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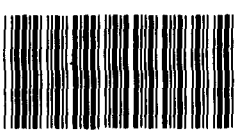
Report to the Chairmen, Subcommittees on Defense, House and Senate Committees on Appropriations

June 1990

MAJOR ACQUISITION PROGRAMS

Selected Aspects of the Army's Forward Area Air Defense System



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National Security and
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The Honorable Daniel K. Inouye
Chairman, Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable John P. Murtha
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

As you requested, we have reviewed selected aspects of the Army's Forward Area Air Defense System (FAADS) program. More specifically, we have developed information on (1) the Army's requirement for FAADS, (2) the Army's expected use of each component in performing its ground-based air defense mission, (3) the cost and schedule of each component, and (4) the Army's reliance on its current air defense systems. This letter and appendixes I, II, and III summarize the results of our work. Our objective, scope, and methodology are discussed in appendix IV.

Recent and continuing developments in Europe and the Soviet Union are greatly altering the national security environment, and these events could significantly affect the requirements for FAADS. According to an Office of the Secretary of Defense official, each FAADS component is under review and in the process of being restructured to take these new actions into consideration.

Results in Brief

In 1986, the Secretary of Defense approved the concept of FAADS to improve the Army's ground-based air defense capabilities. In December 1989, the Secretary of Defense eliminated the planned procurement for one of the five FAADS components, the non-line-of-sight missile, and uncertainty now exists as to whether this weapon will ever become a part of FAADS. In May 1990, the Army advised us that it now plans to revise its acquisition plan for the line-of-sight forward heavy missile system because the system did not meet the Army's goals during operational testing.

The Army estimates that the FAADS components will cost about $11 billion to develop and produce.[1] The fielding of FAADS began in 1989 for one component, and the others are expected to be fielded between 1993 and 1998. The Army plans to rely on some older forward area air defense systems to differing degrees for the near future because of anticipated delays in fielding several FAADS components.

Background

Before the Army began fielding FAADS, its forward area air defense weapon systems included two heat-seeking missiles—the Chaparral and the man-portable Stinger—and the 20-millimeter Vulcan gun. These systems are supported by an aging radar network—the Forward Area Alerting Radar (FAAR)—and a manual command, control, and communication system.

The Army has been trying to improve its ground-based air defense capabilities at or near the front lines for almost two decades. In late 1985, at the direction of the Secretary of Defense, the Army Chief of Staff convened a group of experts to develop a new air defense strategy to overcome long-standing and newly identified weaknesses in ground-based air defense. This group concluded that no single weapon system could provide adequate forward area air defense and that complementary capabilities were needed to overcome the existing and projected air threat. It recommended a five-component concept referred to as "FAADS." In July 1986, the Defense Acquisition Board approved the FAADS concept.

Due to the perceived urgency of the problem and the need to field FAADS as soon as possible, system development was to be minimized, and weapon selection was to rely on available systems and "off-the-shelf" technology, or nondevelopmental items, to the extent possible.[2] The nondevelopmental approach was to be flexible enough to satisfy immediate requirements while providing an opportunity for preplanned product improvements.

Requirement for FAADS

The Army is acquiring FAADS because it does not have a weapon system or set of systems with a command and control system that can defeat the type of aircraft that threaten the forward area. More specifically, the Army does not have

[1] The Army's estimate includes the cost to develop but not procure the non-line-of-sight missile.

[2] The Army considered it imperative that it field a new air defense system by 1995.

- a frontline missile system that can reach threat aircraft before these aircraft can fire their missiles;
- a radar system that can identify low-flying, terrain-hugging, fixed-wing aircraft and helicopters, particularly when threat helicopters use "pop up and fire" tactics; and
- an automated command, control, and communication system that can quickly distribute target information to air defense weapons.

FAADS is intended to be a self-sufficient, frontline, air defense system encompassing all the functions necessary to detect, identify, and destroy attacking threat aircraft. FAADS' other mission is to assist theater air defense by providing additional target detection and tracking information and by engaging low-flying, high-speed, fixed-wing aircraft headed for targets in the rear.

Expected Use of the FAADS Components

FAADS was to consist of three new missile systems; a new command, control, communication, and intelligence system (C3I); and "Combined Arms Initiatives," which were to enhance the air defense capabilities of certain ground weapon systems and helicopters. The three new missile systems—the line-of-sight forward heavy missile, the line-of-sight rear missile, and the non-line-of-sight missile—were to have distinctly different missions.

Line-of-Sight Forward Heavy Missile System

The first weapon, the Air Defense Antitank System (ADATS), was selected to satisfy the Army's requirement for an armored, line-of-sight missile and gun system that could operate with and protect frontline troops and armor from fixed-wing and helicopter attack aircraft. The system entered low-rate production in July 1989, and the Army conducted operational testing of ADATS during the first half of 1990. During these recent operational tests, the system did not meet the Army's goals for continued production. As a result, a senior Army official told us in May 1990 that the Army plans to revise its acquisition plan.

Line-of-Sight Rear Missile System

The second missile system, the Pedestal Mounted Stinger, called the "Avenger," was selected to satisfy the Army's requirement for a line-of-sight rear missile system that could (1) protect static assets and convoys several kilometers behind the front line from primarily fixed-wing attack aircraft and (2) be deployable by air in support of light divisions and specialized forces. The Army began fielding the system in April 1989 and approved it for full-scale production in April 1990.

Non-Line-of-Sight Missile System

The third weapon, the Fiber Optic Guided Missile (FOG-M), was selected to satisfy the need for a non-line-of-sight missile that could seek and destroy attack helicopters hidden from other air defense missile systems by terrain and other obstacles. For self-protection, it was to be located a few kilometers behind the front line, but it was to have the range necessary to attack threat helicopters long before they could reach their attack positions.

The future of the FOG-M system is in doubt because in December 1989 the Secretary of Defense deleted the fiscal year 1991 procurement funding and removed system procurement from the 5-year defense plan. This creates uncertainty as to whether the FOG-M will ever become a part of FAADS. Without FOG-M, the Army does not have the ability to attack enemy helicopters hidden from view by the terrain. According to Army representatives, a requirement for the FOG-M capability still exists, and an appeal for the reinstatement of procurement funds is planned. Current plans are to complete FOG-M development in December 1993.

C3I Component

The C3I component is to provide better detection and identification of threat aircraft than are available with currently fielded systems and to get this information more quickly to the weapon systems. It is to consist of four elements: (1) an automated command and control system, (2) a ground-based radar, (3) a masked target sensor, and (4) aircraft identification devices.

Combined Arms Initiatives

The final component is referred to as the "Combined Arms Initiatives." It is intended to provide certain helicopters, the M1/M1A1 tanks, and the Bradley Fighting Vehicle with air defense capabilities. The Army does not include the cost of the initiative in its estimates of FAADS costs because they are recorded as part of the other programs.

Cost and Schedule

In December 1989, the Army estimated the FAADS acquisition cost at about $11 billion. This estimate excludes the costs of the Combined Arms Initiatives and the procurement costs for the FOG-M system. Table 1 shows the Army's December 1989 cost estimates for FAADS.

Table 1: Army's Cost Estimates for FAADS

Then-year dollars in millions

FAADS component	Development cost estimate	Production cost estimate	Total
ADATS	$318.8	$6,516.4	**$6,835.2**
Avenger	12.8	1,276.1	**1,288.9**
FOG-M	630.8	[a]	**630.8**
C3I	1,120.8	1,103.1	**2,223.9**
Total	**$2,083.2**	**$8,895.6**	**$10,978.8**

[a]The Army had estimated the FOG-M procurement costs at about $2.5 billion before the Secretary of Defense deleted the fiscal year 1991 procurement funding and removed system procurement from the 5-year defense plan.

FAADS fielding for the Pedestal Mounted Stinger began in April 1989 and is continuing. Fielding schedules for the other FAADS systems have slipped by several years. The Army plans to field ADATS beginning in June 1993, which is about 1 year later than originally planned. The various C3I components' schedules have slipped about 3 years overall, and these components are now expected to be fielded between December 1993 and September 1998, depending on the component.

Continued Reliance on Some Current Systems

The Army will rely on selected existing forward area air defense systems (the Chaparral missile system, the man-portable Stinger missile system, and the Vulcan air defense gun) to differing degrees until FAADS is fully fielded. The Army eventually plans to use these older weapons to provide air defense in areas that it believes have not had sufficient coverage in the past. These older weapons may be transferred to the reserve components as active forces receive the new systems.

As requested, we did not obtain written agency comments on this report; however, we did discuss it with responsible Army officials and have incorporated their comments where appropriate.

We are sending copies of this report to the Chairmen of the Senate and House Committees on Armed Services, the House Committee on Government Operations, and the Senate Committee on Governmental Affairs. Copies are also being sent to the Secretaries of Defense and the Army, the Director of the Office of Management and Budget, and other interested parties. Copies will be made available to others on request.

Please call me at (202) 275-4141 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix V.

Richard Davis

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Director, Army Issues

Contents

Abbreviations

ADATS	Air Defense Antitank System
AWACS	Airborne Warning and Control System
C3I	command, control, communication, and intelligence
DIVAD	Division Air Defense
FAADS	Forward Area Air Defense System
FAAR	Forward Area Alerting Radar
FOG-M	Fiber Optic Guided Missile
JSTARS	Joint Surveillance and Target Attack Radar System
POST	Passive Optical Seeker Technique
RMP	reprogrammable microprocessor

The Army's Rationale for Acquiring FAADS

Soviet fixed-wing aircraft, helicopters, and missiles have presented a serious threat to U.S. and allied ground forces and other assets. An effective air defense needs to protect ground assets, provide for freedom of maneuver, and assist in the achievement of air superiority. Air defense is particularly critical in the forward areas where the majority of the Army's combat troops and major combat weapon systems, such as tanks and armored fighting vehicles, are located. Further from the front, but still vulnerable to enemy air attack, are artillery sites, airfields, command and communication centers, fuel and ammunition dumps, supply centers, and ballistic missile sites.

The Army and the Air Force share responsibilities for air defense missions in the forward area of the battlefield. The Army is to provide air defense with its Apache and Cobra helicopters and several ground-based air defense weapon systems, while the Air Force is to provide close air support for the Army's frontline combat forces with its fixed-wing aircraft. The Air Force also is to intercept enemy aircraft that approach or cross into corps areas and to attack ground targets that support enemy air operations.

The following sections reflect the Army's threat assessment at the time of our review and do not take into consideration the recent and continuing developments in Europe and the Soviet Union, which could significantly affect the requirements for FAADS.

The Air Threat to the Forward Area

The Army's older ground-based systems cannot identify and reach certain existing and projected air threats to combat forces in the forward area. Threat helicopters are now capable of identifying and destroying U.S. and allied forces and assets at distances greater than 6 kilometers. The Army projected that the helicopter threat would increase with the full fielding of more advanced Soviet helicopters. These advanced helicopters are expected to be much more difficult to identify and to be able to fire effectively from even greater distances. Therefore, the Army considers it imperative that it field a new air defense system by 1995.

The most serious air threat faced by Army ground forces comes from low-flying, terrain-hugging, fixed-wing aircraft, such as the Soviet "Frogfoot" fighter bomber and stand-off, hovering, or hidden attack helicopters, such as the Soviet "Hind" and "Havoc" helicopters. The helicopter threat presents ground-based air defense systems with their greatest challenge.

The Hind helicopter, which has been fielded in significant numbers, is capable of effectively firing its missiles from distances beyond the capabilities of the Army's currently fielded forward area air defense systems. The addition of the Havoc helicopter, with its ability to hover, "pop up," and fire (a capability that the Hind helicopter does not possess), presents a greater challenge. Existing radar systems will have more difficulty finding Havoc helicopters because they can hide among terrain features and pop up quickly to fire their weapons.

Helicopters that use pop-up tactics will be extremely hard to locate and defeat with line-of-sight weapon systems because the helicopters may not be exposed long enough for the weapon systems to autonomously locate them and to fire weapons in time to hit them. Also, Soviet helicopters soon may not need to expose themselves at all because they will be able to fire laser-guided missiles from behind cover and then "hand off" control of the missile to another observer with a laser designation device.

The Army expects the Soviets to simultaneously employ two basic strategies with their air forces. Their first strategy will be to employ very large numbers of bombers and fighter bombers to cross the front to attack high priority targets in the rear. To reduce losses, the bombers will penetrate allied air defenses along specific narrow corridors, thereby overwhelming ground air defenses. Air defense radars, command centers, and weapon systems located along the attack corridor will be among the highest priority targets for the initial wave of aircraft. Intelligence and electronic warfare countermeasures will also be used to "blind" Army radar and other air surveillance assets, disrupt communications in order to slow the Army's air defense response, and degrade weapons' effectiveness.

The second strategy will involve Soviet offensive maneuver operations. Smaller groups of low-flying, close air support helicopters and fixed-wing aircraft are expected to attack Army armor and troop concentrations at the front. The aircraft will also try to destroy vital support assets and reserve forces immediately to the rear.

Soviet close air support pilots are expected to place a high priority on destroying Army forward area air defense weapons, command and communication centers, and radars. Also, the Soviets are expected to use helicopters in a stand-off jammer role, to disrupt air defense radars and communication systems.

Air Defense Zones

Ground-based air defense coverage is divided into categories based on the altitude (low, medium, or high) the weapon system can reach or, conversely, where the expected threat will be found. Low altitude threats, up to about 600 meters, are considered the most difficult to engage because of radar acquisition limitations due to terrain. Short range air defense weapons systems, such as the Stinger and Chaparral missiles and the Vulcan gun, were developed to engage low-flying attack aircraft and other aircraft passing through this area to targets in the rear.

The medium altitude zone is from 600 meters to 7,500 meters, and the high altitude zone is above 7,500 meters. Both of these zones are defended by the Hawk and the Patriot missile systems, located in the corps and theater areas. These longer range missile systems are expected to engage fighters, fighter bombers, strategic bombers, and tactical ballistic missiles flying through this airspace.

Efforts to Improve Air Defense Capabilities

The Army has been trying to improve its ground-based air defense capabilities for a number of years. However, its previous efforts have fallen short of the Army's requirements. For example, the Army attempted to strengthen its frontline air defense capability by developing the Division Air Defense (DIVAD) gun. The DIVAD gun was expected to replace the aging Vulcan gun and to complement the Chaparral and Stinger missile systems by engaging low-flying aircraft at very close ranges, where the missile systems are ineffective. The DIVAD program, however, was terminated by the Secretary of Defense in August 1985 because it could not handle the stand-off attack helicopter threat. Army analysis and training had revealed that the projected air threat could strike ground forces from distances beyond the range of current frontline missile systems and the DIVAD. According to the Army, the projected air threat to forward area combat forces has increased since the termination of the DIVAD.

Inception of the Forward Area Air Defense System

In late 1985, after the Secretary of Defense terminated the DIVAD program, the Army Chief of Staff convened a group of experts to develop a new air defense strategy for overcoming identified weaknesses in ground-based air defense. This group concluded that no single weapon system could provide adequate forward area air defense and that complementary capabilities were needed to overcome the air threat. It recommended a five-component concept referred to as the "Forward Area Air Defense System" (FAADS).

The Army's group of experts believed that the command, control, communications, and intelligence (C3I) component was critical to the overall success of FAADS. It was to include a ground-based radar, an aerial or "masked" target sensor, several aircraft identification ("friend or foe") devices, and a command and control network. The group considered it important that these capabilities be available when the weapon systems are fielded.

In January 1986, the Secretary of Defense approved the FAADS concept and directed the Army to define, acquire, and deploy FAADS as quickly as possible. To field the FAADS system quickly, the Army decided to find or develop systems that, if not configured exactly as needed, were configured in such a way that desired features or improvements could be added without substantial modification. Weapon selection was to rely on available systems, or "off-the-shelf" technology, to the extent possible.

The FAADS concept stresses the mobility and survivability of the air defense weapon system. Mobility is considered important because combat doctrine depends on a highly maneuverable force; an air defense weapon should move with the assets it is protecting. Survivability is crucial because air defense weapon systems are likely to become early and lucrative targets. Accordingly, FAADS weapons are to be mounted on different armored or unarmored, tracked or wheeled vehicles, depending on the degree of desired mobility and the location of the weapon on the battlefield. The same weapon system may be placed on different vehicles to satisfy the different requirements of heavy and light divisions.

The Forward Area Air Defense System

The FAADS system consists of five components: (1) the Air Defense Antitank System (ADATS) as the line-of-sight forward heavy missile and gun system; (2) the Fiber Optic Guided Missile (FOG-M) system as the non-line-of-sight missile system; (3) the Pedestal Mounted Stinger, or Avenger, as the line-of-sight rear missile system; (4) a command, control, communication, and intelligence (C3I) system; and (5) improvements to certain existing systems, which the Army calls the "Combined Arms Initiatives." In December 1989, the Secretary of Defense eliminated planned procurement for the FOG-M system. This creates uncertainty as to whether the FOG-M will ever become a part of FAADS.

Line-of-Sight Forward Heavy Missile System

The Army selected Martin Marietta's ADATS for its line-of-sight forward heavy requirement. The ADATS system consists of a launcher with eight ready-to-fire missiles mounted on a modified Bradley Fighting Vehicle chassis. The ADATS uses a hypervelocity, laser-guided missile, manufactured by Oerlikon- Buhrle (Switzerland). The missile is considered to be faster, more accurate, and have greater range than the Stinger and Chaparral missiles that are currently deployed in the forward area. The system has a radar and a forward-looking infrared device, which provide aircraft detection, acquisition, identification, and electronic countermeasure capabilities, and it is expected to operate during the day, at night, and in adverse weather. The ADATS is not currently configured with the air defense gun the Army considers necessary for close ranges.

The ADATS is intended to detect and reach low-flying targets well beyond the range of the Stinger and Chaparral heat-seeking missiles. The weapon, mounted on a tracked, armored vehicle, is to be located in the forward area of the battlefield to take advantage of its range and to be close to the assets it is to protect. ADATS can fire only one missile at a time because its targeting and guidance system must stay locked onto the target until its missile hits or misses the target.

The Army's current plan is to purchase 562 ADATS fire units and 10,078 missiles. According to the Army, each heavy division will receive 36 fire units. The Army has purchased 4 fire units and 14 missiles for testing and training purposes. In December 1989, the Army estimated the ADATS development and production cost at over $6.8 billion—$318.8 million for development and $6,516.4 million for production.

During recent operational tests, conducted during the first half of 1990, the system did not meet the Army's goals for continued low-rate production. As a result, a senior Army official told us that the Army now plans

to revise its acquisition plan for the system. As required by the National Defense Authorization Act for Fiscal Year 1989, we are evaluating the performance of ADATS and plan to provide a report to the Senate and House Committees on Armed Services on the results of our evaluation after the Army completes its tests.

Non-Line-of-Sight Missile System

The Army has been developing a fiber optic guided missile technology for an antitank role since the mid-1970s. Though it selected the FOG-M as its non-line-of-sight missile system, the Secretary of Defense deleted all procurement funds for the FOG-M from the 5-year defense plan in December 1989. According to Army representatives, a requirement for the FOG-M capability still exists, and an appeal for the reinstatement of procurement funds is planned for fiscal year 1994. Current plans are to complete FOG-M development in December 1993. The FOG-M's development cost is estimated at about $631 million.

The FOG-M was to be located within a few kilometers behind the front lines to protect ground troops and vehicles against enemy helicopters in the forward area of the battlefield, but unlike the ADATS it was to operate from concealed positions, out of direct enemy view. The missile is considered too slow to be effective against higher-speed, fixed-wing aircraft, so its use will be limited to attacking helicopters.

The FOG-M system consists of a missile and a launcher/gunner station. The missile, which contains a small television camera to help the gunner direct the missile to hidden targets, has sufficient range to attack helicopters before they can effectively fire their weapons. Upon launch, the gunner locates targets through the video display, which portrays the missile seeker's view as the missile cruises at low altitudes. These images pass through a fiber optic link to the gunner's console. The FOG-M is also to have a passive sensor that can detect and identify threat helicopters.

The system was to be deployed on a derivative of the Multiple Launch Rocket System vehicle for heavy divisions and on the High Mobility Multipurpose Wheeled Vehicle for light divisions. The version for heavy divisions was to have 12 to 24 ready-to-fire missiles, and the version for light divisions was to have 6 missiles.

The FOG-M missile is undergoing development for use in an air defense role. The Boeing Military Airplane Company and the Hughes Aircraft

Company are currently doing development work to (1) increase the missile's range, in anticipation of changes in the threat; (2) add an imaging infrared target acquisition seeker to the missile; (3) add a variable speed motor that will permit the missile to be launched faster but to slow down when searching for targets; and (4) develop two versions of the fire unit, one for light divisions and the other for heavy divisions.

The FOG-M has limited capabilities to autonomously detect targets and, therefore, must rely to a large degree on external sources for target information, such as radars or observers. The Army states that the missile system's effectiveness would be greatly enhanced by the planned C3I network and its proposed masked target sensor and ground-based radar. It can, however, send out a "scout" missile to locate targets with its television camera or imaging infrared target acquisition seeker and flight data recording devices.

Originally, the Army planned to purchase 403 FOG-M fire units and 16,550 missiles. Each heavy division was to receive 18 FOG-M fire units plus spares, while light divisions were to receive varying numbers of fire units. The Army had estimated the FOG-M procurement costs at about $2.5 billion before the Secretary of Defense deleted the fiscal year 1991 procurement funding and removed system procurement from the 5-year defense plan. The Army has purchased six FOG-M units for initial development and testing and was planning to buy eight of the fully developed systems for future testing and training purposes, four for light divisions and four for heavy divisions.

Line-of-Sight Rear Missile System

The Army selected the Avenger to satisfy its requirement for a line-of-sight rear missile. This system, which is being developed by Boeing Aerospace as a replacement for the man-portable Stinger missile system, consists of a launcher with eight heat-seeking Stinger missiles mounted on a modified High Mobility Multipurpose Wheeled Vehicle. It has a 360-degree rotatable turret and can "shoot on the move" or be operated from a remote terminal. The same configuration will be used for both light and heavy divisions.

The Avenger is a mobile, rapid-fire, line-of-sight missile system that is intended to be located throughout the rear division and corps areas. It is to provide air defense for convoys and stationary critical assets, such as command posts and bridges, by detecting and engaging low-flying, fixed-wing aircraft and helicopters that have evaded ADATS and are headed toward rear targets. It has an autonomous target acquisition capability

consisting of a forward-looking infrared device, which enables the gunner to detect and acquire targets during the day, at night, and in adverse weather.

The Army plans to purchase 1,207 Avengers for use in heavy and light divisions and other units. Each division will receive 36 Avengers plus spares, and each corps will receive 54 Avengers plus spares. The system, which is in low-rate production, was approved for full-scale production in April 1990. The first active unit was equipped with Avengers in April 1989. In December 1989, the Army estimated its development and production cost at about $1.3 billion—$12.8 million for development and $1,276.1 million for production.

Command, Control, Communication, and Intelligence System

Although the ADATS, the FOG-M, and the Avenger each has an autonomous target detection capability, the Army believes that expected changes in the threat require that better and more timely target detection and identification information be provided to the weapons. The C3I network is to have overlapping radars and other sensors to expand detection capabilities and increase system survivability. The Army also believes that automated command and control are needed to facilitate the distribution of information and to reduce the chances that different weapons will all fire at the same targets. Therefore, FAADS' overall effectiveness depends on the successful development and timely fielding of the C3I component.

The FAADS C3I component consists of four elements: (1) computer hardware and software to automate the processing and dissemination of command and control tracking and target information; (2) a ground-based radar; (3) a masked target sensor (aerial sensor), which is intended to detect targets hidden from direct view; and (4) an aircraft identification and recognition element. The system is to be integrated with the Army Tactical Command and Control System, a larger system intended to automate various battlefield functional areas, such as air defense, maneuver control, fire support, and intelligence. In December 1989, the Army estimated the acquisition cost for the FAADS C3I component at over $2.2 billion—$1,120.8 million for development and $1,103.1 million for procurement. The various C3I elements are scheduled to be fielded between December 1993 and September 1998, depending on the element.

Automated Command and Control

In order to destroy enemy aircraft after they have been identified, their locations must be quickly communicated to air defense weapon systems. Currently, the Army manually develops and communicates target information to air defense weapon systems. Target data from numerous sources is received, plotted, and analyzed by command center personnel at the division and then transmitted to each successive level of command down to the platoon command post. Decisions about the target data are communicated by radio to the appropriate weapon systems. The Army considers this process too time-consuming because, in many cases, the information arrives at the weapon system too late to be of use.

In the late 1970s, the Army began a project to automate its air defense command and control network because the manual system was too slow in distributing target information to the ground-based weapons. The project became an important part of the FAADS program since it consisted of the computer hardware and software needed to automate the processing and dissemination of target-tracking and control information to the weapon systems. The communications equipment is to use existing and fielded voice and data radios and a battlefield telephone system.

The FAADS Command and Control system will automate most processing and dissemination of target information to weapon systems. Command center computers at each level of command will analyze target data and filter, or reduce, it so that only the local picture is transmitted to the weapon system. The weapon system operations screen will receive and display the specific local target picture, taking into account priorities and the immediacy of the threat. The assigned areas of coverage may sometimes overlap from one weapon system to another, and the same air targets may be displayed. However, their targeting priorities may vary because one particular aircraft threat may present a greater threat to one weapon than to another.

Ground-Based Radar

The FAADS ground-based sensor, or radar, is to replace the currently fielded Forward Area Alerting Radar (FAAR). According to Army officials, because the FAAR is ineffective, the Army plans to begin retiring the FAAR from its inventory in fiscal year 1990. The candidate radar system most recently evaluated by the Army was not able to meet some of the Army's desired performance requirements. The Army, therefore, plans to issue a new request for proposals with modified requirements.

Masked Target Sensor

The masked target sensor has not been fully defined by the Army. It is to be positioned above the battlefield to detect the approach of low-flying threat aircraft hidden by terrain from ground-based radars or forward-looking infrared devices. The Army considers the masked target sensor important to detecting hidden and stand-off "pop up" helicopters, which the FOG-M is designed to defeat.

Aircraft Identification

Once aircraft have been detected in flight, ground-based weapon systems try to determine whether they are friends or foes. This may be done either electronically or visually. The first method provides identification at distances greater than the eye can see, but it endangers the aircraft providing the information by giving away its position and identity. Since pilots are, therefore, obviously reluctant to use such devices, the Army is generally limited to positive visual identification of aircraft before its gunners can fire. This may result in the gunner's identifying the aircraft too late to prevent it from striking its target.

The FAADS aircraft identification element is to use two methods of distinguishing between friendly and threat aircraft. One is to identify incoming aircraft by recognizing electronic signals transmitted by friendly aircraft, and the other is to identify hostile aircraft by passively comparing the characteristics of incoming aircraft with a library of known aircraft characteristics. The Army plans to use the existing Mark XII system, which identifies aircraft by their electronic signals, for the initial deployment of the FAADS C3I system until the follow-on Mark XV system is fielded in fiscal year 1997.

Other Sources of Target Information

The Army plans to get its air target picture from both strategic and tactical detection sources. Strategic systems, which include military satellites, the Air Force's Airborne Warning and Control System (AWACS), and the Joint Surveillance and Target Attack Radar System (JSTARS), are capable of providing the earliest possible alert and continuous surveillance of very large areas of the battlefield. These systems provide intelligence on troop concentrations and movements as well as the location of and activity at enemy air bases. AWACS' airborne radars can track enemy aircraft at great distances and provide the early warning needed by air defense units. This early warning, or alert data, will be manually transmitted to the theater, corps, and division command centers by radio on a near-real-time basis. Once this information reaches the division, it will be entered into the FAADS automated network.

To get the best possible picture of the airspace it must defend, the Army plans to use a variety of tactical radars with different capabilities. The Army believes that using these radars will increase the weapons' chances of hitting targets at the weapons' maximum ranges.

Two of five tactical radars—associated with the Patriot and the Hawk—are located in the theater and corps areas. The Patriot radar provides three-dimensional target data (measuring distance, direction, and altitude) for distances up to 100 kilometers away. The Hawk radars provide two-dimensional target information (measuring distance and direction) for up to 50 kilometers away. Target information received from these sensors is to be provided to the associated missile batteries and to division command centers, which will integrate the picture with information received from other sources, such as AWACS, and relay it to the appropriate FAADS weapon systems. Until the function can be automated, communication from Hawk and Patriot units will be transmitted manually to the FAADS command centers, where they will be entered into the automated FAADS Command and Control system. The other three tactical radars are those organic to FAADS—the ADATS radar, the ground-based radar, and the masked target sensor.

The use of different radars, according to the Army, will also increase weapon systems' survivability. FAADS weapons give away their positions when they use their on-board radars for detection. To overcome this problem, FAADS weapons will use remote radars such as the ground-based radar to provide their target information. If remote radar target information is unavailable for some reason, the weapon systems will be able to use their on-board radars or passive detection means such as forward-looking infrared devices. The on-board radars can be linked, or netted, between weapon systems so that no one system is operating for too long, thereby reducing the chances of being located. Remote systems are made more survivable by moving them around, overlapping their coverage, and randomly switching operation from one to another so that their positions cannot be pinpointed easily.

Combined Arms Initiatives

The Combined Arms Initiatives are efforts to maximize the air defense potential inherent in frontline weapon systems, such as tanks and other armored vehicles. The effort involves (1) placing air-to-air Stinger missiles on helicopters such as the OH-58 Kiowa to counter Soviet helicopter forces, (2) providing tanks with ammunition that is more effective against helicopters, and (3) placing new devices on Bradley Fighting Vehicle sights that will help gunners lead aircraft.

Army's Reliance on Current Systems

The Army will have to rely on some older forward area air defense systems to differing degrees for the near future because of delays in fielding several FAADS components. The Army plans to use some of these systems to provide air defense in areas that it believes have not had sufficient coverage in the past. Older air defense weapons may be transferred to the reserve components as the active forces receive FAADS.

Man-Portable Stinger

The Army employs the Stinger missile in what are referred to as "man-portable air defense Stinger teams." The mission of the Stinger team is to provide low altitude air defense against attacking fixed- and rotary-wing aircraft in the forward areas of the battlefield. The team consists of two personnel, one to act as driver and observer and the other to act as principal launcher. Each is trained to perform either function and has a shoulder-mounted launcher. The team uses a High Mobility Multipurpose Wheeled Vehicle to carry equipment, gear, and four additional missiles as reloads.

The Stinger missile, which is replacing the older Redeye man-portable air defense missile in the field, weighs about 35 pounds and has improved speed, range, and maneuverability. It is a supersonic missile that can attack aircraft from any angle. The Army has three versions of the Stinger missile: the basic Stinger, the Passive Optical Seeker Technique (POST) Stinger, and the reprogrammable microprocessor (RMP) Stinger. The basic Stinger and the Stinger POST are no longer being procured by the Army. The Stinger POST differs from the basic Stinger in that it has increased infrared countermeasure capability and improved acquisition due to its two-color seeker, which measures ultraviolet as well as infrared images. The RMP Stinger, the latest version being procured by the Army, has more improved seeker and infrared countermeasure capabilities. The RMP Stinger also has external reprogrammable software, which allows the Army to change the missile's capabilities to meet the growing threat without costly retrofit programs.

The Stinger team's principal means of target detection and acquisition is visual. The team is equipped with an identification friend or foe device, which queries aircraft electronically to help the team determine whether approaching aircraft are friendly or hostile. The launcher operator points the missile tube at the target and initiates the missile seeker. When the seeker has locked on to the target, it notifies the gunner by emitting an audible tone. The gunner then elevates the launcher and fires the missile from the tube with a small launch motor. When the missile has traveled a safe distance from the gunner, its main engine ignites

and propels it to the target. The missile employs a proportional navigation system, which keeps the missile on target. The missile must impact the target in order to explode.

The 72 man-portable Stinger teams assigned to a division are placed in accordance with the commanding officer's tactics. Generally, they are located completely around the divisional zone of control, with the heaviest concentration located in the area that the enemy is most likely to attack. There are not enough teams to cover the division, so there may be gaps in coverage in some areas and overlapping coverage in others, depending on the defensive strategy.

The Army states that since Stinger missile teams are essentially completely exposed, they have practically no protection at the front. Their only protection is their ability to change locations and to take advantage of natural or man-made cover. Because they use a High Mobility Multipurpose Wheeled Vehicle for transportation, they cannot keep up with armor units over rough terrain.

The missile's acquisition system requires a visible target, and although it is very effective against objects in the clear blue sky, it generally cannot acquire targets at night or in adverse weather. Neither can it easily determine targets against a backdrop of other objects that produce thermal signatures or clutter. Enemy close support aircraft and helicopters would be coming in at low altitudes in precisely that kind of thermal clutter. Also, current hostile aircraft identification systems are so limited that unless certain area procedural orders are in effect, Stinger teams need to have positive hostile identification before they can fire. Finally, the Stinger's range, which is limited because the missile must be small and light enough to be man-portable, is insufficient to defeat enemy helicopters at stand-off ranges.

Chaparral

The Chaparral missile weapon system consists of a tracked vehicle with a pedestal-type launcher mounted on the back. The launcher can hold four ready-to-fire Chaparral heat-seeking missiles. Eight additional missiles for reloading are stored on the carrier. Aircraft alert information can come from radio communication feeds from the Forward Area Alerting Radar or other sources. The Chaparral uses a forward-looking infrared device and visual sightings for target detection and acquisition. The system also contains the recognition equipment for identifying friend or foe aircraft that is available to Stinger teams.

As FAADS is deployed, the Army plans to move the Chaparral units from the divisional area to the corps area. Teams of the man-portable Stinger now perform the forward area mission. Chaparral's new mission is to provide low-altitude air defense for various static sites such as bridges, depots, and command centers. Eventually, the Avenger is expected to replace the Chaparral in the active forces, and the Chaparrals are to be redistributed to reserve component forces.

Although the Chaparral missile system is on a tracked vehicle, it has neither the speed to keep up with heavy armor nor the armor to survive at the front. The Chaparral has a forward-looking infrared device, which gives it some capability to perform at night and in adverse weather, but it has difficulty locating targets in thermal clutter and does not have the range to defeat the current stand-off threat.

Although the system can fire its four ready-to-launch missiles quickly, it takes a long time for its crew to reload the launcher. Army representatives said that the Chaparral crew could reload the launcher quickly once but would be worn out afterwards. They said that each reload would take the crew increasingly more time.

Vulcan Gun

The Army's concept for low-altitude air defense calls for a combination of missile systems and air defense guns to provide for the "blanket" of needed coverage. The Army's current air defense gun, the Vulcan, is needed because all missile systems have a zone surrounding them in which they cannot acquire and lock on targets. This zone, which is referred to as the "missile dead zone," is where the gun systems are supposed to take over. Air defense guns can only fire effectively at short ranges within this zone. Although the gun may not account for very many actual kills, concentrated bursts of rounds from the gun may cause enemy pilots to change course and disrupt their attack runs. An Army official stated that keeping the enemy from completing its mission is still effective air defense, although not as desirable as a kill.

The Vulcan gun system consists of a tracked carrier with a 20-millimeter six-barreled gun mounted on top. The gun has a range of approximately 1,200 meters. Primarily, targets are detected and acquired using enhanced optical devices or visually. However, aircraft alerts can come from other sources through radio links. Like the other forward systems' crews, Vulcan gun crews must positively identify threat aircraft before firing.

Although the Vulcan gun is mounted on a tracked carrier, it does not have the speed to keep up with the assets it is intended to protect and does not have sufficient armor protection to survive at the front. The gun turret is completely open, leaving the gunners exposed to small arms fire as well as fragmentation. The Vulcan gun has been in use since 1968 and is effective at very short ranges. The Army plans to start retiring the Vulcan gun as ADATS is fielded.

Hawk and Patriot

Although the Hawk and Patriot missile systems are not considered forward area air defense weapons, they are critical elements of the Army's ground-based air defense capability. Forward area systems are to provide low-altitude air defense against aircraft attacking assets at or near the front. Other threat aircraft may attack targets at the front at higher altitudes, and still other threat aircraft may attempt to "hop" over the front, flying above the low-altitude defenses and back down to attack rear area targets from low altitudes. Currently, the Hawk and the Patriot are intended to address threats not protected by forward area air defense weapons.

Hawk

The Hawk is a surface-to-air missile system designed to defend against enemy aircraft flying at low to medium altitudes. Located in the rear combat areas, the system includes a command post, radar stations, launchers, and missiles. It is used by the Army, the Marine Corps, and allies to protect ground forces and high-value assets such as bases and logistics complexes. The Army places special emphasis on countering aircraft that attack at low altitudes to escape radar detection and take advantage of the degradation of pulse-type radars caused by ground clutter. The Hawk's continuous wave radars and semi-active homing guidance are not seriously degraded by ground clutter. However, a Hawk fire unit can engage only one target at a time.

Patriot

The Patriot is a surface-to-air missile capable of engaging multiple high-performance aircraft. The system consists of a radar, ground support equipment, missile launchers, and missiles. It is intended for use primarily against enemy aircraft flying at high to medium altitudes, and it is designed to protect ground forces and other high-value targets such as air bases in the rear combat zone.

The Patriot missile system, which has replaced the Nike Hercules, is the first major air defense artillery system designed to defeat defense suppression tactics such as saturation, maneuver, and electronic countermeasures. The Patriot can simultaneously detect, identify, track, and destroy large numbers of attacking aircraft. The Patriot will provide essential air defense improvements, including substantially more firepower, increased survivability, and greatly reduced susceptibility to electronic countermeasures. The Patriot system employs an integral, battalion-level command and control system.

C3I Network

The existing C3I network consists of a number of strategic and tactical elements. Early warning and alert data can be received by frontline air defense weapons from AWACS or Patriot and Hawk batteries. This data must be manually processed and transmitted to the weapon systems and is not generally timely or adequate for weapons cueing. Primarily, current target detection is accomplished with the FAAR. The FAARs use the Mark XII aircraft identification device, which can only provide positive identification of friendly aircraft from which it receives a return signal. The FAARs transmit target detection and identification information, by voice, to the air defense command and control center, where it is manually integrated with other information received. The command center transmits, over a radio network, target information to the weapon systems. The Army believes that the current C3I network cannot provide adequate aircraft identification, detection, and acquisition information to units in time to alert them of the approach of threat aircraft.

Objective, Scope, and Methodology

At the request of the Chairmen of the Subcommittees on Defense, Senate and House Committees on Appropriations, we reviewed selected aspects of the Army's acquisition of FAADS. The objectives of our review were to develop information regarding (1) the Army's requirement for FAADS, (2) the Army's expected use of each component in performing its ground-based air defense mission, (3) the cost and schedule of each component, and (4) the Army's plans for its current air defense systems.

We performed our review at the Office of the Secretary of Defense, Washington, D.C.; Headquarters, Department of the Army, Washington, D.C.; the U.S. Army Missile Command, Redstone Arsenal, Alabama; and the U.S. Army Air Defense Artillery Center and School, Fort Bliss, Texas. We interviewed program officials and obtained information on system requirements, cost estimates, development and acquisition programs, fielding schedules, and testing results.

We discussed a draft of this report with officials from the Office of the Secretary of Defense and the Department of the Army, and we have incorporated their comments where appropriate. As requested, we did not obtain official agency comments on the report.

We performed our review from March 1989 through March 1990 in accordance with generally accepted government auditing standards.

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