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Report to the Secretary of Defense

June 1997

ARMY ARMORED SYSTEMS

Meeting Crusader Requirements Will Be A Technical Challenge

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United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

Army Armored Systems: Meeting Crusader Requirements Will Be A Technical Challenge

B-276453

June 6, 1997

The Honorable William S. Cohen
The Secretary of Defense

Dear Mr. Secretary:

The Army is developing its next generation field artillery system, called the Crusader, to support its fast moving maneuver forces. The Crusader system consists of a self-propelled 155-millimeter howitzer and a resupply vehicle. We reviewed selected aspects of the Crusader program to determine (1) what the status of the program was and (2) whether there are any alternative howitzer systems that could meet the Crusader requirements.

Background

The Crusader was to be developed with an advanced technology, liquid propellant cannon; however, in March 1996, the Army decided to develop the system with an advanced technology solid propellant cannon because of escalating developmental costs and chronic technical problems associated with the liquid propellant cannon. The Army plans to replace its current self-propelled artillery system—the M109A6 Paladin and the M992 Field Artillery Ammunition Support Vehicle (FAASV)—with the Crusader system in the rapidly deployable and forward deployed forces. The Army estimates it will cost over $12 billion (in fiscal year 1995 constant dollars) to design and procure 824 Crusader howitzers and 824 Crusader resupply vehicles.[1] The Crusader system unit cost is estimated to be $14.7 million (in fiscal year 1995 constant dollars)—$7.5 million for the howitzer, $5.8 million for the resupply vehicle, and $1.4 million that the Army could not divide between the two vehicles.

The system is being designed under its program definition and risk reduction phase, with the first prototype scheduled for delivery in October 1999. The Crusader program is using the integrated product development philosophy with a Crusader development team consisting of the Army and a contractor team led by United Defense Limited Partnership. Department of Defense (DOD) regulations require that decision criteria be established for each major decision point in a major defense acquisition program.[2] In

[1]The Crusader costs are program acquisition costs and consist of research and development, procurement, and military construction costs that are in direct support of the system.

[2]DOD Regulation 5000.2-R "Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs," dated March 15, 1996.

August 2003, the Army plans to decide whether the program should be allowed to enter the low-rate initial production.

DOD determined that the primary threat future U.S. artillery systems would encounter is target acquisition radars and other reconnaissance and surveillance systems that would enable an enemy to quickly locate and return fire once a howitzer starts firing. To be successful against this threat, the Army determined that it would need an artillery system that could provide accurate and lethal fire from longer ranges than the current systems and that could move and generate combat firepower quickly to evade enemy counterfire. In addition, some foreign howitzers currently have greater range than the Army's current system, the Paladin, and Operation Desert Storm demonstrated that current U.S. howitzers were unable to keep up with the maneuver force.

The Crusader system's five key requirements, called key performance parameters, call for improved performance in these areas over existing systems. System lethality and survivability are expected to be improved by meeting the requirements that the Crusader cannon have a range of 40 to 50 kilometers, a maximum rate of fire of 10 to 12 rounds per minute for 3 to 5 minutes, and the ability to rearm the howitzer with 60 complete rounds in less than 12 minutes. Mobility is expected to be improved by meeting requirements for both vehicles to be capable of sustained cross country speeds of 39 to 48 kilometers per hour and sustained highway speeds of 67 to 78 kilometers per hour.

Results in Brief

The Army believes that the Crusader system, using advanced technologies, has the potential to revolutionize field artillery operations. According to Army analyses, the system could increase force effectiveness—in terms of rounds fired, missions completed, and enemy systems destroyed and reduce U.S. losses—up to 52 percent.

However, developing and integrating the Crusader system to meet all the Army's requirements will be technically challenging because it depends heavily upon the accomplishment of many technological firsts for U.S. field artillery systems. These include the automated ammunition loading and handling system, automated ammunition and fuel transfer system, and actively cooled cannon barrel. Not meeting some requirements could have an adverse effect on system potential. For example, the system needs to achieve a 10-rounds-per-minute firing rate because the Army's force effectiveness analyses showed that an 8-round rate would cause the U.S.

force to lose in some battlefield scenarios. Also, as currently designed, some subsystems have no backup capabilities; therefore, if the system does not meet its reliability requirement, it may not be able to perform its mission. For example, the Crusader's autoloader has no backup. If the autoloader fails, the Crusader howitzer will be unable to fire because the cannon cannot be hand loaded.

In response to funding reductions, the Army is making critical program scheduling decisions that will compress the program's schedule beyond its already-compressed schedule under the streamlined acquisition process. In the past, such schedule adjustments have resulted in reduced testing and/or concurrent testing, allowing programs to enter low-rate initial production before they were ready. Allowing programs to enter low-rate initial production before they were ready has often resulted in procurement of substantial inventories of unsatisfactory weapon systems that required costly modifications or, in some cases, substandard weapon systems being procured for combat forces.

No existing alternative artillery system meets all of the Army's projected artillery requirements. However, if the Crusader cannot meet its requirements, other artillery systems, such as an improved Paladin or the German PzH 2000 self-propelled howitzer, may provide an alternative to improve the Army's current artillery capabilities.

Army Believes Crusader Could Revolutionize Field Artillery Operations

According to the Army, the Crusader system could revolutionize Army field artillery operations. It is expected to be the Army's first fully automated and computerized, tracked combat vehicle system. Also, it is expected to be the first tracked vehicle system designed for the digital battlefield. The Army expects these features to change the way it uses artillery.

The system is expected to eliminate repetitive, time-consuming, labor-intensive tasks traditionally performed by artillery system crews. Currently, the Paladin's crew manually loads and fires the cannon. Likewise, Army officials said that the FAASV crew generally carries the projectiles and propellant between vehicles during resupply because it is faster than using the FAASV shuttle arm—a small conveyor belt—to move projectiles between the vehicles. However, in the Crusader system's current design, all cannon loading, firing, and resupply tasks will be fully automated, controlled by crewmembers seated at their computerized crew

stations. The resupply vehicle will require some manual effort for replenishing its load.

The Army plans to use the Crusader howitzer in more flexible ways than traditional artillery. Unlike the Paladin, the Army expects the Crusader howitzer to be capable of operating independent of a fire control center on missions such as raids and ambushes. In the digital environment, the crew is expected to receive up-to-date intelligence on their crew station displays that allows them to be aware of the battlefield situation and to make tactical decisions. Also, the Army expects a single howitzer to be capable of firing from four to eight artillery rounds, depending on range to the target, fast enough and on different trajectories, so that they all impact close together and at the same time. One Paladin cannot perform this mission. It would require from two to four Paladins to fire an equivalent number of rounds to impact close together and at the same time.

Also, the Army expects the Crusader resupply vehicle to be capable of independent operations and resupplying and refueling more than one howitzer. Currently, a FAASV must remain close to its assigned Paladin and has no refueling capability. The Paladin howitzer must leave its firing position and go to a separate refueling point.

Army Analyses Show Crusader More Effective

In support of the Crusader design effort, the Army has performed detailed force effectiveness and other analyses, using computer modeling. The Army based its analyses on a Crusader system that met its minimum requirements. The analyses indicated that such a Crusader system would be more operationally effective than the Paladin and resupply vehicle or improved versions of the two vehicles. Also, they indicated that the Crusader system would be able to engage the enemy at longer ranges and for a longer time, would be more available for firing missions, and would have more rounds readily available for firing missions.

The analyses simulated battle in 2006 using four scenarios—both defensive and offensive operations in both southwest and northeast Asia—and concluded that the Crusader system would best meet the Army's needs. In one analysis during a simulated 4-hour counter battery artillery mission, the computer model indicated the Crusader howitzer could reduce U.S. losses by 34 percent and could fire 215 percent more rounds, could fire 145 percent more missions, and could kill 175 percent more targets than the Paladin. The analyses suggested that the Crusader

system would increase force effectiveness by up to 52 percent and defeat the future threat.

Crusader Must Meet Its Requirements to Achieve Its Full Potential

Development and integration of the Crusader system are challenging because the system incorporates many new technologies. Moreover, the Crusader system must meet its minimum requirements if it is to provide the benefits described in the Army's analyses.

Developing and Integrating the Crusader Are Technically Challenging

The many new subsystems make developing and integrating the Crusader system a challenge technically. The technology is mostly driven by three key requirements—the rate of fire, the resupply rate, and the cannon range. Most of this technology has never been fielded in an Army artillery system and is currently in various stages of development.

To meet the 10- to 12-rounds-per-minute firing rate, the current Crusader howitzer design incorporates the following new subsystems:

- A computer controlled, fully automated autoloader that will identify, select, and load projectiles and propellant.
- A solid propellant system, called the Modular Artillery Charge System, to enable propellant autoloading.
- A fuze, called the Multi-Option Fuze for Artillery, that can be set remotely.
- An actively cooled cannon tube and recoil mechanism to dissipate the heat generated by firing at the required rate.
- A laser ignition system to electronically fire the cannon.

The Army is developing the new propellant system and the new fuze for use in all its artillery fleet, not just the Crusader system. The new propellant system consists of two different propelling charges contained in combustible cases that the Army expects will replace the cloth bags of propellant currently used in artillery operations. The remaining subsystems are being developed specifically for the Crusader system, although the laser ignition system may later be applied to the Paladin.

The Army believes that the Crusader howitzer and resupply vehicle will need to interface with each other and will require computer controlled, fully automated ammunition handling and refueling systems to meet the less than 12-minute resupply requirement. The current resupply vehicle design incorporates a telescoping transfer boom to dock with the howitzer

so that the crews can remain in the vehicles during the transfer of ammunition and fuel. The Army expects the vehicles' computers will interface with each other and transfer information on what needs to be resupplied and what is being supplied such as projectile type, weight, and fuze type. In the current design concept, the howitzer's autoloading system also functions as its automatic ammunition handling system.

Because of the range requirement, the Army believes that the Crusader howitzer will need a 54-caliber cannon, which will be significantly longer than the Paladin's 39-caliber cannon. Developing a 54-caliber cannon that also meets the Crusader's durability requirement is challenging because longer cannons wear out faster than shorter ones. The Crusader's durability requirement is that the cannon have a 30-day battlefield life. Recently, the Army made this requirement more stringent by reducing the artillery battery from eight to six howitzers without changing the battery's mission. Now, six howitzers must do the firing formerly planned for eight howitzers. If the battery contained eight howitzers, each Crusader howitzer would have to fire 10,500 rounds to meet the cannon durability requirement. However, with the reduction to six howitzers, each Crusader howitzer will have to fire 13,800 rounds to meet the requirement. A program official said that the cannon's durability will also be adversely affected because the six howitzers will have to fire more rounds at longer ranges. The Army is exploring different coatings for the inside of the cannon and possible improvements to artillery projectiles to increase the cannon's life.

Also, the current Crusader system design includes other new technologies. Preeminent among these technologies are (1) advanced automated crew stations; (2) advanced fire control; (3) embedded command, control, communications, and intelligence, and training; (4) improved navigation systems, signature management, defensive systems, and nuclear, chemical, and biological protection; and (5) state-of-the-art mobility systems, including drive-by-wire, external hydropneumatic suspension, improved tracks, and an improved diesel power train.[3] The Army expects that the Crusader system will be the first tracked vehicles driven by wire with their movement, engine speed, transmissions, breaking, and steering, controlled through the vehicles' computers.

[3]A drive-by-wire system replaces mechanical linkages and controls with electrical impulses through a wire to operate the vehicle's transmission, engine, and steering.

Achieving Projected Force Effectiveness Requires the Crusader to Meet Minimum Requirements

As previously mentioned, the Army's force effectiveness analyses were based on a Crusader system that met its minimum requirements. Therefore, to reach its full potential, as described in the Army's analyses, the Crusader system needs to meet its minimum requirements. The Army's force effectiveness analyses indicated that the system would be more operationally effective than existing artillery systems because of its advantages in rate of fire, resupply capability, and system reliability. However, the system's advantages can be quickly eroded if its requirements are not met.

For example, a Crusader project official said that Army's analyses indicated that if the Crusader howitzer could only fire 8 rounds per minute instead of 10, the Army would lose in some battlefield scenarios. Also, an Army's analysis showed significant improvement in the number of rounds available to the howitzer if it could be resupplied within 12 minutes. However, during the time the howitzer and resupply vehicle are close together or docked during resupply and the howitzer is unable to fire, they are more vulnerable. Therefore, missing the required resupply time increases the vehicles' vulnerability and reduces the howitzer's availability for firing missions.

The Crusader system needs to meet its reliability requirement because its advantage in system reliability was one of the main reasons the Crusader was determined to be more effective than the Army's existing artillery system. The Crusader howitzer and resupply vehicle have different reliability requirements. The howitzer is required to have at least 34 hours mean time between essential function failures and at least 62 hours mean time between system aborts. The resupply vehicle is required to have at least 62 hours mean time between essential function failures and at least 104 hours mean time between system aborts. An Army official said that an essential function failure allows the vehicle to complete its mission in a degraded capacity while a system abort ends the mission.

Additionally, the Crusader system must achieve high reliability because many of its subsystems will not have a backup, and a failure in one of those subsystems could cause the Crusader to be unable to complete its mission. For example, the Crusader howitzer only has one autoloader, and the current howitzer design will not allow the crew to hand load the cannon if the autoloader fails. Therefore, the Crusader howitzer cannot fire if the autoloader fails. Likewise, the cannon will not be able to fire at sustained high rates if the cannon cooling or recoil cooling fails. In this case, the howitzer could still fire but at a 10-rounds-per-minute rate for

1 minute, after which it could only fire at a one- to two-rounds-per-minute rate.

As currently designed, the two Crusader vehicles each will possess only one automated ammunition handling system. The automated systems allow Crusader crews to remain in the crew compartments, under armor, while performing the resupply. This increases crew survivability by minimizing exposure to counterfire and contaminated air. However, if either handling system breaks down, the crews must dismount and perform the resupply by a time-consuming, hand process, making them more vulnerable to counterfire and contaminates.

The current Crusader computer concept contains some redundancy in that each crewmember will have a computer control display that can perform all the crew functions and the computer system itself will have three central processing units. However, the transmission and the engine each will have only one microprocessor linked to the central processors. A project office official said that failure of one of these microprocessors would be a mission-ending failure because the crew could not drive the vehicle without the unit.

Army Is Making Critical Crusader Program Scheduling Decisions

In response to funding reductions, the Army is making critical program scheduling decisions that will compress the Crusader program's schedule beyond its already compressed schedule under the streamlined acquisition process. In the past, such schedule adjustments have resulted in reduced testing and/or concurrent testing, allowing programs to enter low-rate initial production before they were ready. This has often resulted in procurement of substantial inventories of unsatisfactory weapon systems that required costly modifications or, in some cases, substandard weapon systems being procured for combat forces.[4]

The Crusader program is using a streamlined acquisition approach consisting of a single, three-phased developmental cycle from milestone I to milestone III. This approach is designed to reduce the time needed to develop, produce, and equip the first artillery unit with the Crusader system by 12 to 15 months. This approach eliminates milestone II by replacing the formal Defense Acquisition Board Review with a less formal Defense Acquisition Executive in-process review, which is scheduled for April 2000. While it is unclear what this review will entail, the current

[4]Weapons Acquisition: Low-Rate Initial Production Used to Buy Weapon Systems Prematurely (GAO/NSIAD-95-18, Nov. 21, 1994).

Crusader acquisition plan states that this approach intends to meet "the spirit of all regulatory guidance for milestone II content."

The Crusader is being designed under its program definition and risk reduction phase (previously called demonstration and validation phase) of the streamlined acquisition cycle. Up to this point, the development team has been involved in further defining the Crusader system's basic design, demonstrating potential Crusader technologies, and developing potential Crusader components using models, simulations, and advanced technology demonstrators. For example, the cannon tube is being safety tested using a combination of actual and simulated firings.

The first Crusader system prototype is scheduled for delivery in October 1999. The Army expects the contractor to produce 10 prototype systems—10 howitzers and 10 resupply vehicles—during the development cycle. Only the last four prototype systems are expected to be fully functional. The current schedule shows that the Army plans to make the low-rate initial production decision in August 2003, with the full-rate production decision following 2 years later, in October 2005. In addition, the Army expects the contractor to produce 115 Crusader systems—230 vehicles—during the low-rate initial production phase. Army officials informed us that they realized that this quantity exceeds 10 percent of the planned Crusader production; however, they believe this quantity will allow the contractor to build up to full-rate production by producing 80 vehicles in the first year and another 150 in the second year.[5] Full-rate production is planned at 240 vehicles a year.

The Army is planning for a full test schedule to demonstrate the Crusader system's capabilities. It expected to use the prototypes in various tests, including the preproduction qualification test, which was scheduled to end in July 2003. According to the project manager, the preproduction qualification test results will be considered in the low-rate initial production decision scheduled for August 2003. The Crusader test master plan states the purpose of this test is to demonstrate that the prototypes can meet all the Crusader technical requirements. However, Army program officials said that if the system does not demonstrate all its requirements, they will assess the significance of the short comings to determine whether the program should enter low-rate initial production. While the Army has not established specific criteria for making this

[5]If the system's low-rate initial production quantities, as determined at milestone II, exceeds 10 percent of the system's planned total production, 10 U.S.C. 2400 requires the Secretary of Defense to include the reasons for such quantities in a statement in the system's next Selected Acquisition Report.

determination, project office officials said they plan to do so before the decision date.

On January 30, 1997, the Crusader project manager informed the Defense Acquisition Executive that the in-process review—the decision to allow the Crusader program to enter its full system development and preproduction phase (previously called the engineering and manufacturing development phase) would be delayed in excess of 6 months due to funding reductions. In the most recent Selected Acquisition Report, the Army reported to the Congress that most of the Crusader program, including the in-process review and the first artillery unit deliveries, would experience an 11-month delay. However, a project official said that the project office is now developing a schedule that delays the in-process review at least 6 months but not the date that the first Crusader artillery unit is fully equipped. Project officials said that they are aware of the problems that could result from compressed schedules and that they are working with the testing community to assure that these problems will not occur in the Crusader program. They added that they are planning to revise the program schedule to maintain the full test schedule. The project office is planning to submit the latest schedule for headquarters approval on July 18, 1997.

No Alternative Meets All Crusader Requirements

No existing artillery system meets all of the Crusader requirements. However, if the Crusader system cannot meet its requirements, other howitzer/resupply vehicles may provide an alternative means to improve the Army's current artillery capabilities.

No existing artillery system has an automated resupply vehicle; therefore, most cannot meet the Crusader key performance parameter for a less than 12-minute resupply and all systems do not have the survivability advantages of being able to resupply without the crew leaving the vehicles. All of the alternative howitzers depend on resupply vehicles where the crews must manually handle and transfer the ammunition between vehicles. As previously discussed, the Crusader's resupply advantage was one of the main reasons the Army concluded that the system would be more effective than alternative systems. While none of the existing self-propelled howitzers can meet all of the Crusader howitzer requirements, an Army study assessed the German PzH 2000 as the most capable foreign howitzer. The PzH 2000 is Germany's next generation 155-millimeter self-propelled howitzer and is scheduled to begin fielding in

1998. As can be seen in table 1, the PzH 2000 is an improvement over the Paladin, but it does not meet all of the Crusader's requirements.

Table 1: Comparison of the Crusader requirements to Paladin and PzH 2000 capabilities

Description	Crusader requirement	Paladin capability	PzH 2000 capability
Maximum rate of fire (rounds per minute)	10 to 12 (for 3 to 5 minutes)	4 (for 3 minutes)	10 (for 1 minute)[a] 8 (for 3 minutes)[a]
Sustained rate of fire (rounds per minute until system is out of ammunition)	3 to 6	1 to 2	3[b]
Maximum range (kilometers)	40 to 50	30	40[c]
Multiple round simultaneous impact (rounds impacting)	4 to 8 (between 8 and 36 kilometers)	2 (between 10 and 20 kilometers)	•[d]
Rearm time (minutes)	Less than 12	22	less than 11 minutes
Cross-country speed (kilometers per hour)	39 to 48	30	45
Highway speed (kilometers per hour)	67 to 78	67	61
Combat loaded weight (tons)	55	32	60
90-second survival dash speed (meters)	750	560	750

[a]Preparing the propellant charge is not included in the time. The PzH 2000 could not fire at this rate at targets located in the longer third of its range because it lacks active cannon cooling.

[b]The PzH 2000 could not fire at this rate at targets located in the longer sixth of its range because it lacks active cannon cooling.

[c]Has not been demonstrated.

[d]As this is not a German requirement, the PzH 2000 has not attempted to fire such a mission. However, contractor officials believe that if the PzH 2000 had a propellant autoloader, it would have the same capability as the Crusader howitzer.

Source: Army data for the first two columns and PzH 2000 contractor data for the third column.

In addition to the differences shown in the table, the PzH 2000's survivability and availability for firing missions would be less than the Crusader's. First, without an automated resupply vehicle, PzH 2000 crewmembers would have to leave the protection of their vehicle to physically carry the projectiles and powder charges between vehicles. This would make them more vulnerable than Crusader crewmembers, who can remain protected in their vehicles to conduct resupply operations. Further,

the PzH 2000's availability for firing missions would suffer because the PzH 2000 would have to leave the battle whenever it needed resupply or refueling.

Second, the location of the crewmembers within the PzH 2000 would adversely affect their survivability. The PzH 2000 is configured as a typical howitzer, with the majority of the crew located in the weapons compartment. As currently designed, the Crusader vehicles have separate crew and weapons compartments, which allows additional armor to be placed around the crew compartment and provides better protection from hits in the weapons compartment.

PzH 2000 contractor officials said that they could develop an automated resupply vehicle based on the PzH 2000 chassis and modify the PzH 2000 howitzer to meet all of the Crusader key requirements and many of the other Crusader requirements. Also, they believed that they could field these vehicles within 6 years of the start of development, assuming that U.S. government-furnished material, such as the actively cooled cannon, was available when needed.

The Army did not perform a detailed assessment of possible modifications to the PzH 2000 to improve its performance. Army program officials said that a detailed analysis was not required because an Army cost analysis had determined that the basic PzH 2000's life-cycle costs were more than the Crusader's and that modifying the PzH 2000 would only increase these costs. However, this reasoning overlooks the possibility that the modifications that would fully automate the firing and resupply processes would likely reduce the PzH 2000's crew requirements. The PzH 2000's crew size, five, was a major factor in its life-cycle costs being more than those of the Crusader howitzer.

PzH 2000 contractor officials said that a modified PzH 2000 howitzer and an automated PzH 2000-based resupply vehicle each would require a crew of three—the same crew size as the Crusader vehicles are expected to require. However, a modified PzH 2000 howitzer would still have crew located in the weapons compartment and the associated adverse impact on survivability. Also, the modified PzH 2000 howitzer would not have interchangeable crew stations at which all crew tasks could be performed.

Because the current PzH 2000 howitzer does not meet the Crusader combat loaded weight requirement, the PzH 2000 contractor would have to look for opportunities to reduce the modified PzH 2000 howitzer's weight.

However, the Crusader contractor is projecting that the Crusader howitzer, as currently designed, will not meet its weight requirement. The Crusader contractor also is looking for opportunities to reduce the Crusader's weight.

The Crusader project manager said that if it became necessary to choose an alternative to the Crusader system, the Army would likely choose an improved Paladin. The Paladin, based on a 1950s design, was first delivered to the Army in 1963 and, over the past 34 years, has been produced in six different models. Paladin project officials believe that some modifications could be made to the Paladin, which would increase its cannon range to the Crusader requirement, its rate of fire to six rounds per minute, and its speed. However, these officials stated that the Paladin's cross-country mobility could not be improved without a major redesign of its chassis. Further, an improved Paladin would maintain the current configuration with most of the crew in the weapons compartment and with the associated adverse impact on survivability. Finally, the Paladin and FAASV could not be automated to allow the crews to remain in the vehicles during resupply.

Recommendations

According to the Army, the Crusader system has the potential for revolutionizing artillery operations. However, the program faces considerable programmatic risks due to the technical challenges faced in developing and integrating advanced technologies, the potential compression of the program's schedule, the use of a streamlined acquisition approach, and the absence of defined criteria for entering into low-rate initial production. Consequently, to minimize the risk of prematurely entering production, we recommend that the Secretary of Defense direct the Secretary of the Army to establish criteria specifying, at a minimum, that the Crusader system demonstrate that it meets all key requirements and is on schedule for meeting its reliability requirement before entering low-rate initial production and is operationally effective and suitable before entering full-rate production. If, at either point, the Crusader system does not demonstrate that it meets its requirements, then the Secretary of the Army should determine whether an alternative artillery system may be a better way to improve the Army's artillery capabilities.

Agency Comments and Our Evaluation

DOD concurred with our report and noted that in accordance with its acquisition management policies and controls, the criteria for entering

low-rate initial production will be established for the Crusader system at milestone II. According to DOD, typical criteria for entering low-rate initial production are that the system meet all key performance requirements and show satisfactory progress toward demonstration of reliability requirements. In addition, DOD commented that its policy requires that should a system fail to meet its key performance requirements, the system requirements and all reasonable options to meet those requirements will be investigated.

While we are aware of DOD's acquisition policies and controls for the normal milestone II review, the Crusader program, as previously noted, is using a streamlined acquisition approach that eliminates the normal milestone II review. In its place is an in-process review by the Defense Acquisition Executive that will authorize the program's transition into the full system development and preproduction phase. The intent of our recommendations is to make sure that this review process ensures that, at a minimum, the Crusader system meets its rate of fire, range, mobility, and resupply requirements and is capable of meeting its reliability requirement before it enters production. If it does not demonstrate these capabilities, then serious consideration should be given to program termination in favor of an alternative system. Also, we have changed the title of the report to more accurately reflect the report's message.

DOD's comments are reprinted in appendix I. DOD also has provided some technical and editorial comments, and we have incorporated them in the text where appropriate.

Scope and Methodology

To evaluate the status of the Crusader program, we interviewed DOD, Army, and contractor officials and reviewed various program documents, including the program acquisition strategy, the system threat assessment report, operational requirements documents, the acquisition program baseline, the test and evaluation master plan, and the results of force effectiveness and other studies. We also observed and operated the contractor's Crusader crew simulator and the Army's Paladin Artillery System to understand the improvements the Army expects to gain from the Crusader. In addition, we discussed the potential threat to artillery systems with officials of the National Ground Intelligence Center, Charlottesville, Virginia.

To determine whether alternative howitzers could meet Crusader requirements, we interviewed DOD, Army, and contractor officials and

reviewed various program documents, including the engineering trade-off study, the cost and operational effectiveness study, other evaluation reports, and operational requirements documents. We also compared Crusader requirements with other current artillery systems. In addition, we discussed the capabilities of and possible improvements to the German PzH 2000 howitzer with officials of both the Army and its prime developer, the Wegmann & Company, GmbH, Kassel, Germany. We did not validate the Crusader requirements.

We performed our work at DOD and the Army headquarters, Washington, D.C.; Crusader and Paladin project offices, and U.S. Army Armament Research, Development, and Engineering Center, Picatinny Arsenal, New Jersey; U.S. Army Field Artillery Center and School, Fort Sill, Oklahoma; and United Defense Limited Partnership's Armament Systems Division, Minneapolis, Minnesota, and Paladin Production Division, Chambersburg, Pennsylvania.

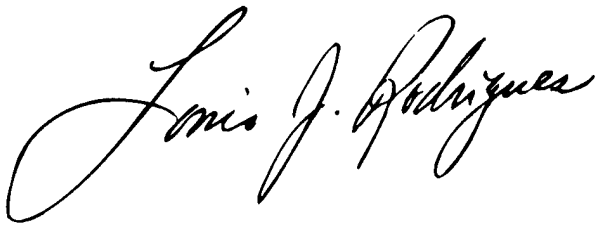
We conducted our review from June 1996 to April 1997 in accordance with generally accepted government auditing standards.

As you know, the head of a federal agency is required by 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 and Oversight not later than 60 days after the date of this report. A written statement also must be submitted 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 the report.

We are sending copies of this report to the Chairmen and Ranking Minority Members, Senate and House Committees on Appropriations, Senate Committees on Armed Services and Governmental Affairs, House Committees on National Security and Government Reform and Oversight; the Director, Office of Management and Budget; and the Secretary of the Army. We will also provide copies to others upon request.

Please contact me at (202) 512-4841 if you or your staff have any questions concerning this report. Major contributors to this report were Robert J. Stolba, Lawrence Gaston, Jr., and John P. Swain.

Sincerely yours,



Louis J. Rodrigues
Director, Defense Acquisitions Issues

Comments From the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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ACQUISITION AND TECHNOLOGY

07 MAY 1997

Mr. Louis J. Rodrigues
Director, Defense Acquisitions Issues
National Security and International Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "ARMY ARMORED SYSTEMS: If Successful, Crusader Could Revolutionize Field Artillery," dated April 7, 1997 (GAO Code 707180/OSD Case 1335). The DoD concurs with the report.

The detailed DoD comments to the GAO recommendations are enclosed. Additional technical comments were separately provided to the GAO staff. The DoD appreciates the opportunity to comment on the GAO draft report.

Sincerely,

George R. Schneiter
Director
Strategic & Tactical Systems

Enclosure:
as

GAO DRAFT REPORT DATED APRIL 7, 1997
(GAO CODE 707180) OSD CASE 1335

"ARMY ARMORED SYSTEMS: IF SUCCESSFUL, CRUSADER COULD REVOLUTIONIZE FIELD ARTILLERY"

DEPARTMENT OF DEFENSE COMMENTS TO
THE GAO RECOMMENDATIONS

RECOMMENDATIONS: The GAO recommended that the Secretary of Defense direct the Secretary of the Army to establish criteria specifying, as a minimum, that the Crusader system demonstrate that it meets all key requirements and is on schedule for meeting its reliability requirements before entering low rate initial production and is operationally effective and suitable prior to entering full rate production. The GAO further recommended if at either point the Crusader system cannot meet its requirements, the Secretary of the Army should determine whether an alternative artillery system may be a better way to improve the Army's artillery capabilities. (p. 14/GAO Draft Report)

DOD RESPONSE: Concur with the following comments. In accordance with recognized DoD acquisition management policies and controls implemented through DoD Directive 5000.1 and DoD Instruction 5000.2, the criteria for entering low rate initial production (LRIP) will be established for the Crusader system at Milestone II. Typical criteria for entering LRIP are that the system meet all key performance parameters and show satisfactory progress toward demonstration of reliability requirements. Additionally, DoD policy requires that should a system fail to meet its key performance requirements, the system requirements and all reasonable options to meet those requirements will be investigated.

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