP hardness. In contrast, the ROC requires that the Medium and Heavy GSM variants have NBC contamination overpressure systems and HAEMP hardening.

In the GSM ROC, the Army stated that the GSM variants are required to operate on-the-move to maintain mission continuity with the forces being supported. The GSM on-the-move concept of operations required crew operators to receive, analyze, and disseminate Joint STARS radar information received from a Joint STARS aircraft. The Light GSM then disseminated the processed radar target data to the supporting forces via voice communication transmission.

Shelter Requirements. The Army's Lightweight Multipurpose Shelter ROC, July 3, 1991, required the shelter to be NBC-contamination survivable. The ROC did not require the shelter to have a NBC overpressure protection system and HAEMP protection. However, Military Standard 44408A(GL), "Shelter, Non-Expandable, Rigid Wall," March 12, 1991, required the shelter to provide 60 decibels of shielding to protect the equipment against E^3.

Survivability Requirements

NBC contamination and HAEMP survivability system requirements for the Light GSM were insufficient for the effective operation of mission-essential equipment. For the Light GSM engineering and development contract, the specification required HAEMP hardness protection for mission-essential equipment but gave no requirement to protect the equipment from NBC contamination. The Light GSM system relied on the Light Shelter's shielding to provide protection of mission-essential equipment inside the shelter from E^3 and HAEMP effects.

Nuclear Survivability Requirements. Nuclear survivability requirements are insufficient because the shelter's E^3 shielding will only provide partial protection for the equipment from HAEMP effects. Because electrical characteristics of HAEMP have a wider range and higher power levels than 60 decibels of E^3, the shelter's shielding will only provide the Light GSM electrical equipment partial HAEMP protection.

NBC Contamination Survivability Requirements. NBC contamination survivability requirements are also insufficient because the crew operators' performance will be degraded by more than 15 percent in a NBC environment without contamination overpressure protection equipment. The U.S. Army Materiel System Analysis Agency report, "Joint STARS, Block I Medium GSM, Interim Independent Evaluation Report," April 9, 1993, stated that a soldier operating Medium GSM mission-essential equipment in partial MOPP gear (gas mask and gloves) experienced a 45-percent degradation in performance of tasks below levels specified for mission-essential tasks in a non-NBC environment over a 24-hour scenario. Since the Light and Medium

GSM's mission and equipment are similar, Light GSM crew operators will experience at least the same or worse levels of degradation of operational performance when using MOPP gear because of the Light GSM's downsized mission-essential equipment and the shelter's smaller interior.

Also, the Light GSM equipment, including computers, printers, radios, and data link terminals, will be contaminated when exposed to chemical and biological contaminants. The Army will not be able to decontaminate the equipment inside the shelter and recover the use of the Light GSM. This condition will further increase the difficulty for operators to efficiently perform Light GSM mission operations and maintenance tasks in MOPP gear. Accordingly, the Army's planned use of MOPP gear to protect Light GSM operators from NBC contamination will degrade mission performance and will not meet performance criteria in the Deputy Chief of Staff for Operations and Plans memorandum, "NBC Contamination Survivability Criteria for Army Materiel," October 1991. The Deputy Chief of Staff for Operations and Plans memorandum requires that operator performance, when operating in MOPP gear, not be degraded more than 15 percent below levels specified for mission-essential tasks in a non-NBC environment over a typical 12-hour mission.

The contract for the Light Shelter provided for the contractor to design interior shelter locations to house NBC contamination overpressure protection equipment and external chemical agent resistive coating. However, the Army did not plan to install the overpressure protection equipment because the NBC overpressure protection equipment is not required by the ROC and it is additional weight to the shelter payload.

Reduced Equipment Survivability Requirements

The Army reduced the Light GSM system's nuclear and NBC materiel contamination and decontamination survivability requirements in the GSM ROC, November 19, 1992, because of Army operational requirements and vehicle and shelter payload limitations. The Light GSM's integration of mission-essential equipment has resulted in Heavy HMMWV and Light Shelter weight payload problems. The Light Shelter is being used because it is an empty shell structure with no preinstalled wiring, equipment racks, work stations, or NBC equipment. The shelter configuration minimizes the shelter's weight (600 pounds) to allow about 2700 pounds for the crew and equipment payload.

The reduced Light GSM survivability requirements did not eliminate vehicle and shelter weight problems as demonstrated by contractor difficulties in meeting vehicle and shelter payload limitations. The contractor's June 1993 weight and balance report understated the extent of the weight difficulties by not applying crew weight standards established in Military Standard 910, "Mobile Tactical Systems Overload Prevention Procedures," February 16, 1990. In computing the vehicle and shelter weight, the Military Standard requires that

crew weights of 566 pounds and 1,080 pounds be applied for crews of two and four persons, respectively. The Military Standard crew weights include the individual's weight, clothing, food, weapon, and ammunition.

Heavy HMMWV Weight. The Heavy HMMWV variant has a rated capacity of 10,001-pounds maximum gross weight. The Heavy HMMWV variant has a rated capacity of 4,401 pounds to carry the Light GSM shelter, crew, and equipment. In June 1993, the prime contractor reported that the mission vehicle payload totaled 4,393 pounds and the support vehicle payload totaled 4,348 pounds, both within the vehicle's rated payload capacity. However, the contractor incorrectly applied a crew weight of 504 pounds instead of 566 pounds for the two-person crew on the mission vehicle and a crew weight of 1,008 pounds instead of 1,080 pounds for the four-person crew on the support vehicle. As a result, we computed that the mission vehicle payload was overloaded by 54 pounds and the support vehicle payload was overloaded by 19 pounds.

Light Shelter Weight. The Light Shelter configuration weighs about 600 pounds when empty and has a rated capacity of a 3,300-pound payload. In June 1993, the prime contractor reported that the equipment configuration has caused the mission vehicle shelter payload to be overloaded by 569 pounds (3,869 pounds) and the support vehicle shelter payload to be overloaded by 567 pounds (3,867 pounds). However, the contractor incorrectly applied a crew weight of 504 pounds instead of 540 pounds for the two-person crew of the support vehicle shelter. Therefore, the support vehicle shelter payload was actually overloaded by 603 pounds, not 567 pounds as the contractor reported. In an attempt to meet Light GSM's payload and mission requirements, the Army used the Heavy HMMWV with the Light Shelter.

Difficulties with the weight of the Heavy HMMWV has also caused the Army to alter its plans for satisfying the Light GSM on-the-move operations mission requirement. Initially, the Army planned on the crew operators performing mission requirements from inside the shelter while on-the-move. Because of Light Shelter weight limitations and safety concerns, the Army relocated the crew operator to the cab of the mission vehicle for on-the-move operations. As a result, the crew operator will be required to use a remote workstation (laptop computer) to perform the Light GSM mission while on-the-move. By making this change, the Army further reduced the equipment survivability and the crew operator's ability to efficiently perform mission functions in MOPP gear while on-the-move in NBC-contaminated and HAEMP environments.

Impact on Mission Requirements

Because of no shelter NBC overpressure system, it is expected during NBC operations that Light GSM crew operators performing in MOPP gear will experience about a 45-percent degradation in their ability to process and disseminate radar target information. The lack of a NBC overpressure system

will also result in the Army's not being able to decontaminate the electrical equipment, such as computer hardware, inside the shelter when exposed to biological and chemical contaminates.

Those operational degradations will impact the ability of the Light GSM to effectively interface with the Army's Tactical Command and Control System, Integrated Meteorological System, and Digital Topographic Support System, as required. Appendix H describes the missions of the three tactical command, control, communications and intelligence (C^3I) systems that will be affected by the inefficient operation of the Light GSM equipment. As shown in Appendix I, several systems have HAEMP and NBC-contamination and decontamination requirements that exceed the Light GSM ROC requirements for mission equipment. Although the Light GSM system may be exposed to the same threats as other Army's C^3I systems, the Light GSM equipment does not have NBC-contamination and HAEMP survivability requirements equivalent to the Army's other C^3I systems.

The Army has emphasized that NBC and nuclear survivability are critical elements for mission-essential tactical systems even though the former Soviet Union is now less of a nuclear threat. On October 2, 1992, the U.S. Army Deputy Chief of Staff for Operations and Plans issued a memorandum on "Nuclear and Chemical Survivability of Tactical Systems." The Deputy Chief of Staff stated that nuclear and chemical survivability of tactical systems continues to be a critical element in Army plans and that, as a minimum, HAEMP protection is required for mission-critical electronic equipment to preclude theater-wide loss.

Shelter Configuration Enhancements

Enhancements to the Light Shelter configuration are available that would improve survivability protection and add minimum payload and program costs. According to the Army's Natick Research, Development and Engineering Center (the Center), the NBC overpressure system could be installed on the Light Shelter with minimum modifications. The Center estimated that the modification would add about 100 pounds and cost approximately $12,000 per shelter. In addition, the U.S. Army Research Laboratory, Woodbridge, Virginia, determined that the Army's standard rigid-wall shelter HAEMP hardness capability can be enhanced with minimum modifications. The laboratory stated that the shelter's HAEMP hardness could be enhanced through the application of radio frequency interference gaskets for all shelter openings and special filters for ingress and egress of the shelter's electrical cables. The laboratory estimated that the modifications would add about 20 pounds and cost approximately $1,000 per shelter.

Recommendations, Management Comments, and Audit Response

1. We recommend that the Army Deputy Chief of Staff for Operations and Plans:

a. Require the performance of a modified cost and operational effectiveness analysis to determine whether the use of the High Mobility Multipurpose Wheeled Vehicle Heavy variant and the mounted Lightweight Multipurpose Shelter will satisfy the Light Ground Station Module mission and survivability requirements in the Joint Surveillance Target Attack Radar System Joint System Operational Requirements Document, February 19, 1993. If not satisfactory, identify and require appropriate vehicle and shelter alternatives in the Light Ground Station Module configuration.

Army Comments. The Army partially concurred, stating that the Army and Air Force are currently updating the Joint STARS COEA as directed by the Defense Acquisition Board in July 1993. The COEA will provide the analytical basis to support the Milestone III decision regarding the ground station modules.

Also, the Army stated that the Light GSM configuration was modified to reduce the mission weight of the HMMWV and provide increased NBC survivability protection. The new configuration includes a trailer-mounted generator towed behind the HMMWV and shelter. The trailer will provide power and allow mission equipment to be off-loaded from the vehicle, thereby reducing the system's weight below the HMMWV's gross weight limitation of 10,001 pounds.

Audit Response. The Army's response is considered responsive to the intent of the recommendation. However, the Army comments were not clear as to whether the off-loading of equipment to the trailer will meet the Light Shelter's gross payload limitations of 3,300 pounds or simply meet the HMMWV's gross weight limitation. When in operation, Light GSM equipment offloaded to the trailer will have to be reinstalled in the Light Shelter. Department of the Army message, R281430Z, "Light and Medium Tactical Wheeled Vehicle and Shelter Payloads," July 1992, requires that when a system's mission requires the use of a specific shelter and the system overloads the shelter, the system's weight must be decreased to meet the shelter's weight limitations.

In response to the final report, we request that the Army clarify whether off-loading equipment to the trailer will result in the Light Shelter, when loaded with GSM equipment, being in compliance with weight requirements in Department of the Army message, R281430Z.

b. Revise the Light Ground Station Module Required Operational Capability Document to require the shelter configuration to have a nuclear, biological, and chemical overpressure protection system and high-altitude

electromagnetic pulse hardness protection as required by Army Regulations 70-60, "Nuclear Survivability of Army Materiel," and 70-71, "Nuclear, Biological and Chemical Contamination Survivability of Army Materiel."

Army Comments. The Army partially concurred, stating that the GSM ROC will be converted to an Operational Requirements Document in 1995. The Operational Requirements Document will incorporate Light GSM shelter configuration changes, such as a NBC overpressure protection system and HAEMP hardness protection, as required by Army Regulations.

c. Revise the Lightweight Multipurpose Shelter Required Operational Capability Document to require high-altitude electromagnetic pulse hardness and nuclear, biological, and chemical overpressure protection system as required by Army Regulations 70-60, "Nuclear Survivability of Army Materiel" and 70-71 "Nuclear, Biological and Chemical Contamination Survivability of Army Materiel."

Army Comments. The Army nonconcurred, stating that the Light Shelter ROC does not need to be revised to include NBC or HAEMP hardening requirements because the Light Shelter configuration can be used to house other non-mission-essential equipment that do not require NBC and HAEMP hardness protection. The Army stated that the level of survivability for the Light Shelter should be tailored to meet mission requirements and addressed at the combat-developer level.

Audit Response. We disagree with the Army's stated position. The Army developed the Light Shelter as a standard configured tactical shelter to be mounted on a HMMWV to satisfy world-wide Army mission requirements. As a result, the Light Shelter configuration houses both essential and non-essential equipment, often simultaneously, in hostile and non-hostile operational environments.

We believe that it would be cost-effective for the Army to revise the Light Shelter ROC to include requirements for both a hardened and non-hardened shelter configuration. By not establishing separate hardened and non-hardened requirements for Light Shelters, Army combat developers are unnecessarily incurring redundant and expensive shelter development and testing costs to satisfy survivability requirements for their mission-essential equipment. Also, procurement organizations that support combat developers would be able to reduce the time and cost required to acquire hardened Light Shelters with the existence of updated drawing packages; satisfactory developmental and operational test results; and a fully developed integrated logistical support package, including the availability of technical manuals and spare parts.

In addition, establishing a requirement for both a hardened and non-hardened Light Shelter is not unique within the Army. Because of the cost benefits, the

Army's Shelter Manager at Natick Research, Development, and Engineering Center has established separate hardened and non-hardened requirements for electronic equipment shelters that are mounted on 5-ton trucks.

Accordingly, we request that the Army reconsider its position in response to the final report.

2. We recommend that the Army Joint Surveillance Target Attack Radar System Ground Station Module Project Manager:

a. Modify the design requirements in the Light Ground Module contract to incorporate the nuclear, biological, and chemical overpressure system in the Lightweight Multipurpose Shelter to comply with Army Regulation 70-71, "Nuclear, Biological and Chemical Contamination Survivability of Army Materiel."

Army Comments. The Army partially concurred, stating that the Light GSM design will be changed to include a NBC positive overpressure system and NBC detection and alarm systems. The Army stated that contract modifications to incorporate those configuration changes would be finalized by April 1994.

b. Modify the design requirements in the Light Ground Module contract to incorporate the high-altitude electromagnetic pulse hardness protection modification for the shelter identified by the Army Research Laboratory, Woodbridge, Virginia, to satisfy Army's survivability requirements in Army Regulation 70-60, "Nuclear Survivability of Army Materiel."

Army Comments. The Army partially concurred, stating that the requirement for HAEMP protection was in the Light GSM's contract modification in June 1993. Also, the Army stated that radio frequency shielding will be placed on the shelter cable harness, ingress and egress of electrical cables, and all other shelter openings. Army's detailed response is in Part IV of this report.

Part III - Additional Information

Appendix A. Description of Joint STARS Subsystems

The Joint STARS airborne system includes the aircraft and four other major subsystems described below.

Operations and Control Subsystem. The operations and control subsystem consists of data processing and operator workstations. This subsystem enables as many as 18 operators to control all airborne subsystems; manages exchange of radar sensor and intelligence data between the aircraft and all external elements; and displays radar imagery, target data, map and terrain features, and other tactical information.

Radar Subsystem. The radar subsystem is a side-looking air-to-ground radar with wide-area target surveillance. The radar can operate in multiple modes, including sector search, moving target classification, and synthetic aperture imagery. The radar can detect fixed and moving targets on the battlefield and behind enemy lines.

Communications Subsystem. The communications subsystem connects aircraft and Joint STARS ground station modules, using voice radio communications and digital data links. The surveillance and control data link is the secure, jam-resistant digital link that broadcasts Joint STARS' radar sensor data to Army ground station modules. The Joint Tactical Information Distribution System Class 2 terminal is used to exchange aircraft command and control information with Air Force air and ground elements.

Self-Defense Suite Subsystem. The self-defense suite subsystem consists of electronic combat and communications components that are either commercially available or already in DoD inventory. This subsystem enhances the aircraft's situation awareness and provides countermeasures against identified threats. However, the subsystem countermeasure capabilities were deferred to a preplanned product improvement as a result of budget reductions in the Fiscal Year 1994 Program Objectives Memorandum.

Appendix B. Description of Joint STARS Ground Station Module Variants

The Joint STARS Ground Station Module (GSM) program consists of six successive block configurations, described below.

Limited Procurement Urgent Configuration. The limited procurement urgent GSM receives and processes sensor data from the Mohawk radar system. The Army purchased the limited procurement urgent GSM to satisfy contingency requirements during the 1980s.

Interim Configuration. The Interim GSM receives and processes sensor data from the Joint STARS aircraft and Mohawk radar systems sequentially (one at a time). The Interim GSM is housed in an S-280 size shelter mounted on a standard Army 5-ton vehicle. The Interim GSM also includes another 5-ton vehicle and two standard Army 30,000-watts generators mounted on trailers.

Block I Medium Configuration. The Medium GSM receives and processes sensor data from the Joint STARS aircraft, the Mohawk, and Unmanned Aerial Vehicles, simultaneously. The Medium GSM also transmits information to the Joint STARS aircraft and other GSMs through the surveillance and control data link, interfaces with the Army's All Source Analysis System, provides color prints of the GSM display, and contains a shelter overpressure system for collective protection for NBC survivability. The Medium GSM is housed in an S-280 size shelter mounted on a standard Army 5-ton truck, which tows a standard 30,000-watts generator.

Block I Light Configuration. The Light GSM will have the same capabilities as the Medium GSM except that the Light GSM will not be able to interface with the Mohawk. The Light GSM will be able to receive, store, and display electronic intelligence data; display moving target indicator data on an electronic map; provide a satellite link of radar data between GSMs; and provide remote display terminals and a secure facsimile. The Light GSM will be housed in the Lightweight Multipurpose Shelter mounted on the Heavy high mobility multi-purpose wheeled vehicle (HMMWV).

Block I Heavy Configuration. In addition to the Light GSM capabilities, the Heavy GSM will have improved mobility; on-board power and cooling; and enhanced ballistic, nuclear, and NBC survivability. The Heavy GSM will be housed in a Bradley Fighting Vehicle System variant.

Block II Common Configuration. The Common GSM will contain enhanced tactical battlefield intelligence capabilities and provide a single intelligence ground station for Army commanders. The Common GSM will be mounted on the Heavy HMMWV and the Bradley Fighting Vehicle System.

Appendix C. Areas Not Requiring Further Review

We determined that additional audit work was not warranted for the following program management elements.

Reliability, Availability, and Maintainability Status. The Joint STARS Program had not progressed so that a meaningful review could be performed of reliability, availability, and maintainability data. However, the Air Force and Army Program Offices had established adequate controls for reliability, availability, and maintainability data collection and validation during the engineering and manufacturing development phase.

Configuration Control. The Joint Program Office did not perform subsystem and system functional and physical configuration audits or fully comply with military standard requirements when performing the system's critical design review for the E-8A test aircraft. The Joint Program Office plans to audit the physical configuration in May 1994. For the Follow-on EMD E-8C aircraft, the prime contractor performed the critical design review in accordance with military standards and the contract statement of work.

For the Medium GSM, the Army Program Office did not accept the initial physical configuration audit performed by Motorola. The Army Program Office is requiring Motorola to correct all discrepancies noted during the physical configuration audit and is performing another physical configuration audit of the Medium GSM as part of the low-rate initial production contract scheduled for FY 1994.

Testing. The update to the Test and Evaluation Master Plan had not been approved and lacked adequate measures of operational effectiveness. We did not pursue this issue during the audit because of Office of the Secretary of Defense actions to ensure that an acceptable Test and Evaluation Master Plan was prepared.

The Joint Test Force had ensured that Joint STARS testing was adequate and performed in accordance with approved test plans.

Cost and Schedule Assessment. The Under Secretary of Defense for Acquisition approved the Joint STARS airborne segment Acquisition Program Baseline on May 26, 1993. The Defense Acquisition Board added $24 million for software Independent Validation and Verification and $90 million for initial spares to the baseline. The Under Secretary of Defense for Acquisition approved the Acquisition Program Baseline for the Joint STARS Ground Station Module program on August 11, 1993.

Production Preparedness. Concern was raised about the amount of leased space at the prime contractor's Lake Charles, Louisiana, facility used to refurbish and modify Joint STARS aircraft. The Defense Plant Representative Office at Melbourne, Florida, adequately pursued this issue. The Defense Plant Representative Office performed a Facility Utilization Study and intended to use the results of the study to negotiate a forward pricing agreement with the prime contractor.

The Joint Program Office staff effectively monitored Joint STARS aircraft production preparedness to ensure a smooth transition from development to production. The staff performed comprehensive production preparedness reviews at the prime contractor's and its major subcontractors' facilities. The staff was also tracking to closure action items identified during the production preparedness reviews.

The Army Program Office effectively monitored production preparedness. The Program Office initially rejected Motorola's Block I Automated Simulator/Tester (special test equipment) that was developed for Government acceptance testing of GSM hardware. The Program Office later accepted the Block I Automated Simulator/Tester with Motorola's submission of a technical description manual.

Appendix D. Other Matters of Interest

During the audit we identified two areas of concern: development of the Joint STARS software and the Surveillance and Control Data Link.

Joint STARS Software Development. The Joint Program Office has two concurrent software development efforts, the software for the E-8A aircraft configuration and for the E-8C Follow-on EMD aircraft configuration. We noted that delays in completing the E-8A software were adversely affecting the development of the E-8C Follow-on EMD software. The E-8C Follow-on EMD aircraft software was being affected because 400,000 lines of code from the E-8A software will serve as the baseline for E-8C Follow-on EMD software and the contractor has only one software testing laboratory.

o The E-8A software baseline has not stabilized. The software baseline will not stabilize until the successful completion of the system functional and physical software configuration audits. The initial contract required these audits to be completed by October 1991. Because of contractor software development problems, the contract was modified to extend the completion dates for the audits to August 1992. The Joint Program Office is now estimating the successful completion of the audits by May 1994.

To complete the audits, the contractor has been trying since June 1992 to locate and correct errors in the E-8A software code and software documentation. In the December 1992 Production Readiness Review report, the contractor identified 12,000 Software Trouble Reports (Trouble Reports) that resulted from testing the E-8A software. Since then, the contractor has averaged 20 software engineering hours to correct each Trouble Report. Continuing software development problems were evident from January through July 1993 when the contractor's staff generated a monthly average of 166 new Trouble Reports and closed a monthly average of 112 Trouble Reports as a result of E-8A software testing.

It is likely that the continued high issuance of Trouble Reports will adversely affect the successful completion of the system's functional and physical software configuration audits and delay the performance of the E-8C multi-Department operational test and evaluation scheduled for June 1995.

o The availability of only one software testing laboratory also affected the contractor's ability to complete the software testing on schedule. Each software version, the E-8A and E-8C, requires its own software laboratory configuration for testing because the software versions have significantly different operations and control subsystem software. Presently, the contractor's laboratory is configured to test E-8A software to resolve Trouble Reports. At the same time, the contractor is writing software for the E-8C and performing

lower level testing. To stay on schedule, the contractor plans to begin laboratory testing of the E-8C software before the successful completion of the E-8A software audits. By making this laboratory configuration change, we expect further delays in the successful completion of the system's functional and physical software configurations.

We are not making recommendations because the Under Secretary of Defense for Acquisition* was aware of the Joint STARS aircraft software problems and had addressed the issue at the LRIP program review in May 1993. The Under Secretary approved an additional $24 million for software-independent verification and validation, established a requirement for the Air Force to report quarterly on E-8C software status, and approved a 6-month delay in the start of multi-Department operational test and evaluation.

Surveillance and Control Data Link. In 1988, an independent technical review team composed of data link experts from various Military Departments evaluated more than 40 data link systems to determine which systems could satisfy the Joint STARS performance requirements. The review team concluded that the Joint STARS surveillance and control data link (SCDL) was the only data link able to satisfy the Joint STARS requirements without further development effort.

Congress expressed concern in 1988 about the proliferation of system-unique communications equipment that resulted in redundancy and increased costs in research and development, production and test, and logistics and training. In response to the congressional concern, the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD[C^3I]) provided detailed direction in 1991 on the development of data links for intelligence collection systems. ASD(C^3I) issued a Common Data Link Program Policy memorandum that directed the Service Acquisition Executives to use the Common Data Link system specifications developed by the Defense Support Program Office in all imagery and signals intelligence collection systems unless an exception was granted by ASD (C^3I). Since 1985, the use of the Common Data Link architecture in the intelligence community has reduced life-cycle costs per unit as much as 65 percent.

Our concern with the development of the SCDL, an Air Force tactical data link, is that no DoD requirement consolidates and standardizes data link system architectures for tactical and intelligence applications. We believe DoD should explore the mission and cost benefits of standardizing all data link system architectures. We are not making recommendations because the SCDL satisfies the Joint STARS requirements.

*Renamed Under Secretary of Defense for Acquisition and Technology November 1993.

Appendix E. Prior Audits and Other Reviews

On April 28, 1993, the General Accounting Office (GAO) issued Report No. GAO/NSIAD 93-117 (Office of the Secretary of Defense Case No. 9312), "Joint STARS Needs Current Cost and Operational Effectiveness Analysis." The GAO found that the 1985 cost and operational effectiveness analysis (COEA) performed for Joint STARS was no longer valid because of significant changes in key Joint STARS concepts. The GAO recommended that the Secretary of Defense direct the Under Secretary of Defense for Acquisition to determine the scope of the updated COEA by March 1994 and to perform the COEA in support of the full-rate production review. The Secretary of Defense partially concurred with the report recommendations. The Under Secretary reviewed the need for updating the COEA at the May 1993 Defense Acquisition Board Joint STARS program review. In the resulting acquisition decision memorandum, the Under Secretary required the Air Force, Army, and the Joint Staff to provide comments and recommendations on the proposed updated COEA.

Air Force Audit Agency report for Project No. 0036316, "Acquisition Management of the Joint Surveillance Target Attack Radar System," August 8, 1991, contained findings on component breakout, software support facilities, and the paperless automated depot. The component breakout finding is discussed in our Finding A. In the software support facilities finding, the auditors reported that the Air Force planned to acquire separate software support facilities without adequately considering cost savings of as much as $14 million by consolidating and collocating the two facilities. The auditors recommended that the Assistant Secretary of the Air Force (Acquisition) require the Joint Program Office to plan for and procure a single software support facility. The Assistant Secretary concurred. On April 15, 1991, the Air Force announced its intention to procure a single Joint STARS software support facility located at Robins Air Force Base. In the paperless automated depot finding, the auditors reported that the Joint Program Office had not submitted a Communication-Computer Systems Requirements Document for the new paperless automated depot. The report recommended that the Assistant Secretary of the Air Force (Acquisition) require the Joint Program Office to prepare the required systems requirements document. The Assistant Secretary concurred. In December 1992, Robins Air Force Base submitted the systems requirements document to Headquarters, Air Force, for approval. Approval had not been given as of March 1994.

Air Force Audit Agency Auxiliary Report No. 063-1-1 for Project No. 003616, "Acquisition Management of the Joint Surveillance Target Attack Radar System (Joint STARS)," November 9, 1990, contained a finding on competitive acquisition of the Joint STARS aircraft refurbishment and modification effort. This report is discussed in our Finding B.

Appendix F. Candidates for Component Breakout

We identified nine Joint STARS components that were suitable candidates for component breakout. Details on how we reached our conclusions for each component follow.

Radar Sensor

Norden Systems began development of the radar sensor in October 1985 under a subcontract with Grumman; development is nearly complete. Norden Systems expects to complete nonrecurring engineering changes to improve radar sensor producibility and to remove obsolete parts by December 1994.

The Radar Sensor's reliability exceeded the Air Force's expectations. The predicted component reliability was 100.6 hours mean-time-between-failures. During Operation Desert Storm, the radar sensor demonstrated component reliability of 130 hours mean-time-between-failures.

At the prime contractor's plant, no additional design or engineering effort is added to the radar sensor. The prime contractor examines and tests the component before its installation into the aircraft. Norden Systems is responsible for repairing failed radar assemblies. In our discussions, Norden Systems officials stated that they would offer the Air Force the same materials and workmanship warranty offered to the prime contractor.

Programmable Signal Processor

Ceridian Corporation (then Control Data Corporation) began development of the programmable signal processor in late 1984. The processor was initially developed for two other programs. The processor's design has been stable since 1988. Ceridian officials stated that they plan to replace obsolete parts during Joint STARS low-rate initial production. Ceridian and Defense Plant Representative Office personnel do not consider the planned parts changes to be major.

At the prime contractor's plant, no additional design or engineering effort is added to the processor. The prime contractor examines and tests the component before its installation into the aircraft. Ceridian Corporation is responsible for repairing failed processor assemblies.

The programmable signal processor is a reliable component. As a result, the prime contractor declined Ceridian Corporation's warranty offered for Joint STARS LRIP. In our discussions, Ceridian officials stated that they would offer the Air Force the same materials and workmanship warranty offered to the prime contractor.

Inertial Measurement System

Litton Guidance and Control Systems Division began development of the inertial measurement system for the Joint STARS aircraft in 1985. The system provides for motion compensation and stabilization for synthetic aperture radar imagery. Although this system is being developed exclusively for Joint STARS, Litton previously built similar inertial measurement systems for other applications, such as the Navy's synthetic aperture radar and airborne missile initialization and alignment system.

The design of the inertial measurement system is stable. For the Joint STARS program, the contractor made minimal design changes to clean up minor circuit interrupts. The contractor plans no other design changes.

At the prime contractor's plant, no additional design or engineering effort is added to the processor. The prime contractor examines and tests the component before its installation into the aircraft. Litton Guidance and Control Systems Division is responsible for repairing failed inertial measurement system assemblies.

Because the inertial measurement system is reliable, the prime contractor furnished the component as contractor-furnished equipment in its radar sensor subcontract with Norden Systems. In our discussions, Litton officials stated that they would offer the Air Force the same materials and workmanship warranty offered to the prime contractor.

Aircraft

Boeing Aircraft Company developed the Boeing 707 aircraft. Since 1958, the Boeing 707 aircraft has been used by domestic and foreign airlines to carry passengers and cargo. This airframe is also the platform for the Air Force's E-3 Airborne Warning and Control System, the Navy's E-6A Airborne Very Low Frequency communications aircraft, the Air Force's EC-18 Advanced Range Instrumentation aircraft, and Saudi Arabia's KE-3A tanker/transport aircraft.

We disagree with the Joint Program Office's position that the prime contractor should be allowed to procure the remaining eight aircraft required on the Joint STARS program as contractor-acquired equipment. The basis for the Joint Program Office's justification was that the prime contractor was being required to survey the used Boeing 707 market and to inspect candidate aircraft. In contrast to this position, the Air Force provided the prime contractor used Boeing 707 aircraft as Government-furnished equipment for the third and fourth Joint STARS production systems even though the prime contractor was required to perform Boeing 707 market survey and inspection services. So, the Joint Program Office can continue to contract with the prime contractor for market survey and inspection services even if the Air Force actually buys the planes.

Secondary Power System

World Auxiliary Power Company (WAPCO) began development of the secondary power system in July 1991. The secondary power system will enable the Joint STARS aircraft to stand and operate alone on the ground.

In our opinion, the design of the secondary power system is sufficiently stable for breakout. The main components of the secondary power system are non-developmental items. The components include a Garrett auxiliary power unit that was developed for the Airbus A330/A340 aircraft and a Lucas Aerospace generator. The secondary power system cannot be accepted until the Federal Aviation Administration approves all design changes and certifies the system for use in the aircraft.

At the prime contractor's plant, no additional design or engineering effort is added to the secondary power system. WAPCO delivers the secondary power system components as a kit. Upon delivery, the prime contractor and WAPCO integrate the power system components into the aircraft. Due to slightly different configurations of the used Boeing 707 aircraft, the prime contractor may make some sheet metal modifications to the aircraft to permit installation of the secondary power system.

WAPCO furnishes its standard warranty for integration and installation of the secondary power systems, plus warranties from the auxiliary power unit and generator manufacturers to the prime contractor. In our discussions, WAPCO officials stated that they would offer the Air Force the same materials and workmanship warranty offered to the prime contractor.

Military VAX™* Computers and Advanced Digital Display Processors

The military VAX computers and the workstation advanced digital display processors are military versions of commercial Digital Equipment Corporation of computers. Raytheon Company has a license to build military versions of Digital Equipment Corporation computers. Under terms of the license, Raytheon can sell its military versions of Digital Equipment Corporation computers to American and foreign military organizations at standard catalog prices. Digital Equipment Corporation validates all Raytheon military computers to ensure compatibility with other Digital Equipment Corporation hardware and software.

The reliability of the military VAX computers was demonstrated during Operation Desert Storm. The Joint STARS aircraft military VAX computers logged 8,736 operational hours with only one failure, which did not have an adverse impact on Joint STARS operations.

Among other military applications, Raytheon has sold the military VAX computers to General Telephone Electronics Corporation and Loral Corporation for the Rapid Execution and Combat Targeting weapon systems and to Grumman Space and Electronics Division for the Follow-on Early Warning System.

The prime contractor chose Raytheon's advanced digital display processor to replace the workstation processors used on the two E-8A test aircraft because the Raytheon processor has improved performance and speed characteristics.

The prime contractor adds no design and engineering effort to the VAX computers and workstations processors. Upon delivery, the prime contractor installs and integrates the computers and processors into the Joint STARS aircraft. Raytheon is responsible for repairing failed computer and processor components. In our discussions, Raytheon officials stated that they would offer the Air Force the same materials and workmanship warranties offered to the prime contractor for the VAX computers and work station processors.

Disk Storage System

Ceridian (then Control Data Corporation) began development of the Joint STARS disk storage system in November 1988. In May 1992, Ceridian initiated a design effort to improve the disk storage system for the third Joint STARS aircraft. The improved system consists of the versatile media mass memory and the operator workstation embedded disk. The key component in both parts is a commercial one gigabit disk drive. The versatile media mass

*VAX is a trademark of Digital Equipment Corporation.

memory contains four disk drives, and the operator work station embedded disk contains one disk drive and an option slot for another. Ceridian expects to complete the design efforts and have the system qualified for use on the Joint STARS aircraft by the end of April 1994.

Because the disk storage system has proven reliable, the prime contractor has broken out the component from its VAX computer subcontract with Raytheon. Upon delivery, the prime contractor adds no additional design or engineering effort into the system. The prime contractor performs acceptance testing and installs a versatile media mass memory drive in each VAX computer on the aircraft. Similarly, the prime contractor will install the embedded disk drive into each advanced digital display processor. Ceridian is responsible for repairing failed disk drives.

Very High Frequency Collocation Filter

The design of RF Products' very high frequency collocation filter is mature and stable. RF Products submitted minor engineering change proposals to the prime contractor to allow for some nonstandard parts. Upon delivery, the filter is ready for integration into the aircraft; the prime contractor does not add additional engineering or design effort.

The filter is very reliable; the initial 11 filters delivered on the Joint STARS contract were failure-free. In our discussions, RF Products officials stated that they would offer the Air Force the same 90-day materials and workmanship warranty offered to the prime contractor.

Appendix G. Potential Component Breakout Savings

Component	Prime Contractor Unit Cost (In thousands)	Total Breakout Savings (In thousands)
Aircraft	$ *	
Number of Used Aircraft beyond current inventory needed to support Joint STARS production during Future Years Defense Program (FYs 1994-1999) starting with the FY 1995 long lead buy	x 8	
Total Prime Contractor Used Aircraft Costs		$ *
Radar Sensor	*	
Programmable Signal Processor	*	
Inertial Measurement System	*	
Secondary Power System	*	
Military VAX Computers	*	
Work Station Processors	*	
Disk Storage System	*	
Very High Frequency Collocation Filter	*	
Total Prime Contractor Unit Costs for Non-Aircraft Components	*	
Joint STARS Systems to be Purchased during Future Years Defense Program (FYs 1994-1999) starting with the FY 1995 production and long lead buys	x 10	
Total Prime Contractor Cost for Non-Aircraft Components		$ *
Total Prime Contractor Component Costs		$ *
Percent Prime Contractor Mark-Up Factor		x *
Total Breakout Savings		$ 77,761

* Proprietary data removed.

Appendix H. Command, Control, Communications and Intelligence Systems Collocated With Ground Station Modules

Army Tactical Command and Control System

The Army Tactical Command and Control System is composed of five Battlefield Automation Systems.

Maneuver Control System. Network of computer equipment that serves the Commander and Staff Corps, Division, Brigade, and Maneuver Battalion. The Maneuver Control System provides force-level information and automated assistance in the coordination of plans, the dissemination of orders and guidance, and the monitoring and supervision of operations. Also, the Maneuver Control System is used to integrate the maneuver function with command and control systems for fire support, air defense, military intelligence, and combat support.

Advanced Field Artillery Tactical Data System. Network of computer equipment that supports all field artillery levels from battery through Corps Level with automated fire direction and tactical control and performance data such as available rounds. Also, the Advanced Field Artillery Tactical Data System provides increased automated support for command and control, target processing, fire support planning, movement control, and decisionmaking.

All Source Analysis System. Tactically deployable automated data processing system used to receive and correlate data from strategic and tactical intelligence sensors and sources, produces ground battle situation displays, rapidly disseminates intelligence data, provide target nominations, help manage organic intelligence electronic warfare assets, and assist in operation security support.

Combat Services Support Computer System. Automated data processing system that provides processing of critical logistics, medical, and personnel information for evaluating current and projected sustainment of capabilities for maneuver control, fire support, air defense, and intelligence capabilities.

Forward Area Air Defense Command and Control System. Automated network of air defense radars, sensors, and identification equipment (ground and aerial, active and passive) with data processing and distribution capability. The Forward Area Air Defense Command and Control System provides target data processing and display capabilities at the Air Battle Management Operations Center, the Army Airspace Command and Control, Sensor Command and Control, battery, platoon, and fire-unit levels.

Integrated Meteorological System

The Integrated Meteorological System provides weather data to support Brigade, Division, Corps, and echelons above Corps. The system provides field artillery and aviation units with target-area weather data and is normally collocated with the units' tactical operations center. To accomplish its mission, the system interfaces with the Army Tactical Command and Control System and other military and civilian weather collection and processing systems.

Digital Topographic Support System

The Digital Topographic Support System provides automated terrain analysis support to Division, Corps, and echelons above Corps. The system is tactically mobile and capable of world-wide operations on a 24-hour basis. To accomplish its mission, the system interfaces with DoD standard automated map data bases normally collocated with the All Source Analysis System to facilitate data exchange.

Appendix I. Required Operational Capability Nuclear, Biological, and Chemical Survivability Requirements

Equipment	Nuclear[1]	NBC[2] Contamination			
	Electro Magnetic Pulse	Contam-ination	Decontam-ination	Collective Protection System	Operate in MOPP[3] Gear
GSM[4] Variants					
Light					X
Medium	X	X		X	
Heavy	X	X		X	
ATCCS[5]	X	X	X		X
MCS[6]		X			X
ASAS[7]	X	X	X		X
AFATDS[8]	X	X	X	X	
CSSCS[9]					X
FAADCC[10]					
IMETS[11]	X	X	X		X
DTSS[12]	X	X[13]	X[13]	X	

Legend

1 Does not include nuclear blast or thermal effects
2 Nuclear, Biological, and Chemical
3 Mission-Oriented Protective Posture
4 Ground Station Module
5 Army Tactical Command and Control System
6 Maneuver Control System
7 All Source Analysis System
8 Advanced Field Artillery Tactical Data System
9 Combat Services Support Control System
10 Forward Area Air Defense Command and Control
11 Integrated Meteorological System
12 Digital Topographic Support System
13 Shelter's external surfaces only

Appendix J. Audit Responses to Specific Management Comments

The Office of the Assistant Secretary of the Air Force (Acquisition) sent audit responses to specific management comments to the draft report.

Finding A. Acquisition Planning for Component Breakout

Air Force Comments. The Air Force stated that the draft report incorrectly asserted that the Joint Program Office did not consider making a comprehensive breakout review to support the Joint STARS FY 1996 acquisition strategy. It stated that the Joint Program Office considered further component breakout for the third EMD and LRIP aircraft systems, but concluded that further component breakout was not feasible or practical. The Air Force stated that this decision was documented in the April 9, 1993, Integrated Program Summary that was approved by the Under Secretary of Defense for Acquisition.

Audit Response. The Air Force misread the draft report. In the draft report, we asserted that the Joint Program Office did not initiate a comprehensive component breakout review as agreed to in response to an Air Force Audit Agency report issued in August 1991. Further, the draft report asserted that the Air Force did not consider making a comprehensive component breakout review in support of the FY 1995 (not FY 1996) acquisition strategy for Joint STARS production and long-lead buys.

Air Force Comments. The Air Force stated that some of the nine components discussed in the Finding contained proprietary technology that could not be released to the open marketplace. The Air Force asserted that without the ability to compete the components in the open marketplace, potential savings gained from breakout into competitive procurements were substantially reduced.

Audit Response. The Air Force was correct in asserting that additional savings from competitive procurements may not be possible for those components that contain proprietary technology. For this reason, all breakout savings cited in the draft report were based on the Joint Program Office buying the components directly from the vendors who supplied the components to the prime contractor.

Air Force Comments. The Air Force stated that the potential cost savings cited in the draft report were overstated because the report assumed that Grumman's component markup rate (overhead costs) would remain the same if the nine components were broken out. Because Joint STARS was a major portion of Grumman's business base, the Air Force believed that Grumman will increase its overhead rate against other Joint STARS program costs to recover continuing overhead costs. Also, the Air Force stated that the draft report did not consider the increased management and technical overhead costs to the

Government of managing the additional contracts for the identified components. Further, the Air Force advised that more current unit component costs for the radar sensor, inertial measurement system, and military VAX computers were lower.

Audit Response. Grumman's component markup rate used in the draft report was Grumman's negotiated markup rate for material overhead costs and profit. This use of this markup rate was conservative, because the rate did not include subcontractor management costs that Grumman charged as direct costs on the Joint STARS contract. We recognize that costs may be added for Government contracting and technical personnel and that these costs should be evaluated in determining the potential savings from component breakout. Accordingly, we have inserted a statement in Finding A in recognition of these added costs. We also adjusted the estimated savings from component breakout based on the more current unit component costs provided by the Air Force.

Finding C. Aircraft Mission-Critical System Software

Air Force Comments. The Office of the Assistant Secretary of the Air Force (Acquisition) stated that the TRW Incorporated study cited in the draft report did not compare multiple systems written in Ada versus multiple systems written in other higher order languages.

Audit Response. We agree. The final report was clarified in response to Air Force comments.

Air Force Comments. The Office of the Assistant Secretary of the Air Force (Acquisition) stated that the results in the TRW Incorporated study concerning software maintenance cost savings were not necessarily directly applicable to other programs. The Air Force stated that the study results may not be directly applicable to Joint STARS mission-critical system software because it is heavily based on commercially-produced hardware that includes some proprietary commercial software.

Audit Response. We agree that the results of transitioning Joint STARS mission-critical system software to the Ada programming language in terms of savings of software maintenance costs may vary from the results in the TRW Incorporated study. However, the results in TRW Incorporated's study are a valid indicator of cost benefits that can be achieved by transitioning Joint STARS mission-critical system software to the Ada programming language. As stated in the report, previous studies of the cost-effectiveness of using the Ada programming language for command, control, and communications systems have also concluded that the results would not differ for computer programs embedded in weapon systems.

Air Force Comments. The Office of the Assistant Secretary of the Air Force (Acquisition) stated that until an Ada cost-benefit analysis is performed for the Joint STARS Program, the assertion is not supportable that the benefits of transitioning to Ada programming language outweigh the cost and schedule impacts.

Audit Response. We agree. However, the results of the Ada cost-benefit analysis will show that the cost of transitioning Joint STARS mission-critical system software into Ada is beneficial as indicated by the results of earlier Air Force studies discussed in the Finding.

The Air Force indicated that more than 65 percent of the estimated 652,000 lines of developed software for the E-8C Follow-on EMD aircraft configuration was completed with the development of the E-8A test aircraft configuration and another 60 percent of the remaining software code has been completed. To perform a useful cost-benefit analysis, the Air Force will have to consider not only the cost to transition completed E-8C Follow-on EMD aircraft configuration software to the Ada programming language but also the costs associated with Air Force pre-planned product improvements.

Joint STARS pre-planned product improvements consist of a multi-stage program to satisfy future Joint STARS mission requirements. Those pre-planned product improvements will result in significant upgrades of Joint STARS mission-critical system software. For example, the planned Self Defense Suite Block II upgrade will require approximately 90,000 lines of new software code. Similarly, the planned mixed mode communication subsystem upgrade will require approximately 15,000 lines of new software code. Because of the magnitude of Joint STARS subsystems software yet to be completed and maintained, a comprehensive cost-benefit analysis will show that the cost of transitioning Joint STARS mission-critical system software into the Ada programming language is beneficial.

Appendix K. Summary of Potential Benefits Resulting From Audit

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
A.1.	Compliance with Regulations and Economy and Efficiency. Will allow the Joint Program Office to identify all aircraft components eligible for component breakout.	Funds put to better use. Air Force could avoid $77.7 million over the Future Years Defense Program. (FYs 1994 through 1999 Aircraft Procurement, Air Force.)*
A.2.	Compliance with Regulations. Will ensure that the Joint Program Office uses the results of the component breakout review for FY 1995 production and long-lead buys.	See A.1.
B.	Compliance with Regulations and Economy and Efficiency. Will ensure that the Joint Program Office is receiving the best possible price for the aircraft refurbishment and modification work.	Funds put to better use. Air Force could avoid $67.0 million of costs over the Future Years Defense Program. (FYs 1994 through 1999 Aircraft Procurement, Air Force.)*
C.1.a.	Program Results. Will ensure that the Joint Program Office transitions to the use of the Ada computer programming language for mission-critical system software by the aircraft initial operational capability date, March 1997.	Undeterminable. There will be monetary benefits that will accrue over the life-cycle of the Joint STARS system from lower maintenance costs. These reduced costs cannot be currently estimated.

*The actual amount of monetary benefits will be determined after the component breakout program is implemented and the aircraft refurbishment and modification effort is completed.

Appendix K. Summary of Potential Benefits Resulting From Audit

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
C.1.b.	Program Results. Will provide the Joint Program Office funds needed to transition to the use of the Ada computer programming language for mission-critical system software by the aircraft initial operational capability date, March 1997.	Nonmonetary.
C.2.a.	Compliance with Laws and Regulations. Will result in the prime contractor transitioning to the use of the Ada computer programming language for mission-critical system software by the aircraft initial operational capability date, March 1997.	Nonmonetary.
C.2.b.	Compliance with Laws and Regulations. Will cause the Joint Program Office to submit a revised Acquisition Program Baseline for approval to show the impact of implementing an Ada transition plan for aircraft mission-critical system software.	Nonmonetary.
D.1.a.	Program Results. Will ensure that the vehicle and shelter designed for the Light Ground Station Module will satisfy Army mission and survivability requirements.	Nonmonetary.
D.1.b.	Program Results. Will ensure that the Light Ground Station Module survivability requirements are in compliance with Army regulations.	Nonmonetary.
D.1.c.	Program Results. Will ensure that the Light Shelter survivability requirements are in compliance with Army regulations.	Nonmonetary.

Recommendation Reference	Description of Benefit	Amount and/or Type of Benefit
D.2.a.	Compliance with Regulations. Will ensure that the contractor for Light Ground Station Module modifies the equipment design to incorporate a nuclear, biological, and chemical overpressure system.	Nonmonetary.
D.2.b.	Compliance with Regulations. Will ensure that the contractor for Light Ground Station Module modifies the equipment design to incorporate high-altitude electromagnetic pulse hardness protection.	Nonmonetary.

Appendix L. Organizations Visited or Contacted

Office of the Secretary of Defense

Office of the Under Secretary of Defense for Acquisition and Technology, Washington, DC
Office of the Assistant Secretary of Defense (Command, Control, Communications and Intelligence), Washington, DC
Office of the Comptroller of the Department of Defense, Washington, DC
Office of the Assistant to the Secretary of Defense (Atomic Energy), Washington, DC

Office of the Joint Staff

Office of the Director, Command, Control and Communications (J-6), Washington, DC
Office of the Director, Force Structure, Resources and Assessments (J-8), Washington, DC

Department of the Army

Deputy Chief of Staff, Operations and Plans, Washington, DC
Army Materiel Command, Alexandria, VA
Army Communications-Electronics Command, Fort Monmouth, NJ
Army Research Laboratory Command, Adelphi, MD, and Woodbridge, VA
Army Test and Evaluation Command, Aberdeen Proving Grounds, MD
Army Training and Doctrine Command, Fort Monroe, VA
Army Intelligence Agency, Falls Church, VA
Army Materiel System Analysis Agency, Aberdeen, MD
Army Nuclear and Chemical Agency, Springfield, VA
Transportation Engineering Agency, Military Traffic Management Command, Newport News, VA
Army Intelligence and Threat Analysis Center, Washington, DC
Army Intelligence Electronic Warfare Center, Fort Monmouth, NJ
Belvoir Research, Development and Engineering Center, Army Troop Support Command, Fort Belvoir, VA
Natick Research, Development, and Engineering Center, Army Troop Support Command, Natick, MA
Joint Surveillance Target Attack Radar System Ground Stations Module Program Office, Fort Monmouth, NJ

Department of the Air Force

Assistant Secretary of the Air Force (Acquisition), Washington, DC
Deputy Assistant Secretary of the Air Force (Communication, Computers, and Logistics), Washington, DC
Directorate of Requirements, Air Combat Command, Langley Air Force Base, VA
Electronic Systems Center, Air Force Materiel Command, Hanscom Air Force Base, MA
Deputy Chief of Staff, Plans and Advanced Programs, Electronic Systems Center, Hanscom Air Force Base, MA
Warner-Robins Air Logistics Center, Robins Air Force Base, GA
4950th Test Wing, Wright-Patterson Air Force Base, OH
Joint Surveillance Target Attack Radar System Joint Program Office, Hanscom Air Force Base, MA

Marine Corps

Marine Corps Combat Development Center (Requirements and Plans), Quantico, VA

Other Defense Organizations

Defense Logistics Agency, Alexandria, VA
Defense Nuclear Agency, Alexandria, VA
Defense Contract Management District South, Aircraft Program Management Office, Marietta, GA
Defense Contract Management Area Operation, Bridgeport, CT
Defense Contract Management Area Operation, Philadelphia, PA
Defense Contract Management Area Operation, San Francisco, CA
Defense Contract Management Area Operation, Twin Cities, MN
Defense Contract Management Area Operation, Litton Resident Office, Van Nuys, CA
Defense Contract Management Area Operation, Lockheed Aero Modification Center Resident Office, Greenville, SC
Defense Contract Management Area Operation, Motorola Resident Office, Phoenix, AZ
Defense Contract Management Area Operation, PEMCO Resident Office, Birmingham, AL
Defense Plant Representative Office, Grumman Melbourne Systems Division, Melbourne, FL
Defense Plant Representative Office, PEMCO Aeroplex, Birmingham, AL
Defense Plant Representative Office, Raytheon Corporation, Burlington, MA
Defense Contract Audit Agency, Grumman Melbourne Systems Division Resident Office, Melbourne, FL
Defense Contract Audit Agency, Scottsdale, AZ

Other Government Organizations

Small Business Administration, Hanscom Air Force Base, MA

Contractors

Ceridian Corporation, Minneapolis, MN
Cubic Corporation, San Diego, CA
Grumman Melbourne Systems Division, Melbourne, FL
Infotech Development, Incorporated, Boston, MA
Litton Industries, Woodland Hills, CA
Motorola Incorporated, Tempe, AZ
Raytheon Corporation, Marlboro, MA
RF Products, Camden, NJ
United Technologies, Norden Systems Division, Norwalk, CT
World Auxiliary Power Company, Alameda, CA

Appendix M. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology
Assistant Secretary of Defense (Command, Control, Communications and Intelligence)
Assistant to the Secretary of Defense (Public Affairs)
Comptroller of the Department of Defense

Office of the Joint Staff

Director, Operational Plans and Interoperability

Department of the Army

Secretary of the Army
Assistant Secretary of the Army (Research, Development and Acquisition)
Auditor General, Department of the Army
Deputy Chief of Staff, Operations and Plans
Joint Surveillance Target Attack Radar System Ground Station Module Project Office

Department of the Navy

Assistant Secretary of the Navy (Financial Management)

Department of the Air Force

Secretary of the Air Force
Assistant Secretary of the Air Force (Acquisition)
Air Combat Command
Auditor General, Air Force Audit Agency
Joint Surveillance Target Attack Radar System Joint Program Office

Other Defense Organizations

Director, Defense Logistics Agency
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
- Senate Select Committee on Intelligence
- 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
- House Permanent Select Committee on Intelligence
- House Subcommittee on Oversight and Evaluation, Permanent Select Committee on Intelligence

Part IV - Management Comments

Under Secretary of Defense for Acquisition and Technology Comments

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND TECHNOLOGY

10 DEC 1993

MEMORANDUM FOR DoD INSPECTOR GENERAL
ATTN DIRECTOR, ACQUISITION MANAGEMENT

SUBJECT: Draft Audit Report on the Acquisition of the Joint Surveillance Target Attack Radar System (Project No. 2AS-0065)

Thank you for the opportunity to comment on the subject draft report. Overall, the draft report is well written, to the point, and covers substantive aspects of the Joint STARS Airborne and Ground programs.

The attached comments are provided for your consideration in finalizing the report. These comments were coordinated at the Deputy Director level within the OUSD(A&T) staff to include Defense Procurement, Acquisition Program Integration, DDR&E/Advanced Technology (Software), and Economic Security/(Production Resources and Weapon System Improvement Group).

I am concerned that the recommended direction under Finding C to convert to the Ada programming language before IOC may have serious cost and schedule consequences. The results of a cost-effectiveness analysis and program impacts for the Joint STARS program, to be identified in the Joint STARS Ada Transition Plan, should be considered before directing a conversion to Ada before IOC.

Frank Kendall
Director
Tactical Warfare Programs

Attachment

*Note: This is a corrected copy w/attachment . Previous memo contained wrong attachment.

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Page No.

Comments on the DoDIG Draft Audit Report on the Acquisition of
the Joint Surveillance Target Attack Radar System
Project No. 2AS-0065

Background

Revised

Page 2, third paragraph, last sentence: the Defense Acquisition Executive approved low rate initial production for 12 Medium Ground Station Modules in the Acquisition Decision Memorandum dated August 11, 1993, vice July 23, 1993.

Revised

Page 2, fourth paragraph, first sentence: the Army plans a total buy of 95 versus 104 GSMs. The additional nine units that show up in program documentation are not Joint STARS GSMs. They are Limited Procurement Urgent (LPU) ground stations bought in the 1980s in the Joint STARS GSM budget line that support only the Mohawk OV-1D sensor. The LPUs will go out of service upon the retirement of the OV-1D sensor before 1996.

Finding A. Component Breakout

The draft report implies that the Joint Program Office (JPO) does not intend to perform a breakout analysis.

The program has already recognized the appropriateness of conducting a component breakout analysis. The Integrated Program Summary prepared by the JPO, and approved by the USD(A) in the Acquisition Strategy Report, states:

> "Due to the highly complex nature of the Joint STARS system, the substantial amount of software and hardware development, and lack of adequate technical data packages to support competition at this point, breakout of major components or subsystems to other contractors is not considered feasible or practical for the Third System acquisition or LRIP. In addition, it is in the Governments best interest to have the contractor retain total systems responsibility through the LRIP phase. However, reprocurement data was purchased under the FSD and the Follow-on contracts. *Component breakout will be addressed as part of the full rate production acquisition strategy.*" [emphasis added] [¶2.b(3),P-26]

One component, the Ground Data Terminal, has already been broken out. Milestone III, the full production decision, is planned for January 1996. Component breakout is expected to be fully assessed prior to Milestone III and addressed at that time.

The draft report's projection of saving $93.3 M through the use of component breakout is premised on several unsupported assumptions:

Attachment - Page 1

- It assumes that all high value components reviewed by the DoDIG should be broken out. The decision whether or not breakout is appropriate will need to be made in the full context of the development and production situation.

- It presumes a savings of * % on all components. Were the JSTARS program a minor component of the business base, and were there no costs involved in handling Government Furnished Equipment (GFE, that might be appropriate. Neither condition applies.

- It assumes that the program would not break out any components absent the DoDIG recommendation. Component breakout is to be addressed for full production; any savings from breakout would be achieved by the program starting in FY96.

The draft report on the component breakout finding considers the potential savings to the government attributed to lower contractor prices. The finding does not appear to have considered the increased management and technical overhead costs to the government of managing the additional contracts for the identified components. The draft report considers the design risk, but does not appear to consider the increased production and system integration risk to the government when the government assumes the responsibility for delivering the (broken out) components to the prime contractor as GFE. These factors should be considered by the Air Force in the recommended comprehensive component breakout review.

Finding B. Aircraft Refurbishment and Modification

The JPO has considered utilizing other sources for refurbishment of airframes and has concluded, based upon experience to date, that there is a significant risk of discovering additional airframe refurbishment requirements in the process preparing the airframes for installation of JSTARS equipment. If the prime contractor is responsible for both airframe refurbishment and equipment installation, the cost and schedule impacts of such discoveries are minimal, whereas introducing a government responsibility due to separate contracts significantly increases risk of adverse impacts. The draft report is correct in stating that the prime contractor could still be held accountable for total systems integration and performance. However, separating the sources of these efforts would likely lead to increased cost and schedule delays attributable to the government's defective GFE.

The savings projected by the draft report are unsubstantiated. The 25% rule of thumb savings may apply in some circumstances. In procurement of used airframes, the limited number of appropriately configured used airframes that are available defines the market. The extent of competition will

* PROPRIETARY DATA REMOVED.

Final Report Page No.

essentially be the same whether the purchase is by the prime contractor for the program, or directly by the government, with some possible advantage from commercial practices utilized by the prime contractor. The cost of refurbishment would, in any case, be driven largely by cost reimbursable terms appropriate for any "open, inspect and repair" effort, and should not differ significantly among vendors.

Page 12, third paragraph, first sentence: It is not clear if the "separate contract" for Joint STARS aircraft refurbishment and modification work is intended to be managed by the government or the prime contractor. If the government manages such a separate contract, then the prime contractor's total systems integration and performance responsibility will be adversely affected. — 13

Finding C. Aircraft Mission-Critical System Software — 17

Page 15, second paragraph, 5th line: The rationale cited for the use of the Ada language (i.e., reduced bug time) is inaccurate. Although it is true that Ada compilers provide greater assistance in the detection of programming errors, one of the greatest assets of Ada is that it facilitates the use of rigorous software engineering approach to the development of software, which results in reduced software maintenance effort and cost. — Revised

Page 15, second paragraph, last sentence: The TRW study applied a standard cost model (COCOMO) in depth to the Ada and C software languages for a typical C3 project, the Command Center Processing and Display System--Replacement (CCPDS-R) Project). The study did not compare "systems .... written in Ada versus systems with software written in other high-order programming languages" as stated in the draft report. — 17 Revised

Page 15, third paragraph: In December 1991, the Deputy Secretary of Defense authorized the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD(C3I)) to serve as the official who could grant special exemptions related to Ada. In a memorandum dated April 17, 1992, the ASD(C3I) redelegated this authority to several officials in the DoD. The Director, Defense Research and Engineering was authorized to grant special exemptions for software that is physically part of, dedicated to, or essential in real time to the mission performance of weapon systems; used for weapon system specialized training, simulation, diagnostic test and maintenance, or calibration; or used for research and development of weapon systems. — 17 Revised

Page 15, footnote: Ada is no longer a registered trademark of the United States Government, Department of Defense. This reference should be deleted. — 17 Revised

Page 16, first paragraph, last line: The DoD policy was — 18 Revised

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incorporated in two DoD Directives: DoD Directive 3405.2, "Use of Ada in Weapon Systems" (March 30, 1987); and DoD Directive 3405.1, "Computer Programming Language Policy" (April 2, 1987). Although DoDD 3405.1 is still in effect, DoDD 3405.2 was subsequently replaced with DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures" (February 23, 1991).

20 Revised

Page 18, first full sentence: In 1985-86 there may have been a lack of Ada software compilers for the Joint STARS computers. Overall, however, there were validated Ada compilers available at that time.

20 Revised

Page 18, second paragraph:

a. The rationale for the statement that the "benefits of the Joint Program Office transitioning to Ada programming language before the aircraft initial operational capability date far outweigh the cost and schedule impacts" is not obvious in the draft report and needs further elaboration. The benefit of the 35% reduction in software life cycle maintenance costs is based on the TRW case study comparison of Ada versus C++ language in a typical system using the Cost Computational Model (COCOMO). The draft report does not quantify the specific costs/benefits for the Joint STARS program and does not address the benefits derived from adoption of commercial software and hardware in the system. The direction to convert to Ada before the cost-effectiveness for the Joint STARS program is demonstrated through analysis appears to be pre-mature. The cost-effectiveness and merits of transitioning to Ada at this point in the system development should be shown in the Joint STARS Ada Transition Plan before the Air Force is directed to implement such an Ada Transition Plan.

b. The draft report states that the results of the TRW study, which showed cost advantages in software maintenance of an Ada developed system versus a C++ developed system, are applicable to the Joint STARS program in that a 35% reduction in Joint STARS aircraft life cycle software maintenance costs can be expected. Although these generalized expectations could very well be valid in the case of Joint STARS, further detailed review is needed. The COCOMO estimated software maintenance costs, for example, are computed as a function of the magnitude and complexity of the development effort and the estimated annual change traffic. The Joint STARS software development is almost completed. Of the estimated 685,000 lines of developed software for the E-8C, 453,000 lines were completed in the E-8A engineering and manufacturing development (EMD) and are in several languages (Fortran, assembly, Ada and C). The remaining 232,000 being modified or newly developed in the E-8C EMD are 50% complete. The E-8C EMD includes extensive use of commercially developed software and hardware. The specific additional costs to convert the Joint STARS software to Ada, plus the costs of the

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Page No.

associated software support tools, should be compared to the anticipated reduction in software maintenance costs estimated specifically for the Joint STARS program.

Page 18, last paragraph: The Joint STARS Program Director is not authorized to update the Acquisition Program Baseline (APB). The Program Director should recommend revisions to the APB for approval by the Defense Acquisition Executive.

22
Revised

Finding D. Light Ground Station Module Survivability. Agree. The survivability of the Light Ground Station Module shelter should be consistent with the adjacent Army field elements and the environment within which the GSM operates.

Attachment - Page 5

Assistant Secretary of Defense Comments

COMMAND CONTROL
COMMUNICATIONS
AND INTELLIGENCE

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3040

DEC 22 1993

MEMORANDUM FOR THE DIRECTOR, ACQUISITION MANAGEMENT DIRECTORATE, OFFICE OF THE INSPECTOR GENERAL, DEPARTMENT OF DEFENSE

SUBJECT: Draft Audit Report on the Acquisition of the Joint Surveillance Target Attack Radar System (Project No. 2AS-0065)

Thank you for the opportunity to comment on the subject draft report. We have reviewed the subject draft report and provide the attached comments for your consideration.

/Kendall

Cynthia Kendall
Deputy Assistant Secretary of Defense
(Information Management)

Attachment

Comments on
Draft Audit Report on Joint STARS
and
proposed reply

	Final Report Page No.
Report:	
1. Executive Summary (page ii). Comments/reply on the report should specifically cite issues with (a) projected 35% software maintenance increase and (b) footnote 2. Rationale: Consistency with subsequent comments.	i
2. Page 15, first paragraph, last sentence. The report does not show that the subsequently cited TRW study provides a valid basis for the 35% software maintenance savings estimate due to use of Ada. It is not clear that the CCPDS-R project findings reported in the TRW study can be directly extrapolated to programs of larger size (scalability issue) or to other C^2 requirements which have differing degrees of software complexity.	17 Revised
3. Page 15, second paragraph, 1st sentence. Although the DoD was developing the Ada programming language in 1980, it did not become a standard (ANSI/MIL-STD)) until 1983, and was not formally required as a DoD approved higher-order programming language by policy until 1987 when DoD Directives 3405.1 and 3405.2 were issued. Previous to 1987, some of the Services had issued service-level policy requiring use of Ada in specified applications.	18 Revised
4. Page 16, first paragraph, 2nd sentence. The memorandum issued by USD (Research and Engineering) on June 10, 1983 "requested" immediate implementation of a draft DoD directive, pending its formal coordination. That policy was not "required," nor was the draft directive ever formally issued. DoD policy requiring use of Ada was issued in 1987 in DoD Directives 3405.1.	18 Revised
5. Page 16, third paragraph, 2nd sentence. The title of the Air Force office should be checked -- believe in 1985 it was Assistant Chief of Staff (Information Systems), not Deputy Assistant...	18
Proposed reply:	
1. Attachment, page 3, Finding C (page 15, fifth line). Note that the report better states the rational for the use of Ada in the second and third sentences of the report's second paragraph, page 18.	17
2. Attachment, pages 3 and 4, Findings C (page 15, second paragraph, last sentence and page 18, second paragraph). The first comment says the TRW report compared Ada and C; the second	17 Revised

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says Ada and C++. While similar and having the same foundations, these two languages are distinct. One comment needs to be corrected for consistency and correctness of detail.

20

3. Cover letter, third paragraph and attachment, page 4, Finding C (page 18, second paragraph, a.) Over at least the past 6 years the Joint STARS JPO has had sufficient opportunity to show any lack of cost-effectiveness and has failed to do so, in spite of specific previous direction to produce transition plans. Additionally the program office subsequently awarded a follow-on contract which failed to comply with specific Air Force direction and with DoD policy. Although policy (i.e., DoDD 3405.1) (1) encourages use of commercial off-the-shelf software (COTS) and (2) does not require such software to be written in nor converted to Ada, unique software developed and maintained by, or for, the DoD is required to be in Ada.

The Joint STARS program should be directed to convert all non-COTS software to Ada to achieve compliance with DoD policy.

Department of the Army Comments

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
WASHINGTON, DC 20310-0400

REPLY TO ATTENTION OF

JAN 1994

DAMO-FDI

MEMORANDUM THRU ~~DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS~~
~~DIRECTOR OF THE ARMY STAFF~~
~~ASSISTANT SECRETARY OF THE ARMY (RDA)~~ 31 Jan 94

FOR THE DEPARTMENT OF DEFENSE, INSPECTOR GENERAL (Auditing)

SUBJECT: Draft DOD IG Audit Report on the Acquisition of the Joint Surveillance Target Attack Radar System (Project No 2AS-0065)

1. Although the Army does not agree with the verbatim finding in the Draft Audit Report, we do agree that NBC protection enhancements can be made and have taken the following actions consistent with the recommendations for corrective action:

a. The Air Force and Army are currently updating the JSTARS program cost and operational effectiveness analysis.

b. The Required Operational Capability Document will be converted to an Operational Requirements Document in 1995. Changes will incorporate applicable regulations.

c. The LGSM configuration has been modified and meets Army requirements.

d. The LGSM contract has been modified to incorporate enhanced high-altitude electromagnetic pulse protection and is in the process of being modified to incorporate NBC overpressure protection, detection, and alarm systems.

2. Based upon previous reviews of this program by the ASARC, AFSARC, JROC, CSC, DAB, and incorporation of the enhancements as described above, the LGSM program fully meets Army requirements.

3. The Army appreciates your comments and recommendations and feels the above enhancements satisfy action items addressed in your report. Specific comments to Finding D and Recommendations are attached as enclosure 1.

JAY M. GARNER
Major General, GS
Assistant Deputy Chief of Staff
for Operations and Plans,
Force Development

93088640

Final Report Page No.

DAMO-FDI 5 January 1994

INFORMATION PAPER

1. **PURPOSE.** To Comment on Draft DOD IG Report 2AS-0065.

2. **COMMENTS.** Keyed to Draft IG Report Finding D and Recommendations.

24 3. **Finding D, p.19:**

a. DOD IG states the Army established NBC contamination survivability requirements for the JSTARS LGSM that were insufficient for the effective operation of this mission essential equipment. This condition was caused by the Army's reducing its LGSM system's equipment survivability requirements and the system's vehicle and shelter payload. As a result of payload limitations, the NBC overpressure protection system was not installed in the LGSM requiring the crew to operate in MOPP.

b. Army concurs: Since the audit period, the LGSM configuration has been modified and now satisfies the auditors concerns outlined in this report. The new configuration includes a trailer towed behind the HMMWV/shelter. The trailer carries a 15 KW generator power source and equipment off loaded from the vehicle. Based upon this configuration change, the system weight will be less than the vehicle's weight limitation (10,000 lbs) and provide adequate power, space, and weight to incorporate a Gas Particulate Filter Unit.

30 4. **Finding D, Recommendation 1a, p.25.**

a. DOD IG states the Army should perform a modified cost and operational effectiveness analysis to determine whether the use of the High Mobility Multi-purpose Wheeled Vehicle Heavy Variant and the mounted Lightweight Multi-purpose Shelter will satisfy the Light Ground Station Module mission and survivability requirements. If not satisfactory, identify and require appropriate vehicle and shelter alternatives in the Light Ground Station Module configuration.

b. Army partially concurs: In July 93, the Defense Acquisition Board approved the Light Ground Station Module acquisition strategy, exit criteria, low rate initial production for 10 systems and "directed the Air Force and Army to update the COEA". The COEA will provide the analytical basis to support the Milestone III decisions regarding the production quantities of aircraft and ground station modules and to support the product improvement decisions. The Air Force and the Army are currently

Encl 1

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DAMO-FDI page 2 5 January 1994
Subject. Comments on Draft DOD IG Report 2AS-0065

updating the JSTARS Program COEA. The Army does not plan to conduct a separate COEA for reasons stated in the report.

5. Finding D, Recommendation 1b, p.25: 30

a. DOD states the Army should revise the LGSM Required Operational Capability Document to require the shelter configuration to have an NBC overpressure protection system and high-altitude electromagnetic pulse hardness protection as required by AR 70-60 and 70-71.

b. Army partially concurs: The Army plans to convert the GSM Required Operational Capability Document to an Operational Requirements Document in 1995. The Army will incorporate changes to this document IAW applicable regulations.

6. Finding D, Recommendation 1c, p.25: 31

a. DOD states the Army should revise the Lightweight Multi-purpose Shelter to require high-altitude electromagnetic pulse hardness and have nuclear, biological, and chemical overpressure protection as required by AR 70-60 and 70-71.

b. Army nonconcurs: As per AR 70-71 and 70-60, survivability applies to mission essential or critical components of mission essential end items of equipment. The Lightweight Multipurpose Shelter can be used to house non-mission essential items as well. The level of survivability should be tailored to meet mission requirements and addressed at the Combat Developer and Systems Integration Level. This was accomplished during the LGSM development process and reviewed by the ASARC, AFSARC, JROC, CSC, and DAB.

7. Finding D, Recommendation 2a, p.26: 32

a. DOD IG states the Army should modify the design requirements in the LGSM contract to incorporate the nuclear, biological, and chemical overpressure system in the Lightweight Multipurpose Shelter to comply with AR 70-71.

b. Army partially concurs: The Army is inserting a positive overpressure system called the GPFU (Gas Particulate Filter Unit) along with detection and alarm systems. The GPFU will be provided to the contractor as government furnished equipment. Contract modifications to incorporate these systems are scheduled to be released NLT January 1994 and definitized by April 1994.

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Subject. Comments on Draft DOD IG Report 2AS-0065

32

8. Finding D, Recommendation 2b, p.26:

a. DOD IG states the Army should modify the design requirements in the LGSM contract to incorporate the high-altitude electromagnetic pulse hardness protection modification for the shelter, identified by the Army Research Laboratory, Woodbridge, VA, to satisfy Army survivability requirements in AR 70-60.

b. Army partially concurs: The requirement for HEMP protection was incorporated under Modification PZ007 to the LGSM contract DAAB07-92-C-L001 and awarded 29 Jun 93. Radio frequency shielding will be placed on the shelter harness, ingress and egress of electrical cables, and all openings to include the door. This modification to the contract and the built in HEMP protection of the Lightweight Multipurpose Shelters meets the requirements of applicable regulations and HQDA DCSOPS Memorandum titled "Nuclear and Chemical survivability of Tactical Systems".

9. There are no monetary benefits derived as a result of implementing the above changes.

10. POC this action is DAMO-FDI, MAJ Nichols, Ext 54222.

Department of the Air Force Comments

DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

OFFICE OF THE ASSISTANT SECRETARY

20 DEC 1993

MEMORANDUM FOR ASSISTANT INSPECTOR GENERAL FOR AUDITING
OFFICE OF THE INSPECTOR GENERAL
DEPARTMENT OF DEFENSE

FROM: Director of Fighter, C2 And Weapons Programs,
Assistant Secretary of the Air Force (Acquisition)

SUBJECT: Acquisition of the Joint Surveillance Target Attack Radar System, Draft DOD IG Audit Report, Project No. 2AS-0065, October 22, 1993 - INFORMATION MEMORANDUM

This is in reply to your request for Air Force comments on the subject report.

Finding A: Acquisition Planning for Component Breakout

We partially concur with the finding and its associated recommendations. However, the IG's assertion that the JPO "did not consider making comprehensive component breakout review to support the Joint STARS FY 1996 acquisition strategy" is incorrect. The JPO has considered component breakout and has bought the Surveillance Control Data Link (SCDL) Ground Data Terminal (GDT) direct from Cubic Corporation. The JPO has also broken out the buy of five Boeing 707 airframes for use during Low Rate Initial Production (LRIP). The JPO considered further breakouts for the E-8C third system acquisition and for LRIP and concluded that it was not feasible or practical. This decision is documented in the Integrated Program Summary (IPS), 9 Apr 93, and approved by the USD(A) in the Acquisition Strategy Report (Annex C of the IPS), as follows:

"Due to the highly complex nature of the Joint STARS system, the substantial amount of software and hardware development, and lack of adequate technical data packages to support competition at this point, breakout of major components or subsystems to other contractors is not considered feasible or practical for the Third System acquisition or LRIP. In addition, it is in the Government's best interest to have the contractor retain total systems responsibility through the LRIP phase. However, reprocurement data was purchased under the FSD and the follow-on contracts. Component breakout will be addressed as part of the full rate production acquisition strategy."

As stated in our Acquisition Strategy Report, the JPO plans to conduct a component breakout review for Full Rate Production (FRP). We plan to review all major components for breakout, including the components listed in the draft audit report. Some of the components suggested by the report (e.g., secondary power system and disk storage system) appear to be viable candidates for breakout. Others (e.g., radar sensor) do not appear to be viable candidates for a variety of reasons. For example, some components contain proprietary technology that cannot be released to the open marketplace. Without the ability to compete the components in the open marketplace, potential savings gained from breakout into competitive procurements are substantially reduced.

Also, note that the potential cost savings identified by the report are inaccurate. The report assumes that 13.1% in overhead costs could be saved in all components. This is an incorrect assumption. Because Joint STARS is a major portion of the business base, and because the continuing overhead costs will be distributed over that business base, the overhead rates are likely to go up and Joint STARS will still be paying for much of it. Furthermore, the procurement costs associated with several of the components listed in the report are inaccurate. For instance, the per unit component costs for the radar sensor, inertial measurement system, and military VAX computers were cited in the report as $ * , $ * , and $ * respectively. In reality, however, the per unit costs are expected to be $ * , $ * , and $ * , respectively.

An additional cost consideration is the increased management and technical overhead costs to the Government of managing the additional contracts for the identified components. Furthermore, although the report considers design risk, it does not consider the increased production and system integration risk to the Government when the Government assumes the responsibility for delivering the (broken out) components to the prime contractor as GFE. These and other factors must and will be considered by the Air Force during a comprehensive component breakout review to be completed in CY94.

Finding B: Aircraft Refurbishment and Modification

Non-Concur.

There are two reasons for our non-concurrence. First, the introduction of a new contractor for our airframe introduces unacceptably high technical and cost risks. Initially, it would seem that any aircraft manufacturer could refurbish and modify a Boeing 707. However, all B707s are not alike. Different series of aircraft exist and, due to the limited number of same-series B707s, we must use

* PROPRIETARY DATA REMOVED.

different types. This forces a "running" redesign of airframe modifications to accommodate Joint STARS Prime Mission Equipment (PME). Redesign activities currently ongoing on the fourth production airframe (P4) illustrate this point. This airframe is a 707-373 model, which is different from the previous 338C models used for P1, P2, and P3. Teardown was just completed on the aircraft and Grumman has identified a significant number of configuration differences resident on this non-standard airframe requiring redesign. As this problem continues, drawing packages will have to be continually updated, eliminating the ability to provide a complete drawing package to industry for competition. Grumman's experience with the used 707 airframes will be invaluable as we enter the later stages of the program and address such problems. To date, Grumman has modified six used B707 airframes, and is currently modifying a 7th airframe. They have become the world's most experienced contractor for modifying used B707 airframes for military use. Using any other company at this stage in the program would court disaster due to cost and technical risks.

The second reason for non-concurrence is because under the concurrent program strategy directed by the Department of Defense in 1985, the opportunity for competing aircraft refurbishment and modification activities comes too late in the program to be very beneficial to the Government. Even assuming that aircraft configurations don't change (an invalid assumption as illustrated above) the earliest that we could compete the refurbishment/modification effort would be Lot VIII (the 15th aircraft). We could not compete it any earlier because a complete drawing package is not contractually required until 3Q FY97. Therefore, after allowing time for proposal response and source selection, the earliest we could award a contract would be Lot VIII. At that point there would be only five aircraft left, two of which are the FSD aircraft which have already received initial refurbishment and modification. Unless Congress increases the buy for Joint STARS beyond these remaining five aircraft, another contractor would not be cost competitive with Grumman. This is due to the lost learning cost associated with taking on a new contractor. If Congress increases the buy for Joint STARS then the issue of competing refurbishment and modification should be re-addressed at that time.

Based on the above reasons, there is no basis to support any cost savings by competing refurbishment/ modification of airframes, much less the $67M claimed by the draft report.

Finding C: Aircraft Mission-Critical System Software

Partially Concur.

The statement that the JPO "has not initiated a plan to transition Joint STARS aircraft mission-critical system software into Ada software programming language" is not accurate. We began development of a transition plan early in 1993 and expect to complete development of that plan by the 2Q FY94. Also, in the Background section, the final sentence of the first paragraph describes the content of a TRW study that addresses cost savings derived by using Ada versus other high-order programming languages. The referenced TRW study applied a standard cost model (Cost Computational Model (COCOMO)) comparison of the Ada and C software languages to only one Command Control, Communications (C3) program, the Command Center Processing and Display System - Replacement (CCPDS-R). The TRW study did not compare multiple "systems written in Ada versus systems with software written in other high-order programming languages," as stated in the draft report.

Additionally, the draft report makes several references to the TRW study finding of 35% savings in software maintenance costs when using Ada. Again, those savings are based on a typical C3 program, and are not necessarily directly applicable to other programs such as Joint STARS. For instance, the Joint STARS mission-critical software is heavily based on commercially-produced hardware. Along with this commercial hardware comes commercial software, some of which is proprietary. As such, we cannot convert all commercial software to Ada. Therefore, any cost savings calculations for Joint STARS must be based on conversion of non-proprietary commercial software and Grumman-developed software, which is a subset of the total Joint STARS software.

Based on the facts stated above, the statement in the last paragraph of the "Ada Implementation" section of the draft report that the "benefits of the Joint Program Office transitioning to Ada programming language before the aircraft initial operational capability date far outweigh the cost and schedule impacts" is totally unsupported. A thorough cost-benefit analysis of Ada transition would need to be performed specifically for the Joint STARS program before an assertion of this type could be proven. The COCOMO model used in the TRW study estimates software maintenance costs as a function of the magnitude and complexity of the development effort and the estimated annual software changes. Over 65% of the estimated 652,000 lines of developed software for the E-8C is complete as a result of the E-8A program. Also, the remaining software code currently being developed under the E-8C third aircraft development effort is approximately 60% complete. The Joint

STARS specific cost benefit analysis would need to incorporate not only software maintenance cost savings realized through transition to Ada, but also the additional costs required to convert all existing Joint STARS software to Ada (both commercial and non-commercial), including the cost of acquiring software support tools.

With regard to Recommendation 1.a. of Finding C, that the Joint STARS Program Office provide an Ada transition plan for the Joint STARS aircraft mission critical system software, we agree that this is necessary, and we are already in the process of developing such a plan to be presented to higher headquarters in the 2Q FY94. The objectives of the plan will be to baseline existing Joint STARS code, determine logical candidate code for conversion, survey Ada conversion efforts on other acquisition programs for lessons learned, determine the costs and benefits of potential conversion candidates, develop a schedule for the conversion candidates, develop a schedule for the conversion, and then determine a recommended acquisition approach. This plan will also consider other factors that could impact the Ada conversion such as weapon system deployment implications, tradeoffs of using other high-order languages, and inputs from commercial software vendors. The cost effectiveness analysis included in the plan will quantify the life cycle impacts of transitioning the Joint STARS program mission-critical software to Ada. This type of analysis, and thus the plan itself, is required before direction to convert Joint STARS to Ada should be considered. For this reason, we feel that any actions taken to provide funding and direction for transition to Ada prior to completion of our transition plan, as indicated in Recommendation 1.b., would be premature.

Likewise, we non-concur with Recommendation 2.a. Without an approved Ada transition plan and adequate approved funding, any contract modifications would be premature. Contract actions made prior to issuance of proper direction and funding would place the Joint STARS program at risk and would complicate the potential competition of an Ada conversion effort.

Summary

The Air Force has thoroughly reviewed the findings and recommendations of the DOD IG draft report. Based on this review we partially concur with Findings A and C, and non-concur with Finding B. These findings would indicate that the Program Office has not addressed or considered the issues of component breakout, aircraft refurbishment and modification, and transition of mission-critical software to Ada, when in fact we have thoroughly considered each. Each of these areas has been carefully considered as part of our acquisition strategies for both EMD and LRIP, both of which

have been approved. As stated above, we intend to address the DOD IG Finding A through evaluation of components for breakout as part of our strategy. Similarly, we are continuing to develop our Ada Transition Plan, in line with Finding C of the draft report.

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