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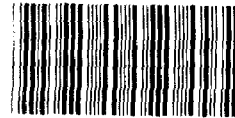
GAO

Report to Congressional Requesters

June 1988

# WEAPON SYSTEMS

## Acquisition of the Army's Line-of-Sight Forward Heavy Air Defense System



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**National Security and  
International Affairs Division**

B-223712

June 30, 1988

The Honorable Denny Smith  
The Honorable Charles Bennett  
The Honorable Tom Ridge  
House of Representatives

In your letter of April 28, 1987, you requested that we review various aspects of the Army's Forward Area Air Defense System (FAADS). Since the Army was about to begin a critical competitive test that would lead to its acquiring a line-of-sight forward heavy (LOS-F-H) system, one of the major FAADS elements, we agreed with representatives from your office to concentrate our review on the LOS-F-H system acquisition. We focused our review on the adequacy and realism of the testing and other aspects of the LOS-F-H system acquisition, including its estimated cost, Army analyses of the system's operational effectiveness, and the validity of the threat the LOS-F-H system is to counter.

In general, we found that the competitive test, although constrained, was objective and adequate to select the best existing system to meet the LOS-F-H requirements. The Army must conduct additional operational tests to determine how the system will work in a realistic environment. Our work is further summarized in this letter and more fully discussed in appendix I. Appendix II describes our objectives, scope, and methodology.

The LOS-F-H system's mission is to provide air defense for elements of the division's forward area against attacks by fixed- and rotary-wing aircraft. The system will include both a missile and a gun and will, with the other FAADS elements, replace the Vulcan and the Man Portable Air Defense Systems. The Army is acquiring the LOS-F-H system to fill the void left when procurement of the Sergeant York gun system was terminated in 1985. The Army plans to eventually acquire 562 LOS-F-H systems.

After assessing industry's interest in competing for the LOS-F-H system, the Army adopted an acquisition strategy to procure a system that is (1) in production or requires minimal development and (2) currently comes nearest to meeting the Army's total system requirements. The Army also wanted a system that has the growth potential to eventually meet those requirements with further development.

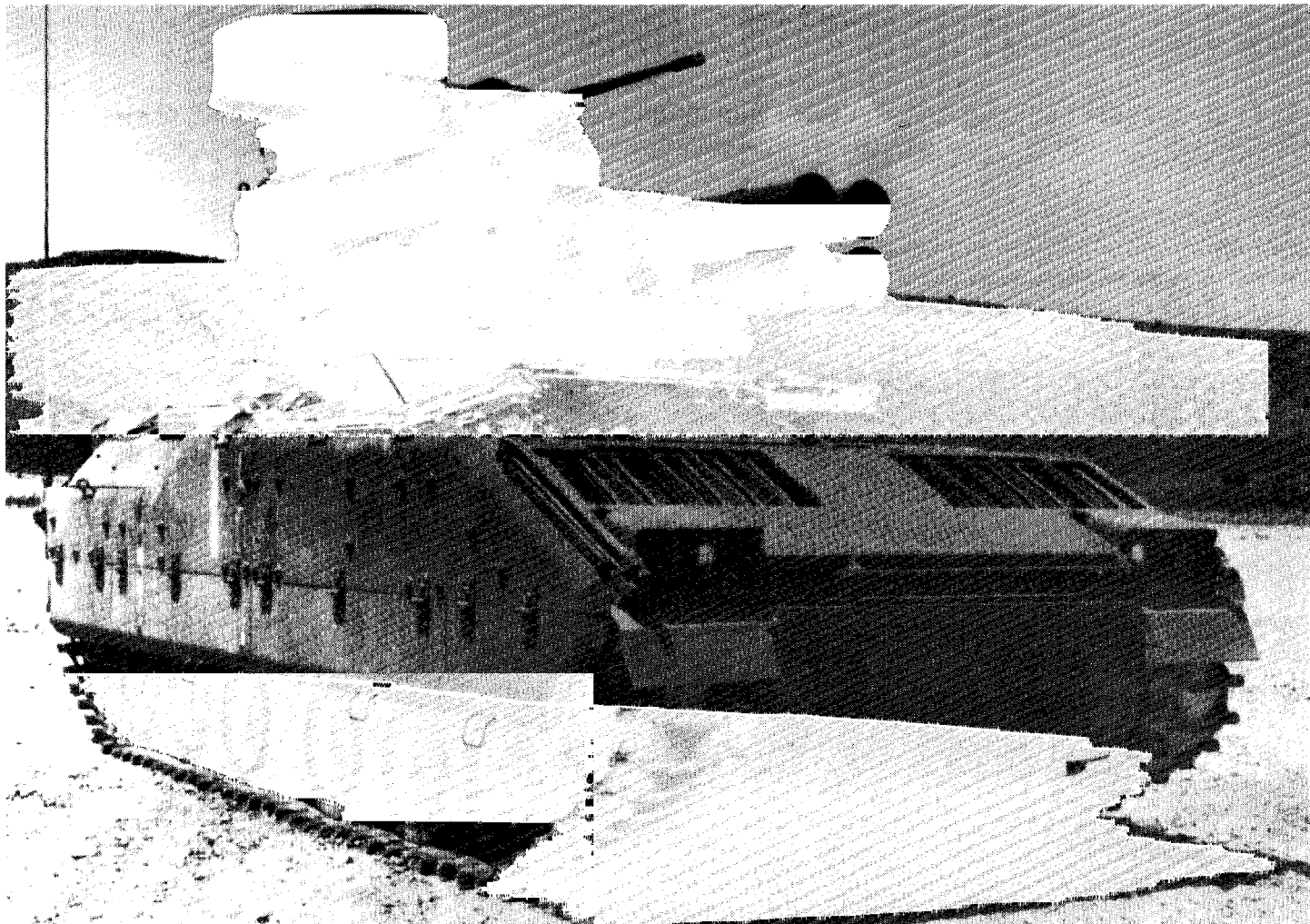
Based on responses to a request for proposals, the Army selected four candidates to compete for the LOS-F-H role. A competitive test was performed at the White Sands Missile Range, New Mexico, from July through early November 1987. On November 30, 1987, the Army announced that it had selected the system produced by a Swiss firm, Oerlikon Buhle, teamed with Martin Marietta, called the Air Defense Antitank System (ADATS). Although none of the four systems tested met the Army's total requirements, the Army concluded that ADATS showed the best potential for achieving that goal. The results of the competitive test are classified. Figure 1 is a photograph of one of two ADATS systems that were tested.

## Limited Scope of Competitive Test

In October 1986, the Congress directed the Department of Defense to test and select an LOS-F-H system by November 26, 1987. According to the Army, the short time available for testing, considerations of test range safety, and range instrumentation limitations led it to impose certain constraints on the testing. Consequently, the Army did not conduct or complete several tests it had planned, or would have liked to conduct, such as reliability, transportability, mobility, and survivability tests. Also, one of the critical elements of FAADS, the command, control, and intelligence network, which is expected to operate with ADATS, was not available for the test. Nevertheless, after it had completed the tests, the Army concluded that it had sufficient data to make a selection.

The competitive test primarily involved missile firings (to demonstrate the system's capability to engage and destroy aircraft) and target acquisition and tracking engagements (to demonstrate its capability to detect, track, identify, and simulate firing at aircraft). The test was not intended to be an operational test in which each system could demonstrate its effectiveness and other characteristics in a simulated operational environment. Rather, it was intended to provide sufficient data for evaluating the relative performance capabilities of the candidates in the technical areas in which they were being tested. Limitations of the test included the following:

- Since Army crews did not fire missiles (because of safety restrictions) and did not maintain the contractors' systems, the ease with which Army personnel can fire ADATS missiles and maintain the system is not known.
- The directions from which the threat aircraft could come were few due to the necessarily restrictive range constraints that were imposed for

**Figure 1: Air Defense Antitank System Tested**

safety, resulting in air defense crews' having smaller areas in which to search for the aircraft.

- Due to test range safety and instrumentation limitations, flight profiles, or patterns, flown by the threat aircraft did not always mirror typical Soviet flight profiles and, according to the pilots, exposed their aircraft for abnormally lengthy periods, giving the candidates a longer time to engage them.
- The inherent nature of the White Sands test site, a terrain with minimal foliage, low humidity, and generally excellent visibility, was considerably different from the European scenario where the first ADATS units will be fielded. In addition, missile firings were conducted only during the

daylight hours as were a vast majority of the acquisition and tracking exercises.

The Army has scheduled additional ADATS tests from April 1988 through June 1989 to include the verification of training doctrine, tactics, and the system's performance in missile firings and acquisition and tracking and to conduct safety and environmental testing. These tests will be followed by a 3-month operational test beginning in July 1989.

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### ADATS Schedule Contains Some Concurrency

The program's schedule has some concurrency. The Army plans to award three ADATS production contracts prior to starting operational testing. Two will provide for the procurement of long-lead items and the initial production of five units. The third will be for long-lead items needed for the first 20 units to be produced in full-scale production. The Army's estimated cost for these contracts is about \$144 million, or about 2 percent of the total estimated program cost. However, the Army does not plan to make its full-scale production decision, due in December 1989, until ADATS successfully completes operational testing.

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### LOS-F-H System's Acquisition Strategy Compared With Sergeant York's

The LOS-F-H acquisition strategy invites comparison with the strategy used to acquire the Sergeant York. There are some similarities, such as the avoidance of a new system development and the presence of concurrency in the schedule. However, the ADATS program does not appear to be driven by the determination to proceed with production in the face of inadequately demonstrated performance that characterized the Sergeant York program.

In the Sergeant York program, top Department of Defense and Army decisionmakers were not sufficiently informed about the system's performance deficiencies because program officials limited the number of officials who were told about Sergeant York's performance during its early testing. In the absence of critical test data, the decisionmakers based their support on claims about Sergeant York's performance by subordinates who were unduly optimistic about its capabilities. We found no such similarities in the case of ADATS as top officials were frequently present to observe the tests.

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### Other Matters

You also asked for information on the adequacy of the scope of the forthcoming LOS-F-H operational test, the system's cost estimate, the

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Army's operational effectiveness analysis, and the validity of the threat against which the system has been designed.

The Army has not prepared its operational test plan and, therefore, we cannot assess its adequacy. When completed, the plan will be submitted to Department of Defense officials responsible for reviewing and approving operational test plans.

In August 1987, the Army estimated the LOS-FH program cost to be \$5.7 billion. Based on a projected procurement of 562 systems, the unit cost would be about \$10 million. The next cost estimate is due in August 1988.

The Army has not completed the cost and operational effectiveness analysis for the entire FAADS system, which it began in February 1986. Although the need for an improved division air defense system is generally acknowledged, the Army has not established, by this type of analysis, whether the FAADS elements including the LOS-FH are the best alternatives available. The Army expects a report to be released in June 1988.

The threat that the Army is grooming ADATS to counter is consistent with that reported in Army documents, which show the principal threat to consist of fixed- and rotary-wing aircraft.

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## Conclusions

Although several constraints were imposed on the testing, we believe that the classified results disclosed that ADATS performed the best among the competing candidates. However, ADATS' capability in a realistic operational environment cannot be assessed until after operational testing. A fair evaluation will require that the test be stringent enough to challenge the system, particularly in demonstrating its ability to detect, track, identify, and engage targets and to survive under battlefield conditions.

Although a certain degree of concurrency is present in the program, the Army plans to proceed fairly deliberately in moving from one acquisition phase to the next. It plans only to acquire long-lead items and a small number of initial production units with a relatively modest expenditure of funds and does not plan to enter full-scale production until ADATS successfully completes operational testing. Using this approach, the Army will obtain some assurance that ADATS will meet requirements before committing large resources to its production.

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**Agency Comments**

The Department of Defense reviewed a draft of this report and agreed with its contents.

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As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 3 days from the date of the report. At that time, we will send copies to interested parties and make copies available to others upon request.

*Richard Davis*

Richard Davis  
Senior Associate Director





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## Abbreviations

ADATS	Air Defense Antitank System
C2I	command, control, and intelligence
COEA	cost and operational effectiveness analysis
FAADS	Forward Area Air Defense System
GAO	General Accounting Office
LOS-F-H	line-of-sight forward heavy



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# Assessment of the Competitive Test of Candidates for the Line-of-Sight Forward Heavy System

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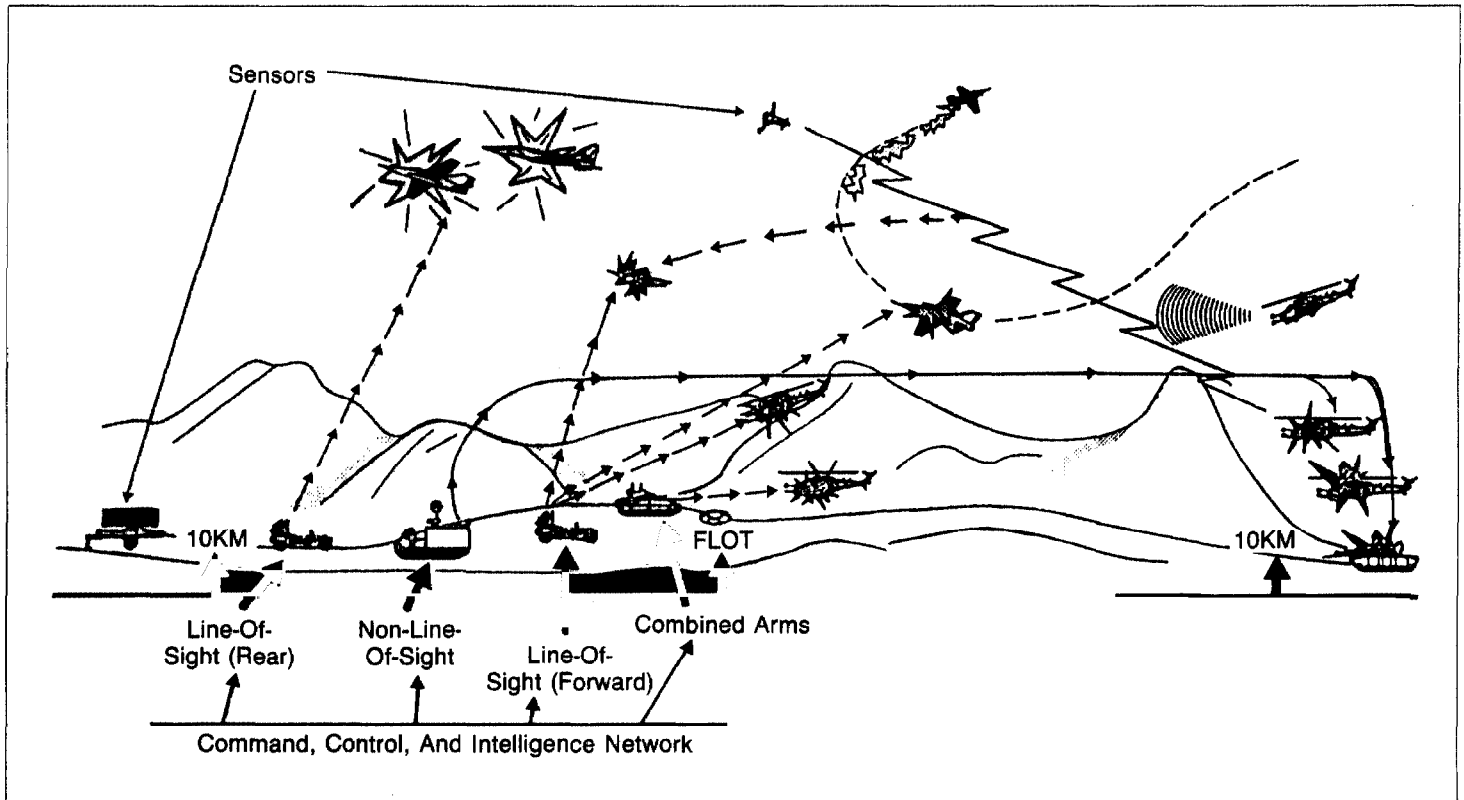
In August 1985, the Secretary of Defense terminated the Sergeant York division air defense gun program because the system could not defeat the projected air threat. Currently, the Chaparral and Stinger missiles and the Vulcan gun are relied on to provide air defense protection. In September 1985, the Army established a working group to develop a strategy and recommend actions to solve the air defense problems. In a January 1986 report, the working group concluded that the air defense problem could not be solved with any one system. Instead, it recommended that the Army acquire several weapons and an improved command and control system to operate as an integrated air defense system. Together these weapon systems comprise the Forward Area Air Defense System (FAADS).

The Army initiated a cost and operational effectiveness analysis (COEA) for the entire FAADS system in February 1986 but has not completed it. According to the study team leader, the study has focused on examining requirements rather than conducting a true COEA, since reliable cost data for the FAADS elements were not available, thereby preventing a cost-effectiveness comparison with alternative systems. The Army expects a report to be released in June 1988.

FAADS is to be made up of five elements: (1) a line-of-sight-forward heavy (LOS-F-H) system, which is to include both a missile and a gun to operate in the forward battle area, (2) a line-of-sight-rear missile and gun to protect the division's rear area, (3) a non-line-of-sight missile system to attack targets hidden from view, (4) increased self-defense capabilities for tanks, infantry fighting vehicles, and helicopters, which will be used to attack aircraft targets in the forward area, and (5) a command, control, and intelligence (C2I) network through which the other FAADS elements will receive information such as the locations of air targets. Figure I.1 shows the five elements of FAADS. This report is concerned with one element of the FAADS, the LOS-F-H system.

Appendix I  
 Assessment of the Competitive Test of  
 Candidates for the Line-of-Sight Forward  
 Heavy System

Figure I.1: Deployment of the Forward Area Air Defense System



The LOS-F-H system, with the other FAADS elements, is to replace the Vulcan and Man Portable Air Defense Systems and to fill the void left when procurement of the Sergeant York, which was to have succeeded the Vulcan, was terminated in 1985. According to Army documents, the LOS-F-H system is to provide protection for tanks and infantry fighting vehicles against fixed- and rotary-wing threat aircraft. In addition to its missile and gun, the system is to have communications equipment and aircraft detection, identification, and tracking sensors integrated on an armored tracked vehicle. The system is to be capable of operating day or night, in adverse weather conditions, and in battlefield environments where electronic and physical countermeasures are prevalent. It also is to operate either autonomously or in conjunction with the C2I network.

The Army plans to purchase 562 LOS-F-H systems. To hasten the fielding of ADATS, the first 160 units will have a missile rather than a missile/gun combination. The system will be initially fielded in November 1991.

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Eventually, the Army plans to install the 25-mm Bushmaster gun on all 562 units.

The Army's first baseline cost estimate, dated August 1987, showed a total estimated program cost for the LOS-F-H system of \$5.7 billion in fiscal year 1988 dollars. This amounts to a program unit cost of about \$10 million. The estimate was based on a generic rather than a specific vehicle. A more accurate estimate is expected in August 1988, since the winning contractor's proposal will be included in the revised estimate. We did not evaluate the August 1987 estimate.

In January 1986, the Army conducted a market survey to identify firms that were interested in competing for the LOS-F-H system and could offer an air defense system ready for production or requiring minimal additional development. Responses from industry disclosed that, while several systems were available to compete, none met the Army's total system performance requirements. In October 1986, the Congress directed the Department of Defense to acquire, test, and evaluate systems for the LOS-F-H role that were either in production or ready for production and to select a system from among the competitors by November 26, 1987.

The Army tested four candidates at the White Sands Missile Range, New Mexico, from July to early November 1987. The competitors were Rapier (produced by British Aerospace teamed with United Technologies), Paladin (produced by Euromissile (a German firm) teamed with Hughes Aircraft), the Air Defense Antitank System (ADATS) (produced by Oerlikon Buhle (a Swiss firm) teamed with Martin Marietta), and Liberty (produced by Thomson-CSF (a French firm) teamed with LTV). There were two major test phases: missile firings and exercises to acquire and track target aircraft.

On November 30, 1987, the Army announced that it had selected Martin Marietta's ADATS as its LOS-F-H system. The Army judged ADATS to have the best potential of all the candidates to meet the Army's total system requirements with the least risk. The results of the competitive test are classified.

The Army plans to conduct various follow-on tests with ADATS. The tests will cover tactics and doctrine, missile firings, acquisition and tracking, safety, and environmental testing. The Army plans to conduct these tests using a refurbished unit that was previously used in the competitive tests, as well as one of four new prototype units fabricated to some

extent with production tooling. These tests began in April 1988. When the tests are completed, the Army will similarly test the four prototypes from April 1989 to June 1989. The Army will follow these tests with an operational test with these same units from July to October 1989 to confirm the system's operational suitability and effectiveness. When the Army completes the plan for operational testing, it will be provided to the Department of Defense's Office of Operational Test and Evaluation for review and approval. A full-rate production decision is planned for no later than December 1989.

Before starting the operational test, the Army plans to award three firm fixed-price production contracts. Two contracts will provide for the advanced procurement of long-lead items and the low-rate production of five units. The third contract will be for long-lead items for the first planned full-rate production of 20 units. The Army estimates the cost of the long-lead items and the five production units to be about \$144 million, or about 2 percent of the total estimated program cost. While this acquisition strategy allows for some concurrency, the Army has stated that the decision on full-rate production will not be made until ADATS successfully completes operational testing.

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## **LOS-F-H System's Acquisition Strategy Compared With Sergeant York's**

There are similarities in the acquisition strategies pursued in the Sergeant York and LOS-F-H system programs.

As in the case of the Sergeant York, the Army has sought to avoid a major development program by soliciting systems for the LOS-F-H system that were ready for production. Also, as with Sergeant York, there is some concurrency in the schedule, and several important tests have not yet been run. However, in the Sergeant York program, the limited testing was driven by an Army decision to accept the risk of proceeding with production before the system had demonstrated its capability. There is no similar indication that a desire to accelerate its fielding is driving the ADATS testing schedule.

A major consequence of the insufficient testing of the Sergeant York prior to production was that top decisionmakers in the Army were not sufficiently informed about that system's performance deficiencies. In the absence of critical test data, the decisionmakers, to make funding and programming decisions, relied on the claims of lower level managers who were unduly optimistic about its capabilities. This situation was aggravated by efforts by program officials to limit the number of Army and Department of Defense officials who were told about Sergeant

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York's performance, particularly during its early development. We found no similar effort to limit the involvement of defense officials in ADATS testing and, in fact, on numerous occasions, noted the presence of top officials at the test site.

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## Limitations of Competitive Test

The purpose of the competitive test was to conduct a technical demonstration of each competing system's capabilities in order to evaluate the candidates. According to the Army, the short time available for testing, considerations of test range safety, and range instrumentation limitations caused it to impose certain constraints on the test. Consequently, the Army did not conduct all the tests it had planned. For example, little or no reliability, mobility, survivability, and transportability testing was done. Also, one of the critical elements of FAADS, the C2I network, was not available for the test. Nevertheless, according to the Army, enough data was accumulated to permit selection of a winner.

Although the Army designated its Operational Test and Evaluation Agency (which normally oversees operational testing) to direct the test, the competitive test was not intended to be an operational test. Each contractor provided two systems for testing from July to early November 1987. One system engaged in missile firings with contractor personnel being used to operate the system. The second system was operated by U.S. Army personnel, previously trained by the contractor, in the acquisition and tracking exercises.

The missile firings were to demonstrate the system's capability to engage and destroy aircraft, and the acquisition and tracking exercises were to demonstrate the system's capability to detect, track, identify, and simulate firing at aircraft. Ten missiles were fired by each contractor at drone targets simulating fixed- and rotary-wing aircraft as they flew various threat flight profiles, or patterns. To complete the acquisition and tracking exercises, simulated engagements were done with manned, fixed- and rotary-wing aircraft, which flew both threat and friendly flight profiles to test the competing candidates' ability to distinguish friend from foe.

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## GAO Observations of the Test

We observed missile firings at the two designated test sites and acquisition and tracking exercises at two of three designated test sites. In the missile-firing phase, a test site was occupied by one candidate at a time, which fired its missile at a single drone target representing a hostile fixed- or rotary-wing aircraft. In the acquisition and tracking phase, two



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candidates, one from each of two contractors, occupied the same test site simultaneously in a simulated mission to defend a tank. Fixed- and rotary-wing aircraft attacked the tank in the division's forward area. Fixed-wing aircraft also attacked other targets normally present in a division's rear area. Included in this exercise were friendly aircraft. Each candidate was required to distinguish between the hostile and friendly aircraft and simulate firing its missile at the hostile aircraft. In each test phase, various types of countermeasures such as flares, chaff, and electronic jamming were used.

Certain elements of realism were lacking during the testing. For instance, the test site—a terrain with minimal foliage, low humidity, and generally excellent visibility—did not resemble the European scenario where the first ADATS units will be fielded. Also, the missile firings were conducted during the daylight hours as were a vast majority of the acquisition and tracking exercises.

Other test conditions, some of which were imposed for reasons of safety, were also atypical of the normal combat environment. In the missile-firing phase, each moving drone target flew at least one preliminary flight profile, or a dry run, before the candidate was to fire its missile, thereby eliminating any element of surprise. According to the Army, dry runs were made to ensure the safety and proper functioning of the communication systems and countermeasure devices.

In the acquisition and tracking exercises, realism was limited because the designated hostile hovering rotary-wing aircraft flew at altitudes higher than the postulated threat to allow the candidates, which were stationed apart from each other, to have equal views of the target. In addition, the fixed-wing aircraft executing fly-over profiles were not permitted to use jinking (a waving maneuver) since test range instrumentation equipment was incapable of tracking the jinking aircraft.

Pilots of fixed- and rotary-wing aircraft who participated in the test believed that the flight profiles they were asked to use permitted their aircraft to be exposed for abnormally lengthy periods. They also believed that the method followed in the use of flares provided the candidates with added time to detect and acquire their aircraft. If test conditions had permitted, the pilots stated, they would have reacted differently so that they could keep exposure time to a minimum and would have used flares to confuse the incoming missiles only when they knew their aircraft had been detected. According to the Army, the flight profiles were validated by the Defense Intelligence Agency.

In our observation of the candidates, it was obvious that, with their exposed antenna and optical equipment, they would be vulnerable to aircraft, artillery, and ground fire. The Army advised us that a live-fire test will be done following the operational testing to evaluate ADATS' vulnerability.

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## ADATS' Operational Capability Still to Be Assessed

Since the competitive test was not designed to elicit complete information about each candidate's performance capability, several questions about ADATS, such as the following, remain to be resolved in future testing:

- Can ADATS be operated and maintained by Army crews?
- Will ADATS be able to engage aircraft approaching from various directions and engage multiple aircraft targets, low-level targets, and aircraft providing minimal exposure time?
- Will ADATS meet requirements imposed by the Army in such areas as reliability, survivability, and logistic support?
- Will ADATS be able to operate with the FAAD C2I network?
- Will ADATS be able to meet the challenge of operating in an environment likely to be encountered on the battlefield?

# Objectives, Scope, and Methodology

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Our objectives were (1) to review the adequacy and realism of the testing and (2) to assess other aspects of the LOS-F-H system acquisition including its estimated cost, Army analyses of the system's operational effectiveness, and the validity of the threat the LOS-F-H system is to counter.

We performed our review at the offices of the Army Air Defense Artillery Board, Ft. Bliss, Texas, and at the White Sands Missile Range, New Mexico. We also obtained information at the Army Missile Command, Huntsville, Alabama; the Army Training and Doctrine Command, Ft. Monroe, Virginia; Army Headquarters, Washington, D.C.; and the Defense Intelligence Agency, Washington, D.C.

To evaluate the test, we reviewed the test plan, observed the testing on site, analyzed test results, and held discussions with responsible Army and Department of Defense officials. Because its studies were incomplete, we were unable to assess the Army's projections of the LOS-F-H system's cost and operational effectiveness.

We performed our review from May 1987 to March 1988 in accordance with generally accepted government auditing standards.



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