

AD-A273 372



November 1993

# ARMY ACQUISITION

## Problems With the Sense and Destroy Armor Munition



2485 93-29540

GAO/NSIAD-94-59

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**National Security and  
International Affairs Division**

**B-241179**

**November 23, 1993**

**The Honorable Daniel K. Inouye  
Chairman**

**The Honorable Ted Stevens  
Ranking Minority Member  
Subcommittee on Defense  
Committee on Appropriations  
United States Senate**

**The Honorable John P. Murtha  
Chairman**

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

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We reviewed the Army's Sense and Destroy Armor (SADARM) program because of cost, schedule, and performance problems and because the Army had expected to decide whether to begin low-rate initial production of SADARM in the near future. Our objectives were to determine (1) whether the 155-mm SADARM projectile will be ready for low-rate initial production in fiscal year 1994, (2) what the Army's current estimated schedule and cost for SADARM are, and (3) whether the Army has fully assessed the need for SADARM against other weapon systems that could potentially satisfy the mission need.

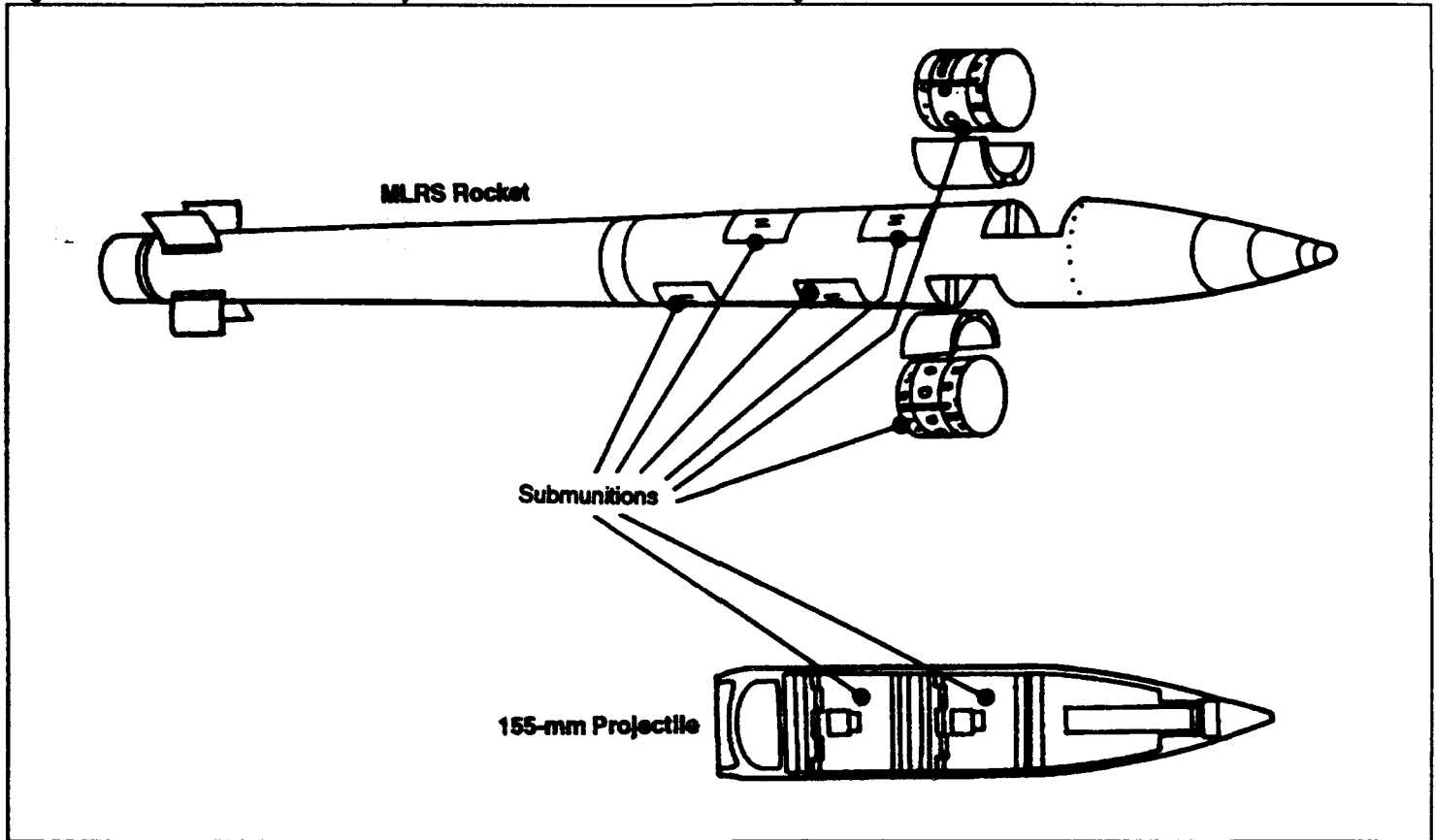
**Background**

SADARM is a "fire-and-forget" submunition designed for the Army's counterfire<sup>1</sup> mission to defeat self-propelled howitzers, armored personnel carriers, and other stationary armored threat vehicles. The Army is developing two sizes of SADARM submunitions for use with 155-mm howitzers and the Multiple Launch Rocket System (MLRS) (see fig. 1). The 155-mm projectile carries two submunitions, and the MLRS rocket dispenser carries six. Each submunition has the capability to sense and defeat a target.

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<sup>1</sup>Counterfire is fire intended to respond to enemy indirect fire systems.

**Figure 1: Illustration of 155-mm Projectile and MLRS Rocket Containing SADARM Submunitions**



In its fiscal year 1994 budget submission, the Army requested \$41 million in research, development, test, and evaluation appropriations and \$77.7 million in procurement appropriations to begin low-rate initial production of 1,213 155-mm SADARM projectiles.

## Results in Brief

The 155-mm SADARM projectile is not ready for low-rate initial production because development testing has not demonstrated that it meets the Army's required level of reliability. In addition, the Army has not resolved concerns with the SADARM submunition's reliability and the contractor's ability to successfully enter production.

The SADARM program is almost 7 years behind the Army's original schedule. The Army now estimates that low-rate initial production will begin in the

second quarter of fiscal year 1996 and full-rate production will begin in fiscal year 1998. The estimated total cost of the SADARM program is \$5.4 billion in then-year dollars. The current estimate differs little from the Army's original 1986 cost estimate; however, the Army will procure about 68 percent fewer munitions than originally planned.

The Army's analysis to support the continued acquisition of SADARM is narrow in scope and does not fully support the conclusion that SADARM is the best way to defeat self-propelled threat artillery.

## **SADARM Is Not Ready for Low-Rate Initial Production**

In July 1993, the Army canceled the final series of developmental tests because early test results showed that SADARM was not going to meet the Army's criteria needed to go forward with low-rate initial production. Specifically, SADARM did not hit the required number of targets and had reliability problems. As a result, the Army no longer plans to begin low-rate initial production of SADARM in fiscal year 1994. Instead, the Army proposed to extend the engineering and manufacturing development phase by at least 2 years in an effort to improve SADARM's reliability and performance.

## **SADARM Program Is Behind Schedule**

The SADARM development program is now almost 7 years behind the Army's original schedule. According to Army officials, the original schedule was unrealistic, and funding reductions also contributed to the schedule slippage. In September 1986, when the Army awarded the competitive submunition contract for SADARM engineering and manufacturing development (then called full-scale development), the Army estimated that SADARM would enter low-rate initial production in May 1989 and full-rate production in June 1991. In September 1993, the Army estimated low-rate initial production would not begin until early 1996 and full-rate production would not begin until fiscal year 1998.

## **SADARM Costs Have Grown**

The Army now estimates the total cost of the program at about \$5.4 billion in then-year dollars. While the Army's latest cost estimate for the SADARM program differs little from the 1986 estimate of about \$5.3 billion, the latest estimate is based on Army plans to procure substantially fewer SADARM munitions than at contract award. Thus, quantity reductions have resulted in a substantial increase in the estimated cost per munition. Since the Army awarded the SADARM submunition development contract in 1986, the projectile's unit cost has more than tripled from about \$11,000 to about

\$36,000, and the rocket's unit cost has quadrupled from about \$41,000 to about \$168,000, calculated in then-year dollars.

In addition, the Army has a proposed product improvement program to further increase SADARM's reliability and effectiveness through modification of a working design. The Army estimates the total funding requirements for SADARM improvements at \$63 million to \$88 million, depending on which alternatives are developed. However, the program is currently unfunded.

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## Army Analysis to Support SADARM Was Too Narrow in Scope

The Army's belief that SADARM offers the best capability to defeat self-propelled threat artillery is based on its March 1993 SADARM cost and operational effectiveness analysis. However, this analysis was limited in scope. The analysis justified the need to acquire SADARM based on a comparison of SADARM to the Army's primary counterfire system, a dual-purpose improved conventional munition. The Army's analysis did not compare SADARM against alternative weapon systems in related mission areas or systems with joint service potential.

The Office of the Secretary of Defense (OSD) plans to begin a study of the continued need for systems with an antiarmor capability throughout the Department of Defense. The study's charter does not list the specific systems to be included in the analysis; however, according to an OSD official, current plans are to include SADARM in the study. This planned study would provide the opportunity to identify alternative weapons that have the potential for the Army's counterfire mission. Preliminary results are expected to be available in fiscal year 1994 and final results in fiscal year 1995. Therefore, if this study is completed as planned, the results should be available in fiscal year 1996 when SADARM is scheduled for a low-rate initial production review.

Appendix I provides more detailed information on the results of our review.

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## Scope and Methodology

During our review, we analyzed test results provided by the Army and the contractor, Aerojet Electronics Systems Division. We reviewed Army analyses prepared for the SADARM low-rate initial production decision review, Army and contractor reports on SADARM production issues, and Army budget documents. In June 1993, we attended a portion of the flight tests of the 155-mm SADARM munition at Yuma Proving Grounds, Arizona.

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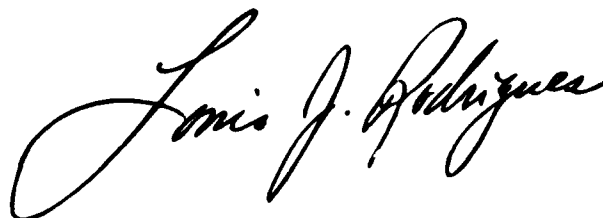
We interviewed and obtained documents on the SADARM program and test-related issues from officials in the Army's Sense and Destroy Armor Project Manager's Office; the Program Executive Office for Armaments; and the Office of the Assistant Secretary of the Army for Research, Development, and Acquisition. We discussed SADARM development and production issues with officials at Aerojet and the Army Materiel Systems Analysis Activity. We also discussed the Army's analyses to support the SADARM low-rate initial production review with officials from (1) the Army's Training and Doctrine Command Analysis Command, (2) the Army's Office of the Deputy Chief of Staff for Operations and Plans, (3) the Office of the Army Deputy Chief of Staff for Intelligence, (4) the Army Office of Program Analysis and Evaluation, (5) the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation, (6) the Defense Department's Office of the Deputy Director for Acquisition Systems Management, (7) the Office of the Assistant Secretary of Defense for Production and Logistics, and (8) the Defense Logistics Agency's Defense Contract Management Command.

We conducted our work from September 1992 to September 1993 in accordance with generally accepted government auditing standards. We did not obtain fully coordinated Department of Defense comments on this report. However, we discussed the results of our work with officials from OSD; the Office of the Assistant Secretary of the Army for Research, Development, and Acquisition; the Army's Sense and Destroy Armor Project Manager's Office; and the Army's Program Executive Office for Armaments. They generally agreed with our findings and conclusions, and we have incorporated their comments in the text of this report where appropriate.

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Copies of this report are being provided to the Chairmen and Ranking Minority Members 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 and the Director, Office of Management and Budget. We will also make copies available to others on request.

Please contact me 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 cursive script that reads "Louis J. Rodrigues". The signature is written in black ink and is positioned centrally on the page.

**Louis J. Rodrigues**  
Director  
Systems Development and  
Production Issues





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## Abbreviations

DDO&S	de-spin, deceleration, orientation, and stabilization
GAO	General Accounting Office
MLRS	Multiple Launch Rocket System
OSD	Office of the Secretary of Defense
SADARM	Sense and Destroy Armor



# Sense and Destroy Armor Munition Is Not Ready for Low-Rate Production

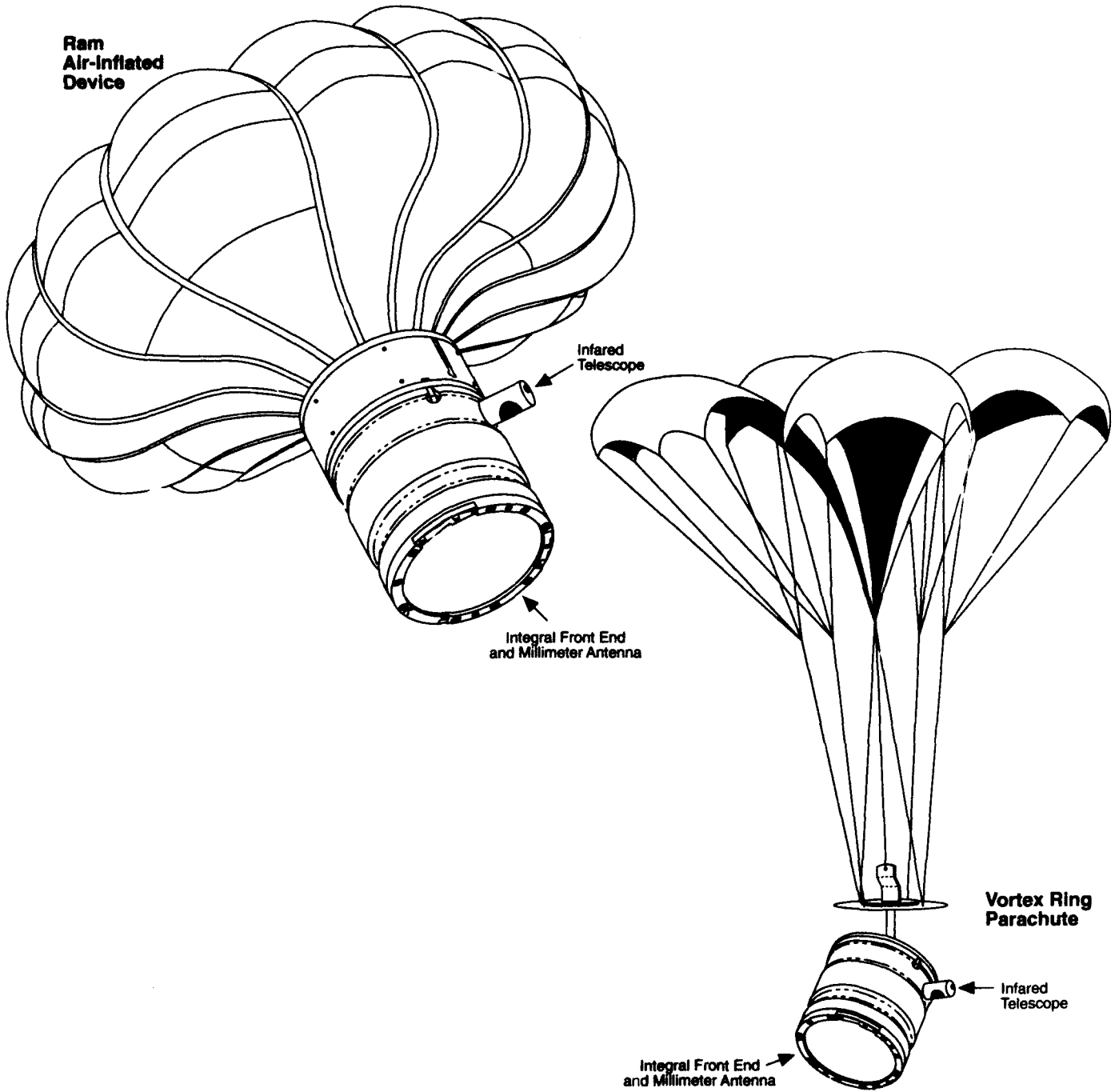
## Background

The Sense and Destroy Armor (SADARM) is a “fire-and-forget” submunition designed for use against self-propelled howitzers, armored personnel carriers, and other stationary armored threat vehicles. The Army is developing two sizes of SADARM submunitions—a 5.8-inch submunition for use with 155-mm howitzers and a 6.9-inch submunition for use with the Multiple Launch Rocket System (MLRS).

Upon ejection from the 155-mm artillery projectile or the MLRS rocket over the target area, each submunition deploys a two-stage mechanism—termed the de-spin, deceleration, orientation, and stabilization (DDO&S) device—that decelerates and stabilizes the submunition to a steady velocity and rotation rate. The DDO&S mechanism has two parachutes (the Ram-Air Inflated Device and Vortex Ring Parachute) that are released sequentially to slow and position the descending submunition (see fig. I.1).

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**Figure I.1: Illustration of SADARM Components**



SADARM employs a multi-mode sensor that includes a dual-mode millimeter wave sensor with an active radar and a passive radiometer, and an imaging infrared telescope. The millimeter wave sensor determines the submunition's distance from the ground and transmits the information to the submunition's fire decision processor. The processor signals the release of the decelerator device and, at a specified distance from the ground, deploys the infrared telescope. The sensors look for targets and provide detection information back to the fire decision processor. If the millimeter wave and/or the infrared sensors detect a target in the search area, a fire impulse is sent to the lethal mechanism, which fires an explosively formed penetrator at the target. If no target is detected, the submunition self-destructs at a specified distance from the ground or after impacting the ground. Aerojet Electronic Systems Division in Azusa, California, is the prime contractor, and Alliant Techsystems in Minnetonka, Minnesota, is the major subcontractor.

In its fiscal year 1994 budget submission, the Army requested \$41 million in research, development, test, and evaluation appropriations and \$77.7 million in procurement appropriations to begin low-rate initial production of 1,213 155-mm SADARM projectiles.

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## **Required Reliability Has Not Been Demonstrated**

During the development phase, the Army has conducted technical, reliability, validation, and performance flight tests of the SADARM 155-mm submunition and projectile to identify and address reliability problems. Reliability concerns were disclosed in each test series.

During 1991, the Army conducted technical tests of the 155-mm submunition components and projectiles to verify system design and development. Because these tests disclosed reliability problems, the Army began a reliability testing program in February 1992 to improve the 155-mm submunition's reliability. The Army fired 46 155-mm SADARM submunitions with either a live or inert warhead. Of the 46 submunitions, 7 functioned successfully, 36 experienced one or more failures, and 3 were not scored because submunition components were not given an opportunity to complete the required sequences.

Based on the reliability tests, the 155-mm submunition demonstrated an overall reliability of only 16 percent. The Army identified 39 different root causes of failures. The Army considered the problems with the fuze, safe, and arm device; the decelerator mechanism; and the millimeter wave sensor to be critical. Among the problems observed during reliability

testing were that the detonator in the fuze, safe, and arm did not align; as a result, the submunition did not fire. Major tears occurred in the decelerator parachute, called the ram air inflation device. In addition, the vortex ring parachute did not quickly inflate, and the millimeter wave antenna cables broke or became detached.

To verify the effectiveness of fixes to improve submunition reliability, the Army conducted four series of firings, called validation tests. From October 1992 through April 1993, the Army fired 17 155-mm projectiles in an end-to-end test against simulated self-propelled artillery targets. In addition, 16 concurrent test firings were conducted to correct problems with the decelerator mechanism. Army officials concluded that testing demonstrated all 39 root causes of submunition failures had been resolved.

According to the Army, the only remaining performance problem was damage to integral front ends of the 155-mm submunition, which impeded the functioning of the millimeter wave antenna. The damage, which occurred during longer-range firings, was attributed to in-flight collisions between submunitions and between submunitions and the plate used to push the submunitions out of the projectile. To correct the latter, a modified plate was developed, integrated into the 155-mm projectile, and fired in subsequent testing. The Army concluded that the modified plate did not damage the submunitions.

The Army conducted the last series of tests, called performance flight, in June 1993 to verify that the 155-mm SADARM munition met the Army's performance requirements prior to beginning low-rate initial production. The Army had planned to fire 36 155-mm projectiles, each carrying 2 tactical submunitions. The criterion for success was to hit 24 targets with the 72 submunitions. However, after firing 21 projectiles, the Army stopped the test. Of 42 submunitions, 9 hit targets, 8 were near misses (within 10 feet from the target), 6 missed their targets by wide distances (more than 20 feet), 12 self-destructed on the ground, and 7 were duds.<sup>2</sup> On July 2, 1993, the Army discontinued the test because of reliability problems and the number of duds. Causes of problems during testing were submunition instability, electronic failures, and collisions between submunitions.

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<sup>2</sup>A dud is defined as a submunition that does not self-destruct after impacting the ground.

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## **Submunition Performance Problems**

In July 1993, an Army analysis team and an Aerojet team were assembled to assess the causes of performance and reliability problems observed during the performance flight tests associated with major submunition components. The Army team reviewed (1) DDO&S failures, (2) collisions, (3) duds, (4) and ranging problems. In September 1993, the Army team reported on its findings and recommendations to the Army Acquisition Executive.

The Army team concluded that SADARM could be a technical success, but that significant changes are needed in testing and verification procedures to ensure that design analysis and qualification testing were sufficient to address problems. In addition, the team concluded that the root causes of many of the failures are still unknown, which the team attributed to inadequate data gathered during testing. The Army Acquisition Executive recently approved a plan to develop and test fixes for the 155-mm submunition reliability problems.

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## **Decelerator Failures**

During the performance flight tests, the DDO&S mechanism did not always stabilize the submunition quickly during its descent. Parachutes did not initially inflate, which the Army cites as a cause of the submunition's failure to stabilize. According to the Army team, submunition instabilities contributed to up to six wide target misses and, perhaps half of the eight near misses. During earlier validation tests, parachutes hesitated after release and did not fully and quickly inflate. However, at that time, Army officials did not consider this to be a significant performance problem. The issue is currently under review.

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## **Collisions**

The Army team concluded that collisions were the probable cause of six submunition failures during performance flight tests at longer ranges. The result of the collisions was to degrade the submunition's sensor capability by damaging the sensor's radar receiver and impeding deployment of the second-stage DDO&S device. According to Army officials, in-flight collision damage to the 155-mm submunition occurred during development testing; however, the severity of the problem was masked by other performance problems. During the validation testing series, video data disclosed that submunitions were colliding with the projectile pusher plate that is ejected with the submunitions. In addition, the Army concluded that submunitions were colliding with each other. A modified pusher plate was developed, integrated into the 155-mm projectile, and fired during the final series of contractor development testing. Aerojet concluded that the modified

pusher plate eliminated one cause of collisions. However, submunition-to-submunition collisions occurred during the performance flight testing series.

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## **Duds**

During the performance flight tests, 7 of the 42 submunitions dispensed, or 17 percent, were duds. Duds occurred more frequently when SADARM projectiles were fired at longer ranges. The Army team concluded that electrical problems most likely contributed to the dud problem. Electrical problems are the primary cause of the submunition's failure to self-destruct. To self-destruct, the submunition's processor must turn on the fuze, safe, and arm device, and the electrical converter must be functioning after ground impact. However, the self-destruct sequence can be prevented by battery problems or electrical converter failure.

Duds are also a significant safety concern for U.S. military and civilians who may subsequently enter the target zone. In August 1993 we reported that at least 25 U.S. military personnel were killed and others were injured from handling unexploded U.S. ordnance during Operation Desert Storm.<sup>3</sup>

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## **Sensor Problems**

The Army team reported that millimeter wave sensor failures most likely caused two far misses, one near miss, and seven self-destructs during performance flight testing. (The performance test was designed so that each submunition would see two to three targets and, therefore, should have fired.) The Army and the contractor are currently reviewing the sensor problems. According to an Army official, sensor ranging problems may be attributed to both hardware and software failures. In such instances, collisions may have damaged submunition hardware such as the millimeter wave receiver and transmitter; the antenna may have been stressed during submunition assembly; or ranging software may have been affected by the submunition's failure to stabilize during descent.

During development testing, the Army identified various reliability problems that affected the sensor's functioning. For example, the submunition's electrical circuitry failed and did not provide power to the sensor. Also, collisions damaged the radar receivers.

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<sup>3</sup>Operation Desert Storm: Casualties Caused by Improper Handling of Unexploded U.S. Submunitions (GAO/NSIAD-93-212, Aug. 6, 1993).



## **Some Submunition Production Issues Remain**

SADARM development disclosed several production issues, many of which have been resolved. However, some production concerns continue. From March 1993 through May 1993, the Army updated its review of SADARM production readiness. The review assessed the level of risk associated with the program's production design plan and cost, schedule, and product performance. The review concluded that changes to component design specifications and transferring the production of some components from one vendor to another were risks to meeting low-rate initial production quantities. Production of a critical component, the integral front end of the submunition, was at 40 percent of the required rate as of May 1993.

According to officials of the production readiness review, the contractor would have been unable to produce the quantities needed to complete the performance flight testing schedule, or for low-rate initial production, due to vendor and component design changes. For example, plans were to shift production and assembly of some submunition components from one subcontractor to another. In some cases, production processes were proprietary, requiring the new subcontractor to develop its own processes, which would lead to production delays. To qualify the submunition's electronic component design, the component was used during performance flight tests. However, the design did not qualify because the component had known failures and caused duds during testing.

During the SADARM development phase, the Army reported that subcontractor production quality and output were unsatisfactory. Millimeter wave antenna assemblies received from the subcontractor were not acceptable due to production and quality problems; necessary capacitors were not installed in some millimeter wave antenna cables, causing production line delays; and parachute stitches unraveled. According to an Army official, these problems were generally related to the production process and most have since been resolved.

In July 1993, the Army Program Executive Officer for Armaments tasked an Army analysis team to assess the SADARM program to identify the probable cause for performance problems and recommended corrective actions. The Army team identified concerns with past engineering practices, such as inadequate qualification procedures for component designs. The Army team reported that Aerojet lacked an organized plan to address design limitations. The team also reported that assembly of components required much re-work and that component, qualification, and other engineering tests were not sufficient to prove the design before the final series of development flight tests. The team recommended a

disciplined engineering process that analyzes and validates system designs to ensure that they meet requirements prior to testing. The Army team also recommended that the contractor conduct tests to prove designs and obtain more and better data.

By late August 1993, Aerojet submitted a draft plan to address component design issues and established a corrective action plan to address testing and verification of component design fixes. According to Aerojet officials, they are making efforts to improve oversight of subcontractors and vendors. In response to the problems experienced during performance flight testing, the Aerojet team had been assessing the problems with individual submunition components.

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## **Program Is Behind Schedule**

The SADARM program is almost 7 years behind the Army's original schedule. The Army had originally planned to begin low-rate initial production of the 155-mm SADARM in May 1989 and full-rate production in June 1991. Now, the Army estimates low-rate initial production will begin in the second quarter of fiscal year 1996 and full-rate production will begin in fiscal year 1998. According to Army officials, congressional directives and funding reductions contributed to some past schedule slippage. However, additional program requirements and funding reductions were based on congressional concerns that the Army's technical and financial decisions were being driven by artificially short deadlines, rather than by specific technical accomplishments and efforts to reduce program risks.

In July 1987, the Army restructured the SADARM program in response to these congressional concerns. The restructured program provided for extending the original 48-month development contract to a 67-month development contract. As required by the congressional directives, the Army's restructured program included the development of the MLRS and the 155-mm versions of SADARM and early firing demonstration tests using modified 8-inch howitzer hardware from the earlier advanced development phase. The congressionally mandated demonstration took longer than the Army expected because of the process to test, fix, and retest the design.

As shown in table I.1, the Army revised the schedule again in 1988, 1990, 1991, and 1993. It was revised in September 1988 when the Army awarded a 60-month contract for engineering and manufacturing development of the MLRS dispenser for SADARM. In March 1990, the schedule was revised a third time to reflect the effects of technical difficulties, budgetary

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shortfalls, and an extensive government testing schedule. The fourth revision, in September 1991, established a new acquisition schedule due to budget reductions. The latest schedule, prepared in September 1993, reflects the Army's recent decision to restructure the SADARM program to include 2 additional years of engineering and manufacturing development in order to address reliability concerns.

**Table I.1: Changes in the SADARM Program Schedule**

Milestone	Date of schedule change					
	Sept. 1986 <sup>a</sup>	July 1987	Sept. 1988	Mar. 1990	Sept. 1991	Sept. 1993
<b>155-mm SADARM submunitions and projectile</b>						
Operational testing completed	Mar. 1991	May 1991	Dec. 1991	Sept. 1993	Oct. 1993	Dec. 1996
Low-rate initial production decision	May 1989	Sept 1989	<sup>b</sup>	Apr. 1993	Apr. 1993	Dec. 1995
Full-rate production decision	June 1991	June 1991	Apr. 1992	July 1994	June 1994	Dec. 1997
First unit equipped with SADARM	Dec. 1991	Mar. 1993	July 1993	July 1994	July 1994	Oct.- Dec. 1997
<b>MLRS SADARM submunitions and rocket</b>						
Operational testing completed	Sept. 1990	Mar. 1992	July 1993	Mar. 1994	Feb. 1994	Apr. 1997
Low-rate initial production decision	Oct. 1988	May 1989	Jan. 1992	<sup>b</sup>	<sup>b</sup>	Jun. 1996
Full-rate production decision	Sept. 1990	Mar. 1992	Sept. 1993	July 1994	June 1994	Dec. 1997
First unit equipped with SADARM	Feb. 1991	Mar. 1993	May 1994	Dec. 1995	Dec. 1995	Jan.- Mar. 1999

<sup>a</sup>September 1986 is the date the Army awarded the competitive submunition contract for SADARM engineering and manufacturing development.

<sup>b</sup>The Army's schedule did not include low-rate initial production decision dates.

## Unit Costs Have Increased

In September 1993, the Army updated its estimated total cost for the SADARM program to \$5.4 billion in then-year dollars, which included the estimated additional costs needed to fund SADARM development for 2 more years.

As shown in table I.2, the Army's estimated cost of the program has changed several times since 1986.<sup>4</sup> For example, to reduce program risk, Congress directed the Army to conduct additional testing from 1987 through 1989. The result was an increase to the cost of the program. During 1991 and 1992, the SADARM program experienced unanticipated cost

<sup>4</sup>Between March 1988, when SADARM entered engineering and manufacturing development, and September 1993, when the Army prepared its latest estimate, the total program cost increased by \$2,250.8 million—from \$1,605.7 million to an estimated \$3,856.5 million (in constant 1989 dollars).

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growth because of reliability problems with the submunition, which required failure analysis and additional testing. Further, in May 1993 Aerojet submitted a cost growth proposal for approximately \$47 million to complete the SADARM engineering and manufacturing development contract. Aerojet's cost increase is currently under negotiation. The Army's September 1993 program cost estimates include Aerojet's estimate to complete SADARM engineering and manufacturing development.

**Table I.2: Changes in the SADARM Program's Cost Estimates**

Then-year dollars in millions			
Date of cost estimate	Development cost	Procurement cost	Total cost
September 1986	\$365.1	\$4,933.0	<b>\$5,298.1</b>
July 1987	589.7	5,104.6	<b>5,694.3</b>
December 1988	673.2	1,113.6 <sup>a</sup>	<b>1,786.8</b>
December 1990	848.6	3,802.9	<b>4,651.5</b>
December 1991	848.2	3,727.9	<b>4,576.1</b>
September 1993	1,103.0	4,303.0	<b>5,406.0</b>

<sup>a</sup>In 1988, the SADARM program was restructured to acquire both the SADARM 155-mm and the MLRS versions. As of December 1988, the Army had not established MLRS procurement quantities. The quantities were established in 1989.

After submitting its fiscal year 1994 funding request, the Army decided to continue development of the SADARM 155-mm program and defer production until 1996. The Army had requested \$41 million in research, development, test, and evaluation appropriations and \$77.7 million in procurement appropriations for SADARM in fiscal year 1994. In light of the Army's decision to extend SADARM development, the Army no longer needs the \$77.7 million in procurement funding it requested.<sup>5</sup> Instead, the Army will need additional research, development, test, and evaluation funding in fiscal year 1994. The Army estimates that it will need about \$98.6 million for SADARM development in fiscal year 1994 and \$112.8 million for fiscal year 1995. The Army's revised estimate was based on the need to implement the recommendations of the Army and Aerojet teams to correct deficiencies and improve reliability. For example, the teams recommended adding program and design reviews and reassessing component design specifications.

In December 1990, we reported that SADARM procurement costs had decreased because the Army substantially reduced the number of SADARM

<sup>5</sup>1994 Defense Budget: Potential Reductions to Ammunition Programs (GAO/NSIAD-93-296, Sept. 20, 1993).

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munitions it planned to buy based on the changed threat environment.<sup>6</sup> As shown in table I.3, the planned procurement quantity has remained relatively unchanged since 1990; however, unit costs have increased substantially. Based on the program cost estimates established when the Army awarded the SADARM submunition development contract in 1986, and the September 1993 estimates, the projectile's unit cost has increased from \$11,307 to \$36,231, and the rocket unit cost has increased from \$40,608 to \$167,646 in then-year dollars.<sup>7</sup>

**Table I.3: Changes in SADARM  
Acquisition Quantities and Unit Costs**

Date of estimate	155-mm SADARM projectiles		MLRS SADARM rockets	
	Acquisition quantity <sup>a</sup>	Unit cost	Acquisition quantity <sup>a</sup>	Unit cost
	Sept. 1986	150,000	\$11,307 <sup>b</sup>	50,000
July 1987	63,530	11,420	59,174	44,380
Dec. 1988	10,156	49,000	<sup>d</sup>	<sup>d</sup>
Dec. 1990	39,150	31,934	23,750	143,213
Dec. 1992	39,150	30,049	23,750	141,651
Sept. 1993	39,270	36,231 <sup>e</sup>	23,759	167,646 <sup>e</sup>

<sup>a</sup>The quantities shown are for both development and procurement.

<sup>b</sup>The unit cost is based on the low-rate initial production quantity of 15,125 projectiles.

<sup>c</sup>The unit cost is based on the low-rate initial production quantity of 82,392 submunitions, which equates to 13,732 MLRS SADARM rockets. The unit cost estimate does not include the cost for the warhead/dispenser.

<sup>d</sup>In 1988, the SADARM program was restructured to acquire both the SADARM 155-mm and the MLRS versions. As of December 1988, the Army had not established MLRS procurement quantities. The quantities were established in 1989.

<sup>e</sup>This figure is based on the Army's revised program cost estimates to reflect the 2-year extension to the program.

**Planned Product  
Improvements**

The Army's cost estimates for the SADARM program do not include the costs for planned product improvements. In May 1993, the Army concluded a study of ways to improve SADARM's capability to defeat targets such as "shoot-and-scoot" howitzers and other moving targets and to further improve the system's reliability and effectiveness. From 44 possible

<sup>6</sup>Army Weapons: Status of the Sense and Destroy Armor System (GAO/NSIAD-91-44BR, Dec. 17, 1990).

<sup>7</sup>Between December 1989 and September 1993, the projectile unit cost increased from \$17,384 to \$26,916 and the MLRS rocket unit cost increased from \$66,361 to \$117,829, in constant-year (1989) dollars.

alternative configurations, the study group narrowed the alternatives to 3. The Army estimates the total funding requirements for SADARM improvements at \$63 million to \$88 million, depending on which alternatives are developed, for 3 years of development followed by 2 years of system qualification. The SADARM improvement program is currently unfunded.

## **SADARM Cost and Operational Effectiveness Analysis Conclusion Is Not Supported**

The Department of Defense 5000 series regulations for defense acquisitions require that a cost and operational effectiveness analysis be prepared or updated at major decision milestones for acquisition programs. According to the regulations, one of the most important steps in developing the analysis is to identify the alternatives to be considered, but the scope of the analysis depends on where the program is in the acquisition process. For example, at the first acquisition milestone called concept demonstration, the analysis considers a range of alternative concepts to satisfy the identified need. For a later milestone, such as a production decision, the scope of the analysis is limited to whether to produce, cancel, or continue development of the proposed system.

The March 1993 cost and operational effectiveness analysis prepared for the SADARM production milestone decision review did not fully support the conclusion that SADARM is the best alternative to meet the counterfire mission need. The analysis did not compare SADARM against alternative weapon systems in related mission areas or systems with joint-service potential. The analysis compared two alternative configurations: SADARM used in conjunction with conventional munitions, to include the dual-purpose improved conventional munition, versus a force with conventional munitions only, primarily the dual-purpose improved conventional munition.

Other weapon systems were included in the analysis models to represent a battlefield environment. For example, the models included aircraft-delivered munitions, but they were not assessed as alternatives to SADARM. The analysis contained two cost comparisons. In the first, the Army compared the individual cost-effectiveness of the 155-mm SADARM and the MLRS SADARM with the collective cost-effectiveness of both versions deployed together. The other compared the cost to integrate SADARM into the force in terms of increased artillery effectiveness against the cost and artillery effectiveness of a force without SADARM.

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**Appendix I  
Sense and Destroy Armor Munition Is Not  
Ready for Low-Rate Production**

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Prepared in an effort to support the decision to begin engineering and manufacturing development, the April 1987 SADARM cost and operational effectiveness analysis compared the capabilities of a mix of conventional munitions to seven alternative configurations. Each configuration consisted of the conventional munitions set and SADARM dispensed from various mixes of 155-mm and 8-inch projectiles, and the MLRS rocket. The scope of the 1987 analysis was limited to determining whether SADARM should be developed for the 155-mm or the 8-inch projectile, or the MLRS rocket. Since then, the cost of the SADARM program has increased, while weapons programs that may have the capability to defeat self-propelled threat artillery have moved into the development phase.

Because of the limited objective and scope of the 1987 and 1993 analyses, the Army does not have adequate assurance that SADARM will not unnecessarily duplicate existing capabilities and is the most cost-effective alternative.

The OSD Office of Program Analysis and Evaluation is planning to conduct a study of the antiarmor mission beginning in fiscal year 1994. The purpose of the study is to establish the continued need for alternative weapon systems with an antiarmor capability. According to an official from the Office of Program Analysis and Evaluation, the scope of the study includes the SADARM munition and a range of antiarmor-capable weapon systems across mission and service lines. This planned study would provide the opportunity to identify alternative weapons that have the potential for the Army's counterfire mission. The preliminary results of the study are expected to be available in late fiscal year 1994 and final results are expected to be available in fiscal year 1995. Because the Army plans to update the SADARM cost and operational effectiveness analysis prior to the next major milestone review in fiscal year 1996, the results of the antiarmor study should be available for use in preparing the analysis.

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