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ARMY ARMORED SYSTEMS

Advanced Field Artillery System Experiences Problems With Liquid Propellant





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

National Security and
International Affairs Division

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November 2, 1994

The Honorable Carl Levin
Chairman
The Honorable John W. Warner
Ranking Minority Member
Subcommittee on Coalition Defense
and Reinforcing Forces
Committee on Armed Services
United States Senate

The Honorable Patricia Schroeder
Chairwoman
The Honorable Bob Stump
Ranking Minority Member
Subcommittee on Research
and Technology
Committee on Armed Services
House of Representatives

The Honorable Joseph M. McDade
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Because of your expressed interest, we are sending you this report on our recently completed self-initiated review of the Army's Advanced Field Artillery System (AFAS) program. In designing this new artillery system, the Army decided to use a liquid propellant (LP) rather than a solid or powder propellant that has traditionally been used in artillery guns. Since this was a major departure from the normal development of an artillery system, we focused our review on the status of the AFAS' LP gun, the nature and extent of any problems being experienced, and the Army's plans for proceeding with the development of the system.

Background

The Army's AFAS program originated in the early 1980s as part of a broader Army program to modernize its armored forces. The program includes the development and integration of the gun and its vehicle. The AFAS will be the first LP gun ever to be developed and fielded. Firing the gun involves the ignition and burning of LP to build pressure in the gun chamber and

launch the projectile. Control of the LP ignition and burning process is fundamental to the new technology because the projectiles and the cannon could be damaged if excessive pressure is generated during the process. Because of technological concerns with the LP gun, the Army also included the concurrent development of a solid propellant gun, called a unicharge gun, in the AFAS program's acquisition strategy.

The AFAS program is currently in the concept exploration and definition phase of the acquisition cycle. During this phase, the Army explores alternatives, defines the most promising concepts, develops information to identify high-risk areas, and composes an acquisition strategy and objectives for cost and scheduling milestones. Before exiting the concept exploration and definition phase, the Army must demonstrate that the AFAS program is affordable in the long term and its technical concepts are achievable.

A milestone I review to seek approval from the Defense Acquisition Board to enter the demonstration and validation phase is currently scheduled for the middle of November 1994. However, during an earlier review, the Under Secretary of Defense for Acquisition and Technology approved the formal release of the demonstration and validation request for proposal before the milestone I review. The request for proposal was released in July 1994.

Results in Brief

The Army's most advanced LP gun was recently severely damaged during a test firing. The Army has suspended all live-fire testing with its most advanced gun until the cause of the explosion is found and corrected. However, in order to maintain the current schedule, the Army has decided to seek the Defense Acquisition Board's approval to continue into the next developmental phase without additional live-fire test data and has requested about \$60.7 million to proceed into the next phase of the gun's development. This approach will allow the Army to demonstrate the program's readiness to proceed into the demonstration and validation phase even though it (1) has not corrected the problem that caused the explosion and (2) uses a technology that cannot currently meet AFAS' required rate-of-fire.

The Army's current acquisition strategy calls for the concurrent development of the unicharge gun as a prudent risk management backup for the AFAS program. However, the Army's current budget request states that funding for this alternative will stop after fiscal year 1995.

Gun Explosion Raises Questions Over Controlling Liquid Propellant

On May 3, 1994, the Army's most advanced version of the LP gun exploded during tests at the Malta Test Station, New York. This was the 30th test shot with this gun and the 3rd time an LP gun exploded and was severely damaged during testing. Army officials described this incident as high-pressure spikes of unknown origin occurring early in the LP ignition process, leading to uncontrolled LP combustion. The explosion caused extensive damage to the gun's hardware and created a secondary explosion, which damaged the fill system for the LP.

A similar incident occurred on April 9, 1992, when uncontrolled combustion damaged an earlier version of the LP gun during tests at Yuma Proving Ground, Arizona. This explosion was attributed to a failure of a temporary device used to assist in the ignition process. Therefore, the Army investigative team recommended that a high priority be placed on designing and developing an ignition subsystem to replace the temporary device. An ignition subsystem was in place on the gun that exploded in May 1994.

Another incident of uncontrolled LP combustion occurred on December 12, 1990, in the earlier version of the gun. This explosion was attributed to an inadvertent leak of LP. The Army did not formally investigate this incident, instead, the contractor at the time prepared a report detailing the incident.

All three of the explosions occurred early in the firing process. An Army official said that incidents of uncontrolled LP combustion occur in about 30 percent of the shots. However, he added that most of these incidents did not cause major damage to the gun because they occurred later in the LP combustion process, when much of the LP has been burned.

The explosions and other incidents of uncontrolled LP combustion emphasize the criticality of controlling the LP combustion process. Because of the most recent explosion, the Army has stopped all live-fire testing with its most advanced gun until officials can isolate, understand, and correct the cause. According to Army officials, their investigative effort will focus on the critical ignition and combustion process. Based on their estimated schedule, which has slipped several times, it does not appear that results of the Army investigation will be known in time to influence the milestone decision.

Army Plans to Proceed Despite Recent Explosion

The Army's current plan will allow the AFAS program to proceed into the next developmental phase (1) without demonstrating that the cause of the recent explosion has been corrected and (2) by using a technology that cannot currently meet AFAS' required rate-of-fire. In a memorandum, dated September 16, 1992, the Under Secretary of Defense for Acquisition and Technology established specific criteria that must be met before the program can proceed to the demonstration and validation phase. These criteria covered the ability to (1) predict the velocity at which the projectile leaves the gun tube, (2) hit a target with four rounds within 12 seconds, (3) determine and manage the heat generated by firing at a required 10- to 12-rounds-per-minute rate, and (4) remotely select and transfer complete rounds from the Future Artillery Resupply Vehicle to the AFAS at a required 6-round-per-minute rate.

Prior to the recent explosion, the Army planned to demonstrate that the AFAS met the criteria through live-fire testing of its most advanced LP gun. The test, to be held at the Yuma Proving Ground, was part of a larger, 500-round, live-fire developmental test. The tests were to use an LP gun built to the same design as the one that exploded at the Malta Test Station in May 1994, except this gun would have used an electronic source to produce a spark that would start the ignition process. All actual firings of LP guns to date have used a percussion cap as the spark source. A program official said that a gun using a percussion cap as the spark source cannot meet the AFAS' required 10- to 12-rounds-per-minute rate for 3 to 5 minutes because the cap needs to be changed after every 4 rounds. An electronic source would not need to be changed and, therefore, could meet this requirement. The live-fire tests were to have started in February 1994 and would have been substantially completed prior to the milestone decision. However, the live-fire tests with the most advanced LP gun were not started prior to the recent explosions because of a delay in the installation of the gun at Yuma. Because they have been put on hold as a result of the recent explosions, the planned live-fire test can no longer be performed prior to the scheduled milestone dates.

Rather than delay the milestone decision, the AFAS Program Office received permission from the Army to modify its strategy to demonstrate the exit criteria. Instead of live-fire testing of the most advanced prototype using an electronic spark source, the Army now intends to meet exit criteria by using a combination of data from (1) live firings of the advanced model gun before it blew up, (2) live firings of an older-generation gun at Malta, (3) simulated firings of the gun at Yuma, and (4) computer modeling that will predict gun performance.

This substitute approach, while allowing the Army to maintain the current milestone schedule, will diminish the amount of quantitative data available for the milestone decision. Moreover, until numerous rounds have been fired from the most advanced gun, the Army will not know for sure whether (1) its diagnosis of the causes of the explosion was correct, (2) the corrective action it took to mitigate the causes of the explosion really work, and (3) the problem is related to something inherently unstable about the use of LP or some other, unknown factor.

Program officials were concerned that delaying the milestone decision would adversely impact the program's momentum. They estimated that if the milestone decision was delayed, it could take as long as 2 years to restart the program because a contractor base is currently in position to support the demonstration and validation effort. They believe that any further delays in awarding the demonstration and validation contract could result in a loss of the contractor commitment and program continuity that would be difficult and costly to reconstitute.

Recommendations

We recommend that the Secretary of Defense ensure that the Army

- continues the concurrent development of the unicharge gun until the LP gun technology has been successfully demonstrated in live-fire tests and
- postpones AFAS system integration until it makes a decision on whether to proceed with the LP or unicharge gun.

We also recommend that if a decision is made to proceed with the LP gun, the Secretary of Defense independently verify that problems concerning the LP burning process have been fully resolved and that the Army has developed an ignition system that will allow the gun to meet its rate-of-fire requirement—10- to 12-rounds-per-minute for 3 to 5 minutes.

Agency Comments and Our Evaluation

The Department of Defense (DOD) agreed with much of the information in our report but indicated that several points required further discussion and clarification. It is DOD policy that the Army must demonstrate that the AFAS' technical concepts are achievable in order to proceed into the demonstration and validation phase. According to DOD, the Army has proven the achievability of the technical concepts associated with the AFAS. Also, DOD said that it is satisfied with the Army's approach for demonstrating the AFAS concept exploration exit criteria.

DOD also stated that to the extent that the LP gun development still contains a measure of risk, the Army has a prudent risk mitigation plan to carry the unicharge gun in parallel development until an appropriate decision point is reached. Further, the request for proposal for the demonstration and validation phase specifically precludes the contractor from engineering a design that could not be fit with a unicharge gun. The Army has scheduled an in-process review for 26 months after entry into the demonstration and validation phase to determine whether the program should be continued with an LP or unicharge gun.

DOD acknowledged that the Army had not requested funding for the unicharge gun development in fiscal year 1995. However, Congress added funding to continue the unicharge development effort in fiscal year 1995. DOD stressed that the Army will seek funding to continue this effort in its fiscal year 1996 budget request.

In light of the additional information provided in DOD's specific comments and the Army's current acquisition strategy, we have modified our recommendations to require the Army to demonstrate that it can control the LP burning process and it has developed an ignition system capable of meeting the AFAS rate-of-fire requirement before integrating the gun into the AFAS system. We have no basis to disagree with DOD's assertion that the interim 26-month period should allow time for the Army to demonstrate whether this is achievable. We have also deleted a suggestion to Congress concerning a possible restriction of funding for the program. DOD's comments are presented in their entirety in appendix I, along with our evaluation.

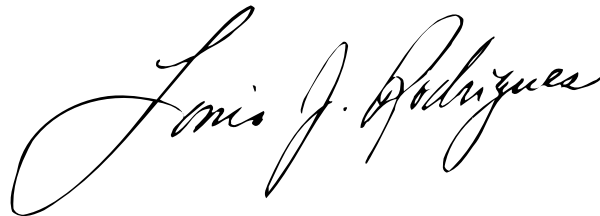
Scope and Methodology

We interviewed and obtained program documents from officials in the Department of the Army headquarters, Washington, D.C.; the AFAS Project Manager's office and the Paladin Project Manager's office, Picatinny Arsenal, New Jersey; U.S. Army Field Artillery School and Center, Fort Sill, Oklahoma; U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, Maryland; and the Office of the Inspector General, DOD, Arlington, Virginia. We discussed technical points on the LP gun with officials from the Institute for Defense Analysis, Alexandria, Virginia.

We conducted our review between July 1993 and July 1994 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Chairmen and Ranking Minority Members of the House Committee on Government Operations and the Senate Committee on Governmental Affairs; the Director, Office of Management and Budget; and the Secretaries of Defense and the Army. We will also provide copies to others upon request.

This report was prepared under the direction of Thomas J. Schulz, Associate Director, Systems Development and Production Issues. Please contact Mr. Schulz at (202) 512-4841 if you or your staff have any questions concerning this report. Other major contributors to this report are listed in appendix II.

A handwritten signature in black ink that reads "Louis J. Rodrigues". The signature is written in a cursive style with large, flowing letters.

Louis J. Rodrigues
Director, Systems Development and
Production Issues

Comments From the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



ACQUISITION AND
TECHNOLOGY

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21 SEP 1994

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "ARMY ARMORED SYSTEMS: AFAS Not Ready to Advance to the Next Phase of Development," dated August 11, 1994 (GAO Code 707027), OSD Case 9762. The DoD partially concurs with the report.

While the Department agrees with much of the information contained in the draft report, there are several points that require discussion and clarification. The GAO primary concerns are (1) that the Advanced Field Artillery System (AFAS) should not proceed into the Demonstration/Validation phase of development until all Regenerative Liquid Propellant Gun (RLPG) problems are identified and corrected and (2) that the program is not meeting all the exit criteria for the demonstration/validation phase. It is established DoD policy that the Army must demonstrate that AFAS is affordable in the long term and its technical concepts are achievable in order to proceed into demonstration/validation. That is the appropriate phase in which to mature the technology and advance its engineering. The Army has proven the achievability of the technical concepts associated with the AFAS. The DoD is also satisfied with the approach the Army is using in demonstrating achievement of the system's exit criteria. The integrated use of live firings, demonstrations, simulations, and analyses is both adequate and appropriate for the current level of development.

To the extent that the RLPG still contains a measure of risk, the Army's plan to carry the unicharge in parallel development until an appropriate decision point is reached is prudent. The Congress has proposed funding in fiscal year 1995 and the Army will fund the 1996 program in its budget. Further, the structure of the demonstration/validation request for proposal (RFP) specifically precludes the contractor from engineering a design which could not be fit with a unicharge propellant system. The DoD has designed into the management of the system sufficient opportunities for review to ensure compliance with the agreements reached on the type of propellant system to be used.



Appendix I
Comments From the Department of Defense

Finally, the Department nonconcurrs with the GAO suggestion that the Congress restrict the Army's obligational authority in 1995. Proper management of any program requires sufficient funding to ensure that schedule and government and contractor support bases are not jeopardized. The Department is providing proper oversight of this major acquisition program and internal mechanisms exist to restrict funding if the need arises.

The detailed DoD comments on the draft report findings, recommendations, and matter for congressional consideration are provided in the enclosure. The DoD appreciates the opportunity to comment on the draft report.

Sincerely,



George R. Schneiter
Acting Director
Tactical Warfare Programs

Enclosure

GAO DRAFT REPORT - DATED AUGUST 11, 1994
(GAO CODE 707027) OSD CASE 9762

"ARMY ARMORED SYSTEMS: AFAS NOT READY TO ADVANCE TO THE
NEXT PHASE OF DEVELOPMENT"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

- **FINDING A: The Army's Advanced Field Artillery System Program.** The GAO reported that the Advanced Field Artillery System (AFAS) will be the first liquid propellant (LP) gun ever to be developed and fielded. The GAO pointed out that the gun involves the ignition and burning of LP to build pressure in the gun chamber and launch the projectile. The GAO noted that control of the LP ignition and burning process is fundamental to the new technology because the projectiles and the cannon could be damaged if excessive pressure is generated during the process. The GAO indicated that because of technological concerns with the LP gun, the Army also included the concurrent development of a solid propellant gun, called a unicharge gun, in the AFAS program acquisition strategy.

The GAO observed that the AFAS program is currently in the concept exploration and definition phase of the acquisition cycle. The GAO asserted that before exiting that phase, the Army must demonstrate that the AFAS program is affordable in the long term and its technical concepts are achievable. The GAO noted that a Milestone I review to seek approval from the Defense Acquisition Board to enter the demonstration and validation phase is currently scheduled for the end of September 1994. (pp. 2-3/GAO Draft Report)

DOD RESPONSE: Concur. The current projected date for the Milestone I Defense Acquisition Board review is mid-November. As the GAO reported, the LP technology is still in the development phase and unicharge is being carried in parallel. The Army has scheduled an In-Process Review for 26 months after entry into the demonstration/validation phase to make a decision whether to continue the program with LP or change to unicharge.

- **FINDING B: Gun Explosion Raises Questions Over Controlling Liquid Propellant.** The GAO reported that on May 3, 1994, the Army's most advanced version of the LP gun exploded during tests at the Malta Test Station, New York. The GAO asserted that was the 30th test shot with the gun and the

Enclosure

Now on pp. 1-2.

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third time an LP gun exploded and was severely damaged during testing. The GAO pointed out that the other two incidents occurred on an earlier version of the gun. The GAO noted that on April 9, 1992, uncontrolled combustion damaged the LP gun during tests at Yuma Proving Ground, Arizona, due to a failure of a temporary device used to assist in the ignition. The GAO reported that the other incident occurred on December 12, 1990, and was attributed to an inadvertent leak of LP.

The GAO asserted that all three of the explosions occurred early in the firing process. The GAO noted that an Army official indicated that incidents of uncontrolled LP combustion occur in about 30 percent of the shots and most did not cause major damage to the gun because they occurred later in the LP combustion process, when much of the LP has been burned. The GAO concluded that the explosions and other incidents of uncontrolled LP combustion emphasize the criticality of controlling the LP combustion process. The GAO pointed out that because of the most recent explosion, the Army has stopped all live fire testing with its most advanced gun until officials can isolate, understand, and correct the cause. The GAO indicated that, according to Army officials, their investigative effort will focus on the critical ignition and combustion process. The GAO asserted that based on their estimated schedule, which has slipped several times, it does not appear that results of the Army investigation will be known in time to influence the milestone decision.

The GAO asserted that the Army acquisition strategy for the AFAS program recognized the need to concurrently develop a solid propellant, unicharge gun as a backup to the LP gun. The GAO noted that the Army officials considered that approach prudent risk management because of the technical immaturity of the LP. The GAO pointed out that, however, according to its FY 1995 budget request, the Army is not planning to fund the effort beyond FY 1995. (pp. 4-6/GAO Draft Report)

DOD RESPONSE: Partially concur. The GAO correctly points out that there have been three incidents of uncontrolled combustion in the LP gun during Concept Exploration. However, the GAO incorrectly implies that the three gun incidents were similar. The first two incidents involved the improper volume (in the first instance-human error) and placement (in the second instance-attachment scheme) of the puddle charge which initiates the regenerative process. Unlike the May 1994 incident, those previous two events caused little damage to the gun. The May 1994 incident, however, involved the timing of the ignition process (ignition delay), causing a significant reversal early in the combustion process. That ignition and start-up process is the focus of the continuing maturation and risk abatement activities. There is a substantial body of data which

Now on p. 3.

See comment 1.

suggests that other ignition strategies, including solid propellant igniter, have the potential to meet the Regenerative Liquid Propellant Gun (RLPG) and the AFAS requirements.

The vast majority of shots to date have had no problems with uncontrolled combustion. Because the purpose of concept exploration is to establish the technical feasibility and not the engineering maturation of a particular technology, the Army maintains it has a technology in hand that is ready to be matured in the next phase of development. Again, as correctly pointed out by the GAO, the unicharge is being developed in parallel as a prudent risk mitigation measure. The unicharge was not funded by the Army in 1995, but the Congress has proposed adding funding to continue the development effort. Additionally, the Army will fund the continuation of that effort in its budget estimate for 1996, culminating in the In-Process Review mentioned in the DoD response to Finding A.

See comment 2.

- **FINDING C: Army Plans to Proceed Despite Lack of Critical Test Data.** The GAO reported that the Under Secretary of Defense for Acquisition and Technology has required the Army to demonstrate that the LP gun technology is feasible. The GAO noted that in a September 16, 1992, memorandum, the Secretary established specific criteria that must be met prior to the program exiting the concept exploration and definition phase. The GAO reported that those criteria covered the ability to (1) predict the velocity at which the projectile leaves the gun tube, (2) hit a target with four rounds within twelve seconds, (3) determine and manage the heat generated by firing at a required 10- to 12-round-per-minute rate, and (4) remotely select and transfer complete rounds from the Future Armored Resupply Vehicle to the AFAS at a required 6-round-per-minute rate.

The GAO reported that prior to the recent explosion, the Army planned to demonstrate that the AFAS met the criteria through live fire testing of its most advanced LP gun. The GAO pointed out that, however, the live fire tests with the most advanced LP gun were not started prior to the recent explosions because of a delay in the installation of the gun at Yuma, and because they have been put on hold as a result of the recent explosions, the planned live fire testing can no longer be performed prior to the scheduled milestone dates.

The GAO reported that rather than delay the milestone decision, the AFAS Program Office sought and received permission from the Army to modify its strategy to demonstrate the exit criteria. The GAO noted that instead of live fire testing of the most advanced prototype, the Army now intends to meet exit criteria by using a combination of data from (1) live firings of the advanced

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model gun before it blew up, (2) live firings of an older generation gun at Malta, (3) simulated firings of the gun at Yuma, and (4) computer modeling that will predict gun performance.

The GAO concluded that this substitute approach, while allowing the Army to maintain the current milestone schedule, will diminish the amount of quantitative data available for the milestone decision. The GAO further concluded that, until numerous rounds have been fired from the most advanced gun, the Army will not know for sure whether (1) its diagnosis of the causes of the explosion was correct, (2) the corrective action it took to mitigate the causes of the explosion really work, and (3) the problem is related to something inherently unstable about the use of LP or some other yet unknown factor.

The GAO observed that the program officials were concerned that delaying the milestone decision would adversely impact the program's momentum. The GAO noted that the program officials estimated that if the milestone decision was delayed, it could take as long as 2 years to restart the program because a contractor base is currently in position to support the demonstration and validation effort. The GAO further noted that the program officials believe that any further delays in awarding the demonstration and validation contract could result in a loss of the contractor commitment and program continuity that would be difficult and costly to reconstitute.

The GAO asserted that, while delaying the milestone decision will delay the program, there is no compelling reason for the Army to move ahead with the AFAS development before the causes of the explosion are fully investigated and corrective action is taken to prevent such explosions from happening again. The GAO concluded that the Army should determine now that the LP process can be controlled; rather than to start constructing the vehicle to contain the LP gun--currently scheduled for the next development phase--only to determine later that the LP process is inherently unstable and cannot be controlled. (pp. 7-10/GAO Draft Report)

DOD RESPONSE: Nonconcur. The DoD does not agree that insufficient critical test data are available to support a Milestone I decision. The DoD policy requires that a system demonstrate it is affordable in the long term and that the technical concepts are achievable prior to beginning the demonstration and validation phase (the Milestone I decision). Accordingly, the technical feasibility of the RPLG as an armament system concept must be demonstrated at Milestone I--not that a particular design has been proven.

The Army has demonstrated the AFAS exit criteria through live firings, demonstrations, simulations, and analyses.

Now on pp. 4-5.

See comment 3.

The use of all these approaches and others is appropriate for the current phase of development for the program. The GAO indicates concern that the multiple round simultaneous impact (MRSI) task is not being fired by the latest design gun. However, the objective of the MRSI is to confirm the control of the regenerative process by conducting a four-round time-on-target mission, using one gun. Success criteria have been developed at a 90 percent confidence level for achieving muzzle velocities representative of a four-round MRSI solution and a system timeline supporting the required launch times and aiming for each round. Each of those success criteria was demonstrated using actual hardware representative of that planned for the exit criteria demonstration. The fact that controlled LP combustion was achieved in the vast majority of the tests to date demonstrates that the technical concept is achievable, as required by DoD policy for a Milestone I decision.

The Army is continuing its investigation and analysis of the May 1994 gun explosion. The DoD does not agree, however, that completion of that analysis should be required before beginning the demonstration and validation phase or that delay of the program is warranted. The development plans for the AFAS indicate that nearly the entire first year of demonstration and validation will involve contract definition--actual systems will not be built during that time. The decision on whether to proceed with the LP gun or to change to the unicharge is scheduled for approximately 26 months after beginning demonstration and validation. Therefore, sufficient time exists to address and resolve technical maturation issues as development continues.

* * * * *

RECOMMENDATIONS

- RECOMMENDATION 1: The GAO recommended that the Secretary of Defense postpone all AFAS milestone decisions, including the request for proposal (RFP), until the Army demonstrates that it has identified and corrected the problems that caused the recent explosions and that it can control the LP process. (p. 10/GAO Draft Report)

DOD RESPONSE: Nonconcur. Although some problems have been experienced with control of the LP combustion process, the DoD does not agree that complete resolution of that problem must be accomplished before entry into the demonstration and validation phase. As the GAO acknowledges on page 2 of its draft report, the AFAS is in concept exploration and the exit criteria to enter demonstration/validation are that "the Army must demonstrate that the AFAS program is affordable in the long term and its technical concepts are achievable." Concept exploration is the phase in which the technology's feasibility is demonstrated. The fact that

See comment 4.

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controlled LP combustion occurred in the vast majority of the shots to date indicates that the technical concept is achievable. The proper phase to validate and mature the technology is demonstration and validation. The issue of long term affordability will be addressed in the affordability assessment which will be presented to the Defense Acquisition Board.

The RFP, which was released in July 1994, was refined to allow for good risk mitigation and continuous oversight of the contract process. The contract for demonstration and validation will be awarded over time with a phased approach to completion of the work. Analysis of the May 1994 explosion has already resulted in duplication of that explosion, which is the critical first step in identifying and correcting the underlying problem. The development schedule provides for ample time to complete the analyses and correct problems as the program proceeds.

- **RECOMMENDATION 2:** The GAO recommended that the Secretary of Defense require that criteria for continuing into the next development phase be met, as a minimum, with live fire tests of the most advanced LP gun, using an electronic spark source. (p.10/GAO Draft Report)

DOD RESPONSE: Nonconcur. The DoD does not agree with the implicit assumption made by the GAO that the latest design necessarily represents the best design. While the exit criteria must be met before entering demonstration and validation, any and all assets which use the most advanced concept should be employed. There are numerous alternative concepts for ignition that may support future exit criteria. Electronic spark and percussion cap are two. Further, properly developed models and simulations that address ballistic issues, when supported by live-fire results, have been utilized to the extent feasible to support the advancement of the program.

- **RECOMMENDATION 3:** The GAO recommended that the Secretary of Defense ensure that the Army does not abandon the concurrent development of the unicharge gun until the LP gun technology has been successfully demonstrated in live fire tests. (p.10/GAO Draft Report)

DOD RESPONSE: Concur. A parallel development program for the unicharge will be funded by the Army for the required term beyond FY 1995. An In-Process Review is planned at 26 months after entry into the demonstration and validation phase which will review the progress of the LP and unicharge. At that time, a decision will be made whether to proceed with the LP or continue AFAS development with the unicharge. The RFP, which was released in July 1994, specifically precludes the contractor from engineering a

See comment 4.

Now on p. 5.

design which could not be fit with a unicharge propellant system. Sufficient review opportunities exist to ensure compliance with the letter and intent of the agreement.

* * * * *

MATTER FOR CONGRESSIONAL CONSIDERATION

- **SUGGESTION:** The GAO suggested the Congress consider restricting the Army's obligational authority for about \$60.7 million of the FY 1995 request of \$114.7 million for the AFAS program until the Army (1) actually meets the criteria for moving the system into the next phase of development and (2) solves the problem that caused the most recent explosions.

DOD RESPONSE: Nonconcur. As explained in the DoD responses to the GAO Recommendations, the purpose of the concept exploration phase is to demonstrate that the program is affordable in the long term and that the technical concepts are achievable. Validation and maturation of the technology is properly the purpose of the demonstration and validation phase. The integrated use of live firings, demonstrations, simulations, and analyses for the current stage of AFAS development is appropriate.

The Army plan to develop the unicharge in parallel with the LP gun is a prudent approach to risk management. Further, the recently released RFP will allow for adequate risk mitigation and continuous oversight of development. Therefore, the program should be provided with sufficient funding so as not to jeopardize the established schedule or the contractor support base. The Department will continue to appropriately manage the program and monitor development progress. Should the need arise, the DoD stands ready to restrict program funding until necessary testing and/or reporting is accomplished.

See comment 5.

The following are GAO's comments on the Department of Defense's (DOD) letter dated September 21, 1994

GAO Comments

1. The three incidents of uncontrolled liquid propellant (LP) combustion are similar in that each incident involved burning too much LP early in the ignition process causing uncontrolled LP burning. We recognize that the factor which caused too much LP to be available for burning differed in each incident. However, the incidents demonstrate the criticality of controlling the LP burning process.

2. We have addressed this comment in the report text.

3. We continue to believe that it is critical for the Army to demonstrate the ability to control the LP burning process before system integration occurs. However, we have no basis to disagree with DOD's assertion that the interim 26-month period should allow time for the Army to demonstrate whether this is achievable.

4. In light of the additional information provided in DOD's comments and the Army's acquisition strategy, we have modified the recommendations to require the Army to demonstrate that it (1) can control the LP burning process and (2) has developed an ignition system capable of meeting the AFAS rate-of-fire requirement before integrating the gun into the AFAS system.

5. We have deleted the matter for congressional consideration as it is no longer germane.

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