United States General Accounting Office

GAO

Report to the Secretary of Defense

April 2001

ELECTRONIC WARFARE

The Army Can Reduce Its Risks in Developing New Radar Countermeasures System

GAO-01-448

Form SF298 Citation Data

Report Date *("DD MON YYYY")* 00APR2001	**Report Type** N/A	**Dates Covered (from... to)** *("DD MON YYYY")*

Title and Subtitle ELECTRONIC WARFARE: The Army Can Reduce Its Risks in Developing New Radar Countermeasures System	**Contract or Grant Number**
	Program Element Number
Authors	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) General Accounting Office, PO Box 37050, Washington, DC 20013	**Performing Organization Number(s)** GAO-01-448
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Monitoring Agency Acronym**
	Monitoring Agency Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes

Abstract
The Army is in the process of acquiring a new, state-of-the-art radar countermeasures systemcalled the Suite of Integrated Radio Frequency Countermeasuresto enable its helicopters and other aircraft to identify, track, and defeat radar-guided missiles in complex electronic environments where many radar systems could be operating simultaneously. Customers for the system include the Armys Apache helicopter and the Air Forces Special Operations CV-22 tilt-rotor aircraft. When the Army began developing the new system in 1994, low-rate initial production was originally scheduled to begin in 1999 and full-rate production in 2001. In 1999, the Army restructured the program to provide more time and money for serious developmental problems uncovered during testing. The Army has delayed the low-rate initial production decision to 2002 and the full-rate production decision to 2003. The systems overall development cost has increased from $54 million to a projected $127 million. Because of the developmental problems with the new radar countermeasures system, we reviewed the Armys acquisition program to determine whether it will provide decisionmakers with sufficient knowledge about the systems readiness to begin low-rate initial production.

Subject Terms

Document Classification unclassified	**Classification of SF298** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** unlimited
Number of Pages 19	

Contents

Figures

GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

April 30, 2001

The Honorable Donald H. Rumsfeld
Secretary of Defense

Dear Mr. Secretary:

The Army is in the process of acquiring a new, state-of-the-art radar countermeasures system—called the Suite of Integrated Radio Frequency Countermeasures—to enable its helicopters and other aircraft to identify, track, and defeat radar-guided missiles in complex electronic environments where many radar systems could be operating simultaneously. Customers for the system include the Army's Apache helicopter and the Air Force's Special Operations CV-22 tilt-rotor aircraft.

When the Army began developing the new system in 1994, low-rate initial production was originally scheduled to begin in 1999 and full-rate production in 2001. In 1999, the Army restructured the program to provide more time and money for serious developmental problems uncovered during testing. The Army has delayed the low-rate initial production decision to 2002 and the full-rate production decision to 2003. The system's overall development cost has increased from $54 million to a projected $127 million.

Because of the developmental problems with the new radar countermeasures system, we reviewed the Army's acquisition program to determine whether it will provide decisionmakers with sufficient knowledge about the system's readiness to begin low-rate initial production.

Results in Brief

The Army will assume increased risks if it begins low-rate initial production of the new radar countermeasures system before determining whether key new components perform as required. The system's contractor is now making software and hardware changes to improve the system's performance and address the obsolescence of parts, reduce cost, and improve producibility. If all goes well, the contractor would complete the software changes and the Army would be able to determine whether the software performs as required before the low-rate initial production decision in early 2002. The hardware changes, however, require more time to complete. The contractor has agreed to develop new components, including a new digital receiver for detecting radar signals (in place of the

current analog receiver), by June 2002. The Army would then determine whether the hardware performs as required, including its successful integration with the software and aircraft, through developmental testing by September 2002. According to Department of Defense guidance for acquiring systems, one of the purposes of low-rate initial production is to produce production representative articles for initial operational test and evaluation. In our view, a key to assuring that these articles will be production representative is to first conduct developmental testing of the modified software and hardware together as a system in the aircraft to ensure the design is stable before beginning low-rate initial production. By deferring the low-rate initial production decision until it has this knowledge, the Army would reduce the risk of incurring unanticipated costs to retrofit articles if the system does not perform as required.

We are recommending in this report that the low-rate initial production decision for the new radar countermeasures system be deferred until the contractor has completed ongoing software and hardware modifications and the Army has determined that the system, as modified, performs as required. In response, the Department stated that we are correct in our assessment that the radar countermeasures program has faced technical challenges both in software and hardware, but it did not concur with our recommendation. The Department maintained that it will have sufficient data to assess the performance of the system's design before the low-rate initial production decision, now scheduled for early 2002.

We continue to believe that the Department would decrease its risks by deferring the low-rate initial production decision until the hardware modifications are completed and integrated and the system is found to perform as required. The system's development has been ongoing for 7 years. In our view, it is prudent that the Army take the several extra months to test the actual replacement hardware components with the software and in the aircraft so that the Army can assure itself that the system design is stable.

Background

Radar-guided missile systems emit radio-frequency energy, that is, radar signals, which reflect or bounce off the surfaces of aircraft in flight. In essence, all radar-guided missile systems use these reflected signals to locate and target aircraft. The Army currently has two types of radar countermeasure systems fielded on its helicopters to defend them from radar-guided missiles. The first type seeks to decoy the missile away from the aircraft by providing alternative reflected radar signals for the missile to follow. This is accomplished by using a missile warning system that

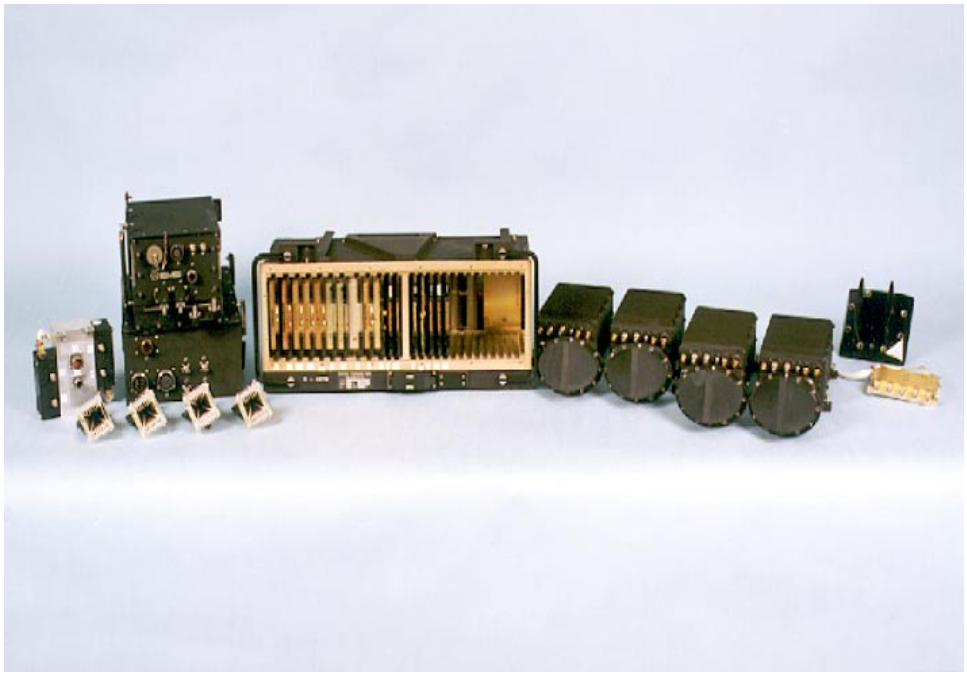
detects approaching missiles and signals countermeasure dispensers on the aircraft to launch chaff in an attempt to confuse the missile's radar.[1] The second type of countermeasure system uses a radar-warning receiver and radar jammer to defeat radar-guided missile systems. A radar-warning receiver detects radar-guided missile systems so the aircraft's pilot can navigate out of the missile's range. If the systems cannot be avoided, a radar jammer emits electronic radio-frequency transmissions to confuse and/or blind the radar-guided missile system.

The Army's Suite of Integrated Radio Frequency Countermeasures system will include an advanced-threat radar-warning receiver and an advanced-threat radar jammer. (See figure 1.) These components are expected to provide state-of-the-art-radar warning and jamming capabilities and to perform better than the Army's currently fielded radar warning receivers and radar jammers.[2] The advanced-threat radar-warning receiver will provide enhanced situational awareness by more precisely detecting, identifying, locating, and tracking multiple radio-frequency threat systems. Likewise, the advanced-threat radar jammer is expected to counter multiple and simultaneous modern radio-frequency threats. In addition, the system can be reprogrammed to defeat different threat systems, and its modular open architecture allows for reconfiguring its components so that applications on multiple aircraft types are possible.

[1] Chaff is made up of bundles of thin strips of metal or semi-metallic material that, when launched from an aircraft, disperse to form a cloud of material that reflects radar energy. These reflections are intended to confuse the radar-guided missile system about the true location of the aircraft.

[2] The Army is improving its missile approach warning systems and countermeasures dispensers as part of the Suite of Integrated Infrared Countermeasures program. See *Electronic Warfare: Phased Approach to Infrared Upgrades Would Reduce Risk to Helicopters.* (GAO/NSIAD-00-171); July 27, 2000.

Figure 1: Suite of Radio Frequency Countermeasures Components



Source: U.S. Army.

For acquiring electronic warfare systems such as the new radar countermeasures system, departmental guidance[3] states that developmental testing provides decisionmakers with knowledge about whether the system is ready to begin low-rate initial production—the next step in the acquisition process after engineering and manufacturing development. Developmental testing begins in a controlled environment by testing individual components of a system in the laboratory. Based on the results of this testing, individual components are modified, improved and/or replaced until they meet component-level performance requirements. After the performance of each component is tested and validated, the developmental test process is repeated at the subsystem and finally system level. The developmental test process continues until the system's ability to meet performance requirements when installed on a weapon system platform is tested and validated.

[3] *A Description of the DOD Test and Evaluation Process for Electronic Warfare Systems*, (DTIC ADA-282514), Revision 2, July 31, 1996.

According to the Department's guidance for acquiring systems, low-rate initial production is designed to (1) establish an initial production base for the system and ensure adequate and efficient manufacturing capability, (2) produce the minimum quantity necessary to provide production configured[4] or representative articles for initial operational testing and evaluation, and (3) permit an orderly increase in the production rate for the system sufficient to lead to full-rate production upon the successful completion of operational testing.[5] Operational testing, which follows developmental testing, is designed to determine whether a production-configured system can meet performance requirements in an operationally realistic environment.

Software Modifications Will Be Tested Before Low-Rate Initial Production Decision, But Hardware Modifications Will Not Be

The Army's contractor for its new radar countermeasures system has substantial software and hardware changes under way to improve the system's performance and address the obsolescence of parts, reduce cost, and improve producibility. The Army intends to determine that the modified software performs as required in time for the low-rate initial production decision now scheduled for some point from January through March 2002. However, the current schedule does not provide for completion and integration of the hardware changes into the system until June 2002 with testing completed by September 2002.

Software Issues

Beginning in 1999, laboratory testing of developmental prototypes of the new radar countermeasures system indicated that significant software deficiencies had to be corrected before the system could meet performance requirements. Because of these software deficiencies, the prototype countermeasures system could not properly perform any of its major functions; that is, it could not properly detect, identify, track, or defeat threat radars. In response to these results, the Army's Program Manager directed the system contractor to undertake the major software maturation effort that is now under way.

[4] An item is "production configured" when the design is stable and matches the design planned to be manufactured on the production line.

[5] See *Operation of the Defense Acquisition System*, 4.7.3.3.4. (DODI 5000.2, Jan. 4, 2000)

For the software maturation effort, the Army directed the contractor to follow a disciplined maturation process. This involved breaking down the system's software into a series of 10 blocks with each successive block introducing more complex functionality (e.g., detect and identify one radar; detect and identify multiple radars; detect, identify and jam one radar; and so forth). To ensure that the contractor adheres to this process, the Army does not approve the introduction of succeeding software blocks into the system until the functionality of the prior block has been demonstrated in the Army's laboratory at Fort Monmouth, New Jersey.

According to the Defense Contract Management Agency, which the Army has engaged to oversee the program, the ongoing software maturation effort, as of April 2001, has been rated as high risk.[6] Laboratory tests indicate that the software continues to have difficulty in properly detecting, identifying, tracking, and defeating threat-radar systems in complex environments where many radars are operating simultaneously. Moreover, according to the Agency, flight-testing on an Apache helicopter has begun recently and a new set of software problems is being experienced because the operating environments of the aircraft and open-air test range are very different than the controlled conditions of the laboratory. For instance, interference resulting from the simultaneous operation of the system with the Apache's fire control radar is resulting in system resets. Resets are totally unacceptable for countermeasure systems because they refer to instances when the software causes the system to reboot. While the system is rebooting, the aircraft and aircrew are completely unprotected.

Overall, the software maturation effort is 4 months behind schedule, and the contractor has been submitting increasing numbers of unanticipated software change requests each month for the past 6 months as the software blocks are becoming more complex. Change requests have increased each month from September 2000, when they numbered 699, to March 2001, when they reached 923. The need to make unanticipated changes is expected in a software maturation process, according to the Defense Contract Management Agency; nonetheless, increasing numbers of changes result in additional cost to the program and the extension of test schedules. Of the 10 software blocks, blocks 1 through 8a have now

[6] "High risk" is defined as likely to result in unacceptable performance, schedule or cost based on complexity of development and technology, history or present performance; or may result in loss of life or mission.

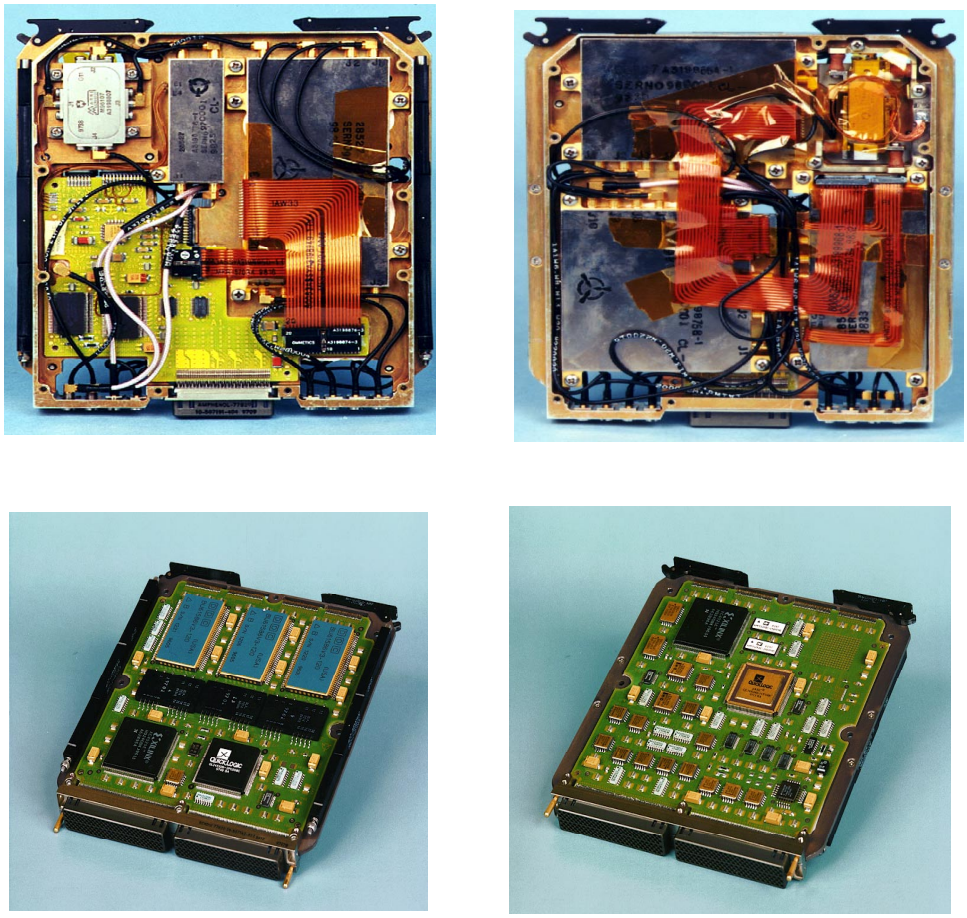
been accepted, and the contractor was scheduled to deliver block 9 for testing in April 2001. (Block 8 did not pass acceptance testing at Fort Monmouth, so the contractor had to create block 8a, which was accepted by the Army in March 2001.)

Hardware Issues

While software maturation continues under the original developmental contract, the contractor is addressing hardware improvements under a separate $13.2 million technology insertion program contract to redesign, develop, and test new system components. The contractor plans to complete and integrate hardware changes into the system by June 30, 2002. The Army then plans to determine whether the modified system performs as required by September 2002.

According to the contractor, replacing key hardware components of the current prototype system is necessary to reduce costs, address the obsolescence of electronic parts, enhance producibility and improve system performance. The contractor is developing replacements for such components as the primary computer processor, the tracker used to locate radar sources, and the frequency synthesizer used to produce the electronic responses to hostile radar signals. The contractor is also replacing the analog wide-band receiver used to detect radar signals with an improved receiver based on digital technology. (See figure 2.)

Figure 2: Contractor Plans to Replace Current Analog Receiver Components (top) with Digital Receiver Technology (bottom)



Source: ITT Industries.

As of April 2001, the Defense Contract Management Agency was rating hardware issues and the system's readiness for production as moderate risk.[7] According to the Agency, the bases for this assessment include staffing shortages, parts delivery delays, and failures during

[7] Moderate risk is defined as likely to result in unacceptable or marginal performance, schedule or cost based on complexity of development and technology, history or present performance.

electromagnetic interference, shock/vibration, and humidity testing, all of which are delaying the contractor's schedule.

Besides physical changes to the system, hardware changes will cause additional changes to be made to the system's software. This is because the hardware functions of the system are software-controlled. In order to exercise this control, the software has to be written to "recognize" the behavior of the new components so the right software commands are issued and the hardware will do what it is supposed to do at the right time.

Additionally, while making changes to hardware components and software, the contractor discovered carcinogenic beryllium oxide residue on the system during humidity testing. To address this problem, the contractor is now developing and testing aluminum component casings for beryllium casings that had already been developed. Substituting aluminum for beryllium is troublesome because (1) aluminum is weaker and heavier than beryllium and (2) the weight of the radar countermeasures system was already more than 20 pounds over the Army's requirement even with use of the lighter beryllium casings.

Department officials told us that the insertion of the hardware modifications is not substantial enough to constitute a significant design change and that little risk is associated with the integration of the new hardware with the software and the aircraft. However, based on test results to date and monthly status reports from the Defense Contract Management Agency, we did not find that integrating the new hardware with the software and the aircraft will be a low-risk undertaking.

According to departmental guidance for acquiring systems, one of the purposes of low-rate initial production is to produce production representative articles for initial operational test and evaluation. In our view, a key to assuring that these articles will be production representative is to first conduct developmental testing of the modified software and hardware together as a system in the aircraft to ensure the design is stable before beginning low-rate initial production. We believe, therefore, that the Department would decrease its risks by deferring the low-rate initial production decision until the hardware modifications are completed and integrated and the system is found to perform as required. Only the testing of the actual replacement components can provide assurance that the system's design is stable.

Conclusion

The Army has identified software and hardware modifications needed for its new radar countermeasures system. The Army expects that future tests will enable it to determine whether the modified software performs as required before the planned low-rate initial production decision in early 2002. However, the testing of the modified hardware is not scheduled for completion until September 2002. By deferring the low-rate initial production decision, the Army would reduce the risk of incurring unanticipated costs to retrofit articles if the system does not perform as required.

Recommendation for Executive Action

We recommend that the Secretary of Defense direct that the Army defer the low-rate initial production decision until software and hardware modifications are completed and the Army determines that the integrated system, as modified, performs as required.

Agency Comments and Our Evaluation

Although the Department of Defense concurred with our finding that the Army's radar countermeasures program has faced technical challenges both in software and hardware, it did not concur with our recommendation. The Department stated that our draft report was incorrect in finding that hardware modifications were being made to correct performance deficiencies. It maintained that the contractor's hardware modifications are necessary to address cost, parts obsolescence and producibility issues, and the changes are only more technologically advanced form, fit, and function replacements for existing components.

We recognize that the purposes of the changes include addressing cost, parts obsolescence and producibility issues. Nevertheless, program documentation provided by the contractor and the Defense Contract Management Agency indicates that these changes are also necessary to meet system performance requirements for several components, including the wide-band receiver and the system processor. We also recognize that any replacement component for a system must be form, fit, and function compatible; otherwise it cannot be successfully installed or expected to work in the system. It cannot be automatically assumed, however, that developing these replacement components is low risk simply because they are planned to be form, fit, and function compatible.

After receiving the Department's comments, we acquired updated data from the Defense Contract Management Agency to provide the most current information on the risks associated with the ongoing software and hardware modification process. After reviewing the additional data, we

continue to believe that the Department would decrease its risks by deferring the low-rate initial production decision until the hardware modifications are completed and integrated and the system is found to perform as required. Although the Department may well be confident in the ability of the contractor to successfully develop replacement components, it cannot conclude on the basis of the performance of existing hardware components that different, replacement components will be satisfactory. System development has been ongoing for seven years. In our view, it is prudent to take the extra several months to test the actual replacement components with the software and in the aircraft so that the Army can assure itself that the system design is stable before it proceeds to low-rate initial production.

Scope and Methodology

To determine whether the Army's decisionmakers will have sufficient knowledge about the readiness of the Suite of Integrated Radio-Frequency Countermeasures system to enter the low-rate initial production decision as planned in the second quarter of fiscal year 2002, we analyzed the Army's modernization, acquisition, and fielding plans for the system and the contractor's performance reports and other program documentation produced by the Army and the Defense Contract Management Agency.

To ensure that we understood the documentation we utilized, we interviewed officials of the Office of the Secretary of Defense, Washington, D.C.; the Department of the Army, at Arlington, Virginia; the Program Executive Office for Army Aviation, and Missile and Space Intelligence Center at Redstone Arsenal, Alabama; the Communications and Electronics Command at Fort Monmouth, New Jersey; and the Army Aviation Directorate of Combat Development at Fort Rucker, Alabama. We also interviewed representatives of the Suite of Integrated Radio-Frequency Countermeasures contractor, International Telephone and Telegraph, Avionics Division in Clifton, New Jersey. We conducted our work from September 2000 through April 2001 in accordance with generally accepted government auditing standards.

This report contains a recommendation to you. The head of a federal agency is required under 31 U.S.C. 720 to submit a written statement of actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Reform not later that 60 days after the date of this letter and to the Senate and House Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of this letter.

We are sending copies of this report to interested congressional committees; the Honorable Joseph W. Westphal, Acting Secretary of the Army; and the Honorable Mitch Daniels, Director, Office of Management and Budget. Copies will also be made available to others upon request. If you have any questions regarding this report, please contact me at (202) 512-4841 or Charles A. Ward at (202) 512-4343. Key contributors to this assignment were Dana Solomon and John Warren.

Sincerely yours,

R. E. Levin
Director, Acquisition and Sourcing Management

Appendix I: Comments From the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND TECHNOLOGY

28 MAR 2001

Mr. R. E. Levin
Director, Acquisition and Sourcing Management
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Levin:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "ELECTRONIC WARFARE: Low-Rate Initial Production Decision for New Radar Countermeasures System Should Be Deferred", dated February 20, 2001 (GAO Code 707553/OSD Case 3042).

The GAO is correct in its assessment that the Suite of Integrated Radio Frequency Countermeasures (SIRFC) program has faced technical challenges both in hardware and software. As stated in the draft report, the Army restructured the program, increased program oversight, and directed the contractor to follow a disciplined maturation process which would result in the award of Low-Rate Initial Production (LRIP) quantities.

As recognized in the GAO Draft Report, the Army has implemented strict controls of the contractor's software development process. The contractor is not allowed to proceed until the Army is assured all problems are fully investigated, identified, and corrected. The Army must approve all software development before it is implemented into the SIRFC system.

The Army is currently executing a software maturation process that is on track to meet an LRIP decision in the 2nd quarter of Fiscal Year 2002. This process encompasses a "building block" approach to software maturation, with each successive block introducing more complex system functionality. Additionally, the Army instituted an independent verification and validation of each software block before allowing the contractor to proceed to the next step.

Software improvements are currently being implemented and will be tested prior to the LRIP decision. The Army continues to stress the system in increasingly severe operational environments to ensure that the implemented software upgrades are effective. The SIRFC system, with the latest software, is currently being evaluated in flight tests at the Naval Weapons Center, China Lake. Detailed data are being collected during flight tests to support laboratory results and to further study the two remaining upgrades identified in Block 7 software. The Army accepted Block 8A software this month.

In FY00, the Army awarded a Technology Insertion Contract to the prime contractor to address system production cost, electronic parts obsolescence, and production processes. This contract is to ensure that the system design, which has already demonstrated acceptable performance, is producible. The SIRFC's modular design provides for the insertion of the most current technology during any phase of production. For example, the Wide-Band Receiver hardware deficiencies contained in the Technology Insertion Contract have already been corrected and tested in the existing systems. However, the changes to enhance producibility will not be inserted prior to the LRIP decision. They will, however, be incorporated into the system in time to support operational testing, which will be conducted prior to the full-rate production decision.

The Department believes that sufficient data will exist to assess the performance of the SIRFC's design prior to entering LRIP. Before an LRIP decision is made, the Government will have obtained sufficient data following extensive testing. This includes laboratory hardware-in-the-loop testing conducted at the Benefield Anechoic Facility (Edwards Air Force Base, CA) and at the Radio Frequency Simulation System Facility (Huntsville, AL), as well as both contractor and government developmental flight tests, and an independent operational assessment.

The Department appreciates the opportunity to comment on the draft report. Detailed comments for technical correctness and accuracy have been forwarded under separate cover.

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure: Response to GAO Draft Report

GAO DRAFT REPORT DATED FEBRUARY 20, 2001
(GAO CODE 707553/OSD CASE 3042)

"ELECTRONIC WARFARE: Low-Rate Initial Production Decision for New Radar Countermeasures System Should Be Deferred"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Army to test and validate the performance of the modified radar countermeasures system before beginning low-rate initial production. (p. 9/GAO Draft Report)

DOD RESPONSE: Non-concur. The "modified radar countermeasures" referred to in the GAO Draft Report will, in fact, be tested prior to a full-rate production decision, but not prior to the low-rate initial production (LRIP) decision. There is a fundamental difference between the Department and the GAO on the purpose of the "modified" radar countermeasure system. It is the GAO's position that the changes to the system currently being tested are required to correct system performance deficiencies. This is not the case. The Army has a process in place to mature the system software. The process is working, and the program is on schedule for an LRIP decision. The system hardware changes for producibility and obsolescence, to be tested prior to the full-rate production decision, are planned during LRIP. These changes are form, fit, and function compatible with the system design presently being tested. The decision to enter into LRIP will be made on the system performance of the hardware and software presently under development.

Ordering Information

The first copy of each GAO report is free. Additional copies of reports are $2 each. A check or money order should be made out to the Superintendent of Documents. VISA and MasterCard credit cards are also accepted.

Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

Orders by mail:
U.S. General Accounting Office
P.O. Box 37050
Washington, DC 20013

Orders by visiting:
Room 1100
700 4th St., NW (corner of 4th and G Sts. NW)
Washington, DC 20013

Orders by phone:
(202) 512-6000
fax: (202) 512-6061
TDD (202) 512-2537

Each day, GAO issues a list of newly available reports and testimony. To receive facsimile copies of the daily list or any list from the past 30 days, please call (202) 512-6000 using a touchtone phone. A recorded menu will provide information on how to obtain these lists.

Orders by Internet
For information on how to access GAO reports on the Internet, send an e-mail message with "info" in the body to:

Info@www.gao.gov

or visit GAO's World Wide Web home page at:

http://www.gao.gov

To Report Fraud, Waste, and Abuse in Federal Programs

Contact one:

- Web site: http://www.gao.gov/fraudnet/fraudnet.htm
- E-mail: fraudnet@gao.gov
- 1-800-424-5454 (automated answering system)