United States General Accounting Office

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Report to the Chairman, Subcommittee on Defense, Committee on Appropriations, U.S. Senate

September 1991

TACTICAL MISSILE ACQUISITIONS

Understated Technical Risks Leading to Cost and Schedule Overruns

GAO/NSIAD-91-280

GAO

United States
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National Security and
International Affairs Division

B-244983

September 17, 1991

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

Dear Mr. Chairman:

As you requested, we examined missile acquisition programs to (1) determine whether they are meeting their cost and schedule goals, (2) determine why some programs fail to meet these goals, and (3) recommend ways to help the acquisition program meet its goals.

This report updates the information we provided to your staff during our February 13, 1991, briefing, and includes the views of Department of Defense (DOD) officials on the results of our work.

To address the objectives of this review, we selected two different groups of missiles. The first group (12 systems) identified whether current missile systems with 5 years of production experience had overrun cost or schedule goals. To analyze why such changes occurred, we selected a smaller group of eight missiles at different milestone decision points. (See app. I for further description of our scope and methodology.)

Results in Brief

All 12 of the missile systems we selected experienced cost and schedule overruns. The unit or total acquisition cost estimates for nine of these systems have increased by 20 percent or more. The scheduled completion dates for all 12 systems have been extended.

These overruns can be attributed to many interrelated factors, some of which are not under DOD's direct control (e.g., changes in threat, congressional direction, etc.). However, optimistic planning assumptions by program officials were a common factor underlying major overruns. Program offices often develop cost and schedule estimates that do not adequately reflect the risks associated with the program's design, development, and production. We found that this is particularly true for technical risk assumptions, which often contribute to cost and schedule overruns.

Our detailed analysis of eight missile systems indicated that key DOD program reviews, designed to help ensure that the service's cost and schedule estimates are not overly optimistic, could be improved if they included a more thorough assessment of the technical assumptions behind the cost and schedule estimates. DOD has recently implemented revised regulations and procedures designed to improve technical risk management.

Background

The DOD acquisition process is governed by a series of regulations, such as DOD Directive 5000.1, Major and Non-Major Defense Acquisition Programs. These regulations established the Defense Acquisition Board (DAB) as the primary focal point within the Office of the Secretary of Defense (OSD) for acquisition policy and major acquisition system reviews. DAB is composed of senior officials from a variety of disciplines, including test and evaluation, logistics, program evaluation and analysis, and budget. During a DAB review, factors such as the program's cost, schedule, and technical status are to be reviewed to determine whether a program should proceed into the next phase of its implementation cycle. DAB is headed by the Under Secretary of Defense for Acquisition, and supported by three committees, which assist in program review and policy formulation.

The regulations also established specific points during a program's acquisition cycle when a DAB review is required. These points, or milestones, include concept development, demonstration and validation, full-scale development, and full-rate production.

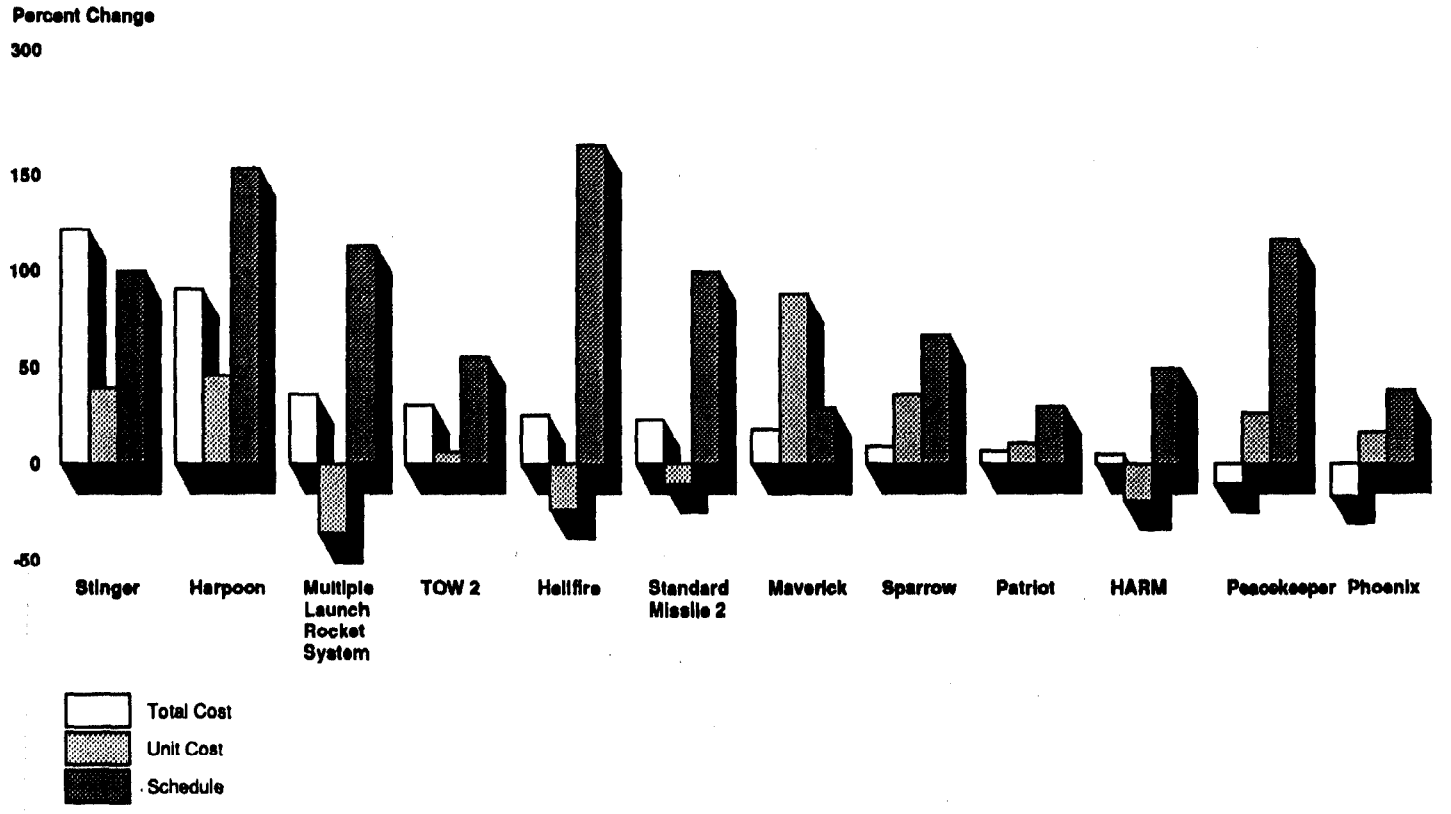
In February 1991, DOD approved revisions to these regulations to incorporate recent policy initiatives such as formal risk management plans. According to DOD officials, the new regulations provide more uniform, streamlined acquisition policy guidance, which focus less on meeting specific milestone dates and more on demonstrating specific capabilities before a program progresses to the next acquisition phase.

Missile Programs Are Not Meeting Cost and Schedule Goals

Figure 1 shows the percent difference between planned and actual unit costs, total costs, and schedules for the 12 missile programs we examined. The percentage of cost change is depicted in constant dollars, which eliminates the impact of inflation. As shown, either the total or unit cost of all the missile programs increased from the initial estimate.

The most striking cost increase was in the total cost of the Stinger missile. In this case, the program's total cost increased by about 122 percent, but most of this increase was attributable to a significant increase in missile quantities. All 12 programs experienced procurement schedule extensions, ranging from a low of about 30 percent to a high of over 180 percent.

Figure 1: Missile Cost and Schedule Changes



Quantity increases generally reduce unit costs, while decreased quantities generally increase unit costs. This is due to production efficiencies and the ability to spread the contractor's overhead over more production units. Nevertheless, we found that unit costs in five missile systems increased despite quantity increases.

For example, although the Stinger missile quantities increased significantly, unit cost did not decrease. Instead, it grew by 39 percent. According to the Army, the missile experienced significant technical problems in its software and testing program, which resulted in cost increases.

A 1989 Institute for Defense Analyses study of weapon system cost and schedule trends found that tactical missiles have experienced the highest total program cost growth of any class of systems examined. The study attributes this growth to the highly technical nature of missile systems.

Optimistic Planning Leads to Overruns

The reasons missile programs overrun their initial cost and schedule goals are numerous but interrelated. Program and other DOD officials, as well as various reports on the acquisition process, point out that programs are often influenced by such factors as budget cuts, threat changes, and technological breakthroughs. However, they also point out that cost and schedule overruns often result from overly optimistic planning assumptions at the start of a program. Our evaluation indicated that overly optimistic assumptions about technical risks were common factors in such overruns.

According to a former Under Secretary of Defense for Acquisition, program managers often have a pervasive mindset that fosters optimistic planning. The Packard Commission[1] referred to this as "hucksterism," a practice in which program managers put forward the most optimistic projections of cost, schedule, and technical risk to sell their programs. Accordingly, managers develop program plans which assume that few, if any, problems of significance will occur during the design, development, and production of weapon systems involving new and complex technologies. According to the former Under Secretary, these managers have an underlying belief that an aggressive schedule (even if it is unrealistic) will result in an earlier deployment than a more realistic schedule. The threat is often cited as the basis for justifying aggressive, high risk schedules. This practice often results in a program with significantly higher costs and a later deployment than either the DOD management or the Congress were led to believe when the program began.

[1]Packard Commission, formally known as the President's Blue Ribbon Commission on Acquisition Reform, was established in 1986 to identify strategies to improve the defense acquisition process.

Underestimated technical risks were identified as a significant driver of cost or schedule overruns in seven of the eight missile programs we reviewed. For example, in the Advanced Medium Range Air-to-Air Missile (AMRAAM) program, the Air Force developed an initial schedule calling for the missile to move from the development phase to initial operating capability in 1986, a period less than 4 years. This was done even though the missile's development required a significant advance in technology and, historically, other air-to-air missiles had taken up to 10 years to develop. The AMRAAM program's initial operating capability subsequently slipped to 1991 and cost increased from $3.4 to $13.1 billion (then-year dollars), because of technological difficulties. The missile has not yet met the DAB's requirements for full-rate production approval.

Technical problems have also affected the Short-Range Attack Missile (SRAM) II program. To meet the directed initial operating capability, the Air Force accelerated the SRAM II acquisition cycle. The Air Force reported at the time that the technical risks were low to moderate. In reality, however, key components of the SRAM II proved to be much more difficult to develop than planned. Instead of the low to moderate risk assigned to the program at its inception, the Air Force now acknowledges that certain technologies were actually a high risk. According to the prime contractor, the technical requirements for the new rocket motor, for example, cannot be achieved under the current schedule. Accordingly, the SRAM II full-rate production schedule has slipped 3 years and unit costs have increased.

Appendix II describes in greater detail the effect technical problems have had on the missile programs we reviewed.

Improvements in Independent Technical Risk Assessments Needed

Technical risk assessments can significantly affect program cost and schedule estimates. Understated program office assessments of technical risks can result in understated cost and schedule estimates. We found that OSD's independent technical risk assessments were limited and that DOD's prior regulations had provided only limited guidance for such assessments.

In 1986, we reported that DOD's technical risk assessment guidance and implementation needed to be improved.[2] Before February 1991, DOD regulations did not require technical reviews and contained no specific guidance for performing technical reviews. The new regulations

[2]Technical Risk Assessment: The Status of Current DOD Efforts (GAO/PEMD-86-5, Apr.3, 1986).

(approved in February 1991) require a formal risk management plan that includes a program office assessment of the risks. However, the new regulations do not specifically define or establish the criteria needed to determine whether risks are high, medium, or low. DOD officials state that weapon systems are so unique that it is not possible to do so.

Each major program is subject to the DAB's reviews as it moves through the acquisition process to minimize or eliminate risks and ensure the programs are technically sound, cost effective, and produced on schedule. To assist DAB, DOD Instruction 5000.2 requires an independent review of program office cost estimates by OSD's Cost Analysis Improvement Group (CAIG). In addition, DOD Directive 5000.4 established CAIG as the principal adviser to DAB on cost matters. Although CAIG assesses both the program office and the independent service cost estimates, it has limited ability to assess the technical risks associated with those costs.

Organizationally, OSD's Defense Research and Engineering Directorate is responsible for technical risk assessments. Within the directorate, the Deputy Director for Tactical Warfare Programs is responsible for the majority of missiles in our review. According to directorate officials, technical reviews have been limited because they have neither the time, money, or staff to perform independent, comprehensive, technical reviews. The officials noted that the Directorate is responsible for overseeing 63 percent of the DAB programs and a significant number of non-DAB programs. A lot of staff time is spent performing administrative tasks to support the DAB process, with limited time available for performing technical reviews. This results in the reviews relying heavily on data provided by the program office. According to these officials, the program offices are sometimes reluctant to provide program details because they are concerned that the program's budget will be cut if problems are surfaced.

Good internal controls are essential to achieving the proper conduct of government business with full accountability; they also serve as checks and balances against undesired actions. Internal control systems, such as doing independent technical risk assessments, should provide reasonable assurances that programs will accomplish their objectives. Reasonable assurance equates to a satisfactory level of confidence under given considerations of costs, benefits, and risks. The required determinations call for judgment to be exercised.

Conclusions and Recommendations

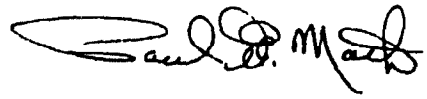
The new acquisition regulations provide more emphasis on technical risk management, but do not contain specific guidance on how the services should uniformly assess or measure such risks. It is too early to predict whether the revised regulations will improve DOD's risk management, but we believe that thorough, independent technical reviews must accompany cost reviews. Without these controls, program offices may continue to prepare program plans that underestimate technical risks. Therefore, we recommend that the Secretary of Defense ensure that the Defense Research and Engineering Directorate independently review program office technical risk assessments. We also recommend that the results of these technical reviews be reflected in the CAIG's cost analyses.

As requested, we did not obtain official agency comments on this report. However, we did discuss the results of our work with DOD program officials and have reflected their comments where appropriate.

We are sending copies of this report to the various congressional committees; the Secretaries of Defense, the Army, Navy, and Air Force; the Commandant of the Marine Corps; the Director, Office of Management and Budget; and other interested parties.

Please contact me at (202) 275-8400 if you or your staff have any questions concerning this report. Other major contributors to this report are listed in appendix III.

Sincerely yours,



Paul Math
Director, Research, Development,
Acquisition and Procurement Issues

Contents

Abbreviations

AAAM	Advanced Air-to-Air Missile
AAWS-M	Army's Advanced Anti-tank Weapons System-Medium
AIWS	Advanced Interdiction Weapon System
AMRAAM	Advanced Medium Range Air-to-Air Missile
ATACMS	Army Tactical Missile System
CAIG	Cost Analysis Improvement Group
DAB	Defense Acquisition Board
DOD	Department of Defense
OSD	Office of the Secretary of Defense
SM-2	Standard Missile
SRAM II	Short Range Attack Missile II

Objectives, Scope, and Methodology

The Chairman of the Senate Appropriations Committee, Subcommittee on Defense, asked us to examine what could be done to improve the Department of Defense's (DOD) acquisition planning process, particularly for missile programs. Our objectives were to (1) determine whether these programs were meeting their cost and schedule goals, (2) identify why they fail to meet these goals, and (3) recommend ways to increase the likelihood that acquisition goals will be met.

To determine whether missiles are achieving their cost and schedule goals, we compared cost and quantity data from the Selected Acquisition Reports on 12 missile systems. These 12 systems represented the universe of missiles with at least 5 years of production experience. We then compared the unit cost, total program cost, and schedule projections made for the development or production estimate to that of the current estimate. The cost comparisons are made in a percentage of constant dollars.

To examine why cost and schedule goals are not met, we performed case studies on a smaller sample of missile systems. After consultation with the subcommittee staff, we selected 8 missile systems for evaluation, which included 2 of the 12 systems cited previously. Our criteria in selecting these systems was to obtain a tri-service sample with two missiles at each key milestone beyond the concept development. We did not select systems at the concept development milestone because there would not be enough specific information on the weapon to evaluate. We selected the following missile systems: the Navy's Advanced Interdiction Weapon System (AIWS), Advanced Air-to-Air Missile (AAAM), and Standard Missile (SM-2); the Army's Advanced Anti-Tank Weapon System-Medium (AAWS-M) and Army Tactical Missile System (ATACMS); and the Air Force's Maverick, Short Range Attack Missile II (SRAM II), and Advanced Medium Range Air-to-Air Missile (AMRAAM).

For each of the eight missiles noted, we contacted the program office and discussed relevant acquisition planning issues. We also obtained and reviewed all available documentation pertaining to the eight missile systems, including program office and independent cost estimates, system concept papers, program baselines, decision coordinating papers, Selected Acquisition Reports, and justifications for major systems new starts. At the service level, we contacted Program Executive Offices and discussed their role in the management of the missile systems.

We discussed individual missile system issues with the Office of the Secretary of Defense (OSD) officials in the Offices of the Director for

Defense Research and Engineering and the Assistant Secretary for Program Analysis and Evaluation. We contacted the directors and staff of OSD's Cost Analysis Improvement Group (CAIG), Tactical Warfare Programs, Strategic and Theater Nuclear Forces, and Test and Evaluation organizations.

To identify ways to improve the acquisition planning process, we examined the internal controls DOD has in place to review the assumptions and acquisition strategy for weapon systems. These internal controls include policies and procedures and oversight reviews. We focused our internal control review primarily on the Defense Acquisition Board (DAB) process because it is the primary OSD oversight forum for acquisition issues and programs. At the service level, we examined acquisition policies and procedures, and discussed these issues with program and service headquarters officials, including Program Executive Officers and their staff.

At the OSD level, we reviewed the current acquisition policies DOD uses for its weapon systems and the draft revisions to those policies. We discussed acquisition policy and oversight review issues with various directorates within the Office of the Under Secretary of Defense for Acquisition and with CAIG officials. In addition, we interviewed the heads of the DAB's Conventional and Strategic Systems Committees as well as an official from the Defense Science Board.

Our review was performed from April 1990 to June 1991 in accordance with generally accepted government auditing standards.

Cost and Schedule Overruns on Selected Missiles

AMRAAM

AMRAAM is an all-weather, all-environment missile system that is intended to meet air-to-air missile requirements into the next century. It was approved as a joint Air Force/Navy program in 1977 to replace the SPARROW missile. AMRAAM is to be compatible with the services' latest fighter aircraft. The inventory objective was recently reduced from 24,320 missiles to 15,450 missiles.

AMRAAM has experienced significant cost increases and schedule delays, much of which can be attributed to understated estimates of technical, cost, and schedule risk. For example, the Air Force originally estimated in 1978 that total program cost for the 20,000 missiles would be $3.4 billion (then-year dollars). By fiscal year 1985, this estimate had grown to $11.5 billion. Despite a decrease in total quantities, the current estimate of $13.1 billion represents a 285-percent increase from the initial plan.

In 1978, the Air Force shortened the AMRAAM development schedule to meet a 1986 initial operating capability date for the system. This development schedule was very success-oriented and involved a high degree of technical risk. Eventually, after several missed milestones, the initial operating capability date was extended 5 years to the current date of 1991. To achieve the optimistic schedule, the contractor used older, more costly technology, which contributed to higher program costs. We reported in 1987 that doubling of the program cost estimate was due primarily to overly optimistic estimates of technical complexity and cost of the missile.[1]

The AMRAAM's technical problems resulted, in part, from a lack of mature electronic circuitry technology that affected the missile's weight, size, and cost. As a result, certain missile components had to be redesigned. A 1984 study commissioned by the House Armed Services Committee determined that the program had experienced significant delays due to the redesign of the terminal seeker and guidance system.

At the DAB milestone review for limited production, the CAIG suggested that the AMRAAM learning curve be reestablished as a flatter curve to reflect a more realistic cost and schedule. Table II.1 summarizes AMRAAM's program changes.

[1] Missile Procurement: AMRAAM Cost Growth and Schedule Delays (GAO/NSIAD-87-78, Mar. 10, 1987).

Table II.1: Changes in AMRAAM Program (Then-Year Dollars in Billions)

Process plan	Development (mos.)	Quantity	Production period	Initial operating capability date	Total cost
1978	36	20,000	1985–93	1986	**$3.4**
1985	79	24,320	1987–96	1989	**11.5**
Current	85	15,450	1987–99	1991	**13.1**

SRAM II

SRAM II is planned to be a nuclear air-to-surface missile capable of penetrating advanced defensive threats to strike hardened, defended, and mobile targets. It is intended for use on the B-1B and B-2 bombers. The Air Force approved SRAM II as a major system new start in 1983 to replace the aging Short Range Attack Missile A. The upgraded missile was planned to include (1) a new rocket motor that would provide high missile velocity and increased range, (2) a guidance system designed to provide high accuracy, (3) a change in the shape and design to reduce radar observability, and (4) a new warhead. The current inventory objective was reduced from 1,633 missiles to 700 missiles in the fiscal year 1992 budget.

The Air Force selected an accelerated acquisition approach for SRAM II because it wanted to field an operational system in the early 1990s. Instead of conducting the normal acquisition phase of concept exploration and proceeding to the demonstration and validation phase, the Air Force moved the program into the full-scale development phase, bypassing demonstration/validation. The Air Force considered the development program's risks to be low to moderate because existing technologies would be used. The Air Force competitively selected three contractors to do system definition studies and component risk reduction tests in the concept exploration phase and used the results to develop the specifications for the full-scale development contract.

These initial assumptions underestimated program risks. Technical problems with the missile guidance software and the rocket motor have significantly increased the program's schedule and costs. In January 1991, the Air Force and contractor agreed there was a high degree of technical and schedule risk to the program.

The original program schedule showed full-rate production was scheduled to begin by June 1990 and reach initial operating capability by March 1992. To meet these dates, missile procurement would peak at

600 missiles in 1993 and finish in 1994. The program schedule has slipped approximately 4 years based on a new production milestone of February 1995. The procurement schedule is not estimated to be completed until 1997, more than 3 years later than originally planned.

The initial Air Force cost estimate for production of 1,633 missiles was $3.065 billion in then-year dollars. After the system definition studies and component risk reduction tests were completed, the program office reduced its estimate to $2.393 billion. Later, in preparation of the fiscal year 1992 budget request, the Air Force reduced the quantity of missiles to be bought to 700 and the estimated cost to $2.235 billion.

AAAM

The primary objective of the Navy's AAAM program is to improve fleet air defense capabilities by destroying enemy aircraft before they reach the release range of anti-ship missiles. Planned to fit any aircraft platform, AAAM is in the demonstration and validation acquisition phase, with a full-scale development decision planned for 1993 or 1994. As of its last milestone review, the AAAM inventory objective was 4,000 missiles.

An acquisition strategy incorporating teaming is to be used to promote competition for the full-scale development and production phases of the program. According to the Navy, cost risks will be reduced through competition, maximum use of off-the-shelf hardware in the design, extensive test and evaluation early in the design phase, and strict control of changes in the latter portion of the design phase.

At the demonstration and validation review of AAAM, CAIG raised issues on the program's technical and cost assumptions. Technical risks included the guidance and propulsion technologies, dual mode seeker, airframe integration, and the significant level of development engineering and testing required. CAIG noted that no air-to-air weapon of this complexity had been developed into a single package.

Because of these technical risks, CAIG's development estimate was 30 percent higher than the Navy's estimate. One area of concern was the Navy's use of AMRAAM costs as an analogy for AAAM because AMRAAM costs are dynamic and not yet completely defined. CAIG also questioned procurement costs because the total AAAM requirement was uncertain. According to CAIG, the assumed competition savings were optimistic and dependent on production quantity levels that may not be achieved.

CAIG concluded that the operation and support costs were underestimated because of the Navy's optimistic assumption regarding AAAM's sustained in-service life. CAIG pointed out that despite historical evidence of an 18- to 24-month in-service life for the Phoenix missile, the Navy had assumed that the highly complex AAAM would have an in-service life of 36 months. Because of technical complexity, CAIG also believed that AAAM repair costs could be significantly greater than those of the Phoenix.

AIWS

The Navy originally initiated the AIWS missile program on the assumption that it would be a low-cost, high-quantity, baseline missile intended for use on multiple, low-value, fixed-land targets in a high threat environment. AIWS is intended to replace such existing operational missiles as the Maverick, Walleye, and Skipper. The Navy plans to have three teams working through demonstration and validation. One team will be selected for development, and those contractors will compete with each other for the production contract. AIWS is currently in the demonstration and validation phase of its acquisition cycle. Its full-scale development DAB review is currently scheduled for November 1991.

Our office[2] and CAIG officials have criticized the acquisition strategy for AIWS. This is because the baseline missile will not meet the full range of operational requirements. Navy officials stated that the baseline missile was not planned to equal the capability of the three missiles it is to replace. To meet the capabilities of the Walleye, Skipper, and imaging infrared Maverick, the Navy plans to develop an improved AIWS missile. According to Navy officials, the AIWS baseline missile combined with the improved version will exceed the capabilities of the three earlier missiles. The Navy is currently exploring enhancements to the improved AIWS missile, but it has not yet established a formal requirement for such a missile.

AIWS' costs may be significantly higher than originally planned. For example, although the program office initially accepted the unit cost ceiling of $50,000 for the baseline missile, this cost did not include the warhead or certain non-recurring costs. Still, in its demonstration and validation phase, the projected AIWS unit cost may rise to over $80,000, a 60-percent increase. The planned improvement to the baseline AIWS missile may cost over $170,000 per missile.

[2]Tactical Missiles: Issues Concerning the Navy's Requirements Determination Process (GAO/NSIAD-90-233, Sept. 12, 1990).

CAIG reported that the Navy's assumed competition savings are overly optimistic. According to CAIG, typical acquisition strategies (sole-source, teaming, and leader/follower) exhibit little if any cost differentials. A CAIG analyst further explained that it is difficult to be confident of the Navy program office estimates for competition savings at such an early milestone.

The planned AIWS production schedule also appears to be very optimistic. This schedule accelerates from 300 missiles in the first year to 1,580 missiles in the second year. Navy officials believe that this schedule is achievable because the baseline missile uses low risk, off-the-shelf technology. However, CAIG believes that such a production profile is overly aggressive and optimistic. According to DOD, the schedule was being changed to reflect a less aggressive production profile.

AAWS-M

The Army's AAWS-M is planned as a one-man portable antitank weapon designed to provide high lethality against advanced armor. It is planned to be simple to operate and easy to maintain, with the capability to defeat both conventional and reactive armor. AAWS-M is being procured for the Army and Marine Corps as a replacement for the DRAGON. It is currently in full-scale development with a limited production decision scheduled for October 1993. The planned inventory objective is 70,550 missiles.

The Army considers the technical risks to be low to moderate, with the producibility of the focal plane array as the primary risk. In its assessment of program costs, CAIG raised issues on the competition savings, operating and support costs, and estimates for the focal plane array. The Army recently acknowledged that the performance and deliveries of the focal plane array have fallen well below its plan.

In addition, other technical problems and test delays have resulted in further program slips. The Army recently relaxed the weight requirement because the contractor was unable to achieve the 45-pound requirement. As a result, the weapon may no longer be transportable by one soldier. The program office acknowledged that the weight requirement was always considered to be a challenging one, especially in view of the success-oriented 36-month development schedule. As a result of the above problems, the Army extended the development schedule from 36 months to at least 48 months and increased its estimated development contract costs by more than 100 percent.

ATACMS

ATACMS is a ground launched missile system consisting of a surface-to-surface guided missile with an anti-personnel and anti-material warhead. It is to be fired from the modified Multiple Launch Rocket System. ATACMS received authority to enter full-rate production in November 1990. The current inventory objective is 1,542 missiles.

ATACMS is an outgrowth of a 1981 special Army task force, which examined requirements for a weapon system to engage high priority targets at extended ranges. This effort evolved into the ATACMS program in 1985. Because of early technology demonstration, ATACMS did not have DAB reviews at concept exploration or demonstration and validation phases. DAB reviews were begun at the full-scale development milestone.

The ATACMS' original inventory objective was 1,000 missiles. This quantity was subsequently increased to 2,834 missiles after the Army completed an assessment of its requirements. This change nearly tripled the total quantity and increased program baseline costs by 88 percent, or $1 billion. In January 1991, however, DOD reduced the planned procurement program from 2,834 missiles to 1,542 missiles because of affordability concerns. According to the Army, this reduction decreased the total program cost, but increased the unit cost estimate by about 7 percent.

In approving ATACMS full-scale development program, the Secretary of Defense indicated that it was expected to be a relatively low-risk program. During our review, we did not find evidence of significant schedule or technical problems that would contradict this expectation.

Maverick

The imaging infrared Maverick is a rocket propelled, air-to-surface, precision guided missile that develops tracking signals from the natural occurring thermal energy of the target. Originating in 1964, the Maverick was to provide a substantial increase in accuracy over existing systems as well as a "launch and leave" capability. Initial feasibility studies for an infrared seeker on the Maverick missile began in early 1970 and subsequent studies confirmed its guidance concept, leading to a joint Air Force/Navy advanced development contract in 1974.

Difficulties with design, test results, quality, and funding adversely affected the Maverick's cost and schedule assumptions. Although the Air Force believed the risks were low to moderate and that the project was ready to go to full-scale development, early design and testing problems with the missile's seeker prompted the Congress to deny fiscal year 1978 funding and direct that 1977 funds be used for advanced

development and testing of the tracker. In 1978 we issued a classified report on the poor test results and questioned the ability of the missile to meet its operational goals. In 1980 we issued another classified report that highlighted serious deficiencies in the Maverick's target discrimination, acquisition, and lock-on capabilities.

After further testing and an 18-month delay in the original schedule, the Air Force began the full-scale development phase. In 1980, the Air Force conducted its critical design review concurrent with the start of the combined development and initial operational test program. During development, additional technical problems surfaced with the cryoengine and stabilization/tracker design that resulted in design changes and contributed to a program slip of nearly another year.

Because of these problems, DAB delayed the limited production of the Maverick; instead, it required the Air Force to improve the missile's reliability and maintainability. Subsequent quality problems with the prime contractor further delayed the schedule. Follow-on tests showed the missile's operational suitability and low-rate production was authorized in September 1982.

Although planned Maverick procurements for fiscal years 1991 and 1992 were eliminated in the fiscal year 1991 budget, the Congress added 600 missiles in fiscal year 1991. This resulted in total Air Force production of the Maverick to 20,259 missiles. Table II.2 shows how the assumptions on the program changed as the program matured. For example, the missile's development estimate took more than 6 years (75 months) longer than the original estimate. Quantities changed significantly over the acquisition period, first increasing by 95 percent, then decreasing by 67 percent. Both changes were threat related. The program office, however, attributed the decrease to schedule stretch-outs and funding reductions as well as intervening technological advancements like the Sensor Fuzed Weapon.

Unit costs increased 180 percent over the original baseline acquisition cost projection. According to the Air Force, the major factor in these increases was schedule delays. However, a Rand Corporation analysis commissioned by the Air Force concluded that given the 75-month increase in development time, the program office was unrealistic in estimating a development cost increase of only 7 percent. Since the contractor had to absorb the costs in excess of the ceiling costs on the developmental contract, the Rand study indicated that the development costs may have grown as much as 50 percent.

Table II.2: Changes in Maverick Program (Then-Year Dollars in Millions)

Process plan	Development (mos.)	Quantity	Production period	Initial operating capability date	Unit cost
1976	33	31,078	1979–85	1981	$0.051
1984	108	60,664	1984–93	1985	0.095
Current	108	20,259	1986–90	1986	0.143

SM-2

SM-2 is part of the Aegis surface-to-air weapon system. It is produced in medium and extended range versions and different block configurations. SM-2 incorporates improvements in the guidance and navigation capabilities that increase the missile's range. The Block II configuration is an improved missile with the capability to counter high speed, higher altitude anti-ship missiles.

Although SM-2 is a major weapon system acquisition program, it was not subject to DAB review because the missile was part of the Aegis requirements, and considered to be a subset of that program. Instead of a DAB review, the Navy conducted its own milestone reviews for the SM-2. The SM-2 Block II is currently in full-rate production, with an inventory objective of 14,677 missiles.

According to the Navy, the SM-2 Block II development and production phases were successful because the program faced few technical and funding problems. Since the Block II was an upgrade of the existing Block I configuration, there was little technical risk. The program's development and production were stable because the missile was needed to protect the Aegis ships. According to these officials, the program was always fully funded, allowing managers to work out problems without worrying about scheduling delays caused by budget cuts. They added that the admiral in charge of the Aegis program insisted on the SM-2 Block II program having a good development team, enough money for sustaining engineering, and in-depth technical reviews every 3 months.

The SM-2 Block II did encounter one significant problem during the missile's development. According to the Navy, the rocket motor had technical requirements that made the motor more difficult to build than anticipated, and the problems delayed pilot production for a year. Specifically, the propellant nozzle was not able to withstand the high heat generated by the rocket motor. This problem, which took 1 year to resolve, caused the initial operational capability date to slip 1 year. To

counter known and evolving threats, the Block III and IV variants of SM-2 are currently in advanced stages of development.

According to the Navy, SM-2 had been fully funded during development and production. Total program costs increased 21 percent from the original Navy estimate. The Navy attributes a significant portion of this cost increase to a 36-percent increase in total quantity. Unit costs decreased by $59,000 (10 percent) as a result of competition introduced for the SM-2 production program.

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