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Report to the Chairman, Committee on Armed Services, House of Representatives

September 1991

ICBM MODERNIZATION

Small ICBM Weapon System Status and Current Issues

GAO/NSIAD-91-275

GAO

United States
General Accounting Office
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National Security and
International Affairs Division

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September 30, 1991

The Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report, prepared at your request, addresses the status of the Department of Defense's (DOD) Small Intercontinental Ballistic Missile (ICBM) program. We have provided additional detail in a classified briefing for your office, and a classified fact sheet will be prepared after this report has been issued.

We recommend that DOD expand the information being reported in the Small ICBM Selected Acquisition Report to enhance congressional oversight of the program. Additionally, we suggest that the Congress consider directing the Secretary of Defense to provide a report on the future structure and pace of the Small ICBM program when he presents the fiscal year 1993 DOD budget.

Unless you announce its contents earlier, we plan no further distribution of this report until 30 days after its issue date. At that time copies will be made available to the appropriate congressional committees; the Secretaries of Defense, the Air Force, and Energy; the Director, Office of Management and Budget; and other interested parties upon request.

Please contact me at (202) 275-4268 if you or your staff have any questions concerning this report. Other major contributors to this report are listed in appendix IV.

Sincerely yours,

Nancy R. Kingsbury
Director
Air Force Issues

Executive Summary

Purpose

U.S. strategic nuclear forces, consisting of submarine-launched ballistic missiles, manned bombers, and land-based intercontinental ballistic missiles (ICBM), provide nuclear deterrence. To counter Soviet nuclear advances, a long-standing national defense goal has been ICBM modernization. One such modernization initiative is the Small ICBM program.

At the request of the Chairman of the House Committee on Armed Services, GAO reviewed the status of the Small ICBM program. GAO's effort included a review of the Department of Defense's (DOD) reasons for continuing development without a present commitment of procurement and construction funds needed to deploy the system. GAO also reviewed the adequacy of the acquisition cost estimate, the outlook for meeting future schedule milestones, the ability of the missile to meet operational needs, and the progress of missile development.

Background

The Small ICBM program began in fiscal year 1984 with the belief that a small ICBM would permit greater flexibility in developing basing concepts to enhance ICBM survivability. Deployment was initially scheduled to begin in 1992. Through 1987, 1 year after the beginning of full-scale development, the program was on schedule. Subsequently, concerns about the cost of the program within the context of other DOD priorities interrupted the pace of development and delayed initial deployment to potentially 1997. During 1988-91, development efforts were primarily missile-related and two test missiles were launched—one in 1989 that was destroyed after about 2 minutes of flight and one in 1991 that was successful. To continue missile development and to resume development of mobile basing components at a pace to support deployment in 1997, DOD is requesting $548.8 million for fiscal year 1992.

Results in Brief

Development of the mobile Small ICBM weapon system is continuing as a hedge against future requirements. DOD's plans for deploying the system are uncertain at this time and unresolved issues remain concerning the system configuration, acquisition costs, and deployment milestones. DOD plans to address these issues in late 1991 reviews of ICBM programs. Based on these reviews, updated Secretary of Defense direction on the structure and pace of the Small ICBM program is expected.

Until the Secretary of Defense provides updated direction, program funding needs are uncertain. To complete the program as currently defined by the Air Force for planning purposes, about $6.1 billion would

have to be added to DOD's fiscal years 1992-97 budget. Conversely, if DOD changes the program, there may not be a need for some of the $548.8 million requested for fiscal year 1992 Small ICBM development.

While progress has been made in developing the Small ICBM missile, uncertainty remains concerning (1) the missile's capability to effectively damage hardened facilities and cover the designated target base and (2) the viability of the missile design and the availability of parts for several missile components and the warhead.

The capability to effectively damage hardened targets depends on the implementation and success of missile improvements under consideration and meeting the range requirement partially depends on successfully controlling missile weight. While the Air Force is confident of meeting these needs, it is not providing sufficient information in the Small ICBM Selected Acquisition Report (SAR) to permit meaningful congressional oversight.

Principal Findings

Program Structure and Pace Are Being Reconsidered

As directed by DOD in 1989, development of the mobile Small ICBM weapon system is continuing at a pace to support initial deployment in 1997. However, DOD is reconsidering that direction. DOD and Air Force officials cited changes in the international environment, the reduced threat in a post-Strategic Arms Reduction Talks environment, and the high cost to procure and operate mobile ICBMs as the basis for not committing to Small ICBM deployment at the present time. These officials stated that development is proceeding to provide a possible replacement for the Minuteman III missiles, to provide a survivable basing option for ICBMs, and to protect an option for basing Small ICBMs in silos. DOD plans reviews of ICBM programs in late 1991, and a subsequent Secretary of Defense decision could reaffirm or change the current structure and pace of the Small ICBM program.

Funding, Cost, and Schedule Are Uncertain

DOD's Small ICBM budget for fiscal years 1992-97 will not support achievement of initial deployment in 1997. In particular, DOD's budget for this period does not contain any construction or procurement funds for the program, which the program office says will be needed beginning in fiscal years 1993 and 1994, respectively. If the Secretary decides to

continue the program, as currently defined, about $6.1 billion would have to be added to DOD's fiscal years 1992-97 budget, based on the Air Force's approved program cost estimate.

As of December 31, 1990, the Air Force's estimate of Small ICBM acquisition costs was about $41.9 billion (then-year dollars), assuming deployment of a force of 500 single-warhead mobile Small ICBMs at three Minuteman bases starting in 1997 and ending in 2008, and a 108 operational missile test flight program. That estimate may not be meaningful. Pending decisions could change assumptions on force size, deployment dates, basing modes, and warhead configuration. The assumption concerning the number of required operational test missiles is also uncertain. In addition, the estimate may not adequately reflect the cost impacts of the many programmatic and weapon system design changes that have occurred. These potential impacts relate to such things as changes to the design of several propulsion system components and increasing the period between initial and final deployment.

At the time GAO prepared this report, the program office was revising the cost estimate. The reliability of that estimate will depend upon the extent to which it addresses the cost issues discussed in this report and the results of a planned review of the estimate by DOD's Cost Analysis Improvement Group.

To begin deployment in 1997, the program office has developed a schedule with some risk. For example, the program's greatest challenge, development of the weapon control system, is being delayed until 1992. Also, weapon system production is scheduled to begin about a year before the first weapon system test flight. The pace of the program is subject to change, as are related schedule risks, pending the upcoming Secretary of Defense decision.

Challenges Remain in Meeting Target Damage and Range Capability Needs

The Small ICBM missile must have the capability to effectively attack soft to super-hard targets and the range to cover the required target base. The capability to meet these goals is uncertain. The ability to effectively damage hardened targets depends upon the implementation and success of programs under consideration to improve accuracy and to redesign the arming and fuzing assembly. Meeting the range goal is partially dependent on whether missile weight growth can be successfully controlled. The program office expects that the missile's ability to meet target damage and range requirements will be proven before the initial production decision scheduled in 1995.

Selected Acquisition Report Is Not Providing Sufficient Information on Performance

DOD submits Selected Acquisition Reports to the Congress to provide information on the status of weapon system acquisitions. The December 31, 1990, ICBM SAR does not contain sufficient information to permit meaningful congressional oversight on the status of achieving target damage and range capability needs. Target damage, accuracy, and range capabilities were reported, but the capabilities being reported were only the required level of performance. Information provided to GAO during its review concerning demonstrated performance or current performance projections were not being reported. Similarly, a generalized missile weight of 37,000 pounds was also being reported, but the projected missile weight with penetration aids, which in December 1990 was about 37,800 pounds, was not being reported.

Status and Issues Concerning Missile Development

Progress has been made developing the Small ICBM missile, but unresolved issues remain. For example, the success of design changes to correct technical and producibility problems with the propulsion system components remain to be conclusively demonstrated. The first flight of the missile with most of the design improvements is not scheduled until 1993. In addition, warhead development has yet to resume, and the availability of a particular nuclear component is uncertain.

Recommendation

GAO recommends that the Secretary of Defense direct that target damage, accuracy, range, and weight information in the Small ICBM SAR be expanded to show the capabilities being achieved to date and the latest forecast of expected performance.

Matters for Congressional Consideration

The Congress may wish to consider directing the Secretary of Defense to provide a report to the Congress on his decision regarding the future structure and pace of the Small ICBM program when he presents the fiscal year 1993 DOD budget. Specific details that the report should include are defined in chapter 2.

Agency Comments

GAO did not request official written comments on this report. However, GAO discussed a draft of this report with DOD and Air Force officials. These officials stated that the data currently being reported in the Small ICBM SAR meets reporting requirements. GAO does not disagree. However, SAR reporting guidelines also allow for additional information to be reported, as GAO recommends, if that information would provide a better understanding of the program.

Contents

Abbreviations

DOD	Department of Defense
GAO	General Accounting Office
ICBM	Intercontinental Ballistic Missile
SAC	Strategic Air Command
SAR	Selected Acquisition Report
START	Strategic Arms Reduction Talks

Introduction

U.S. strategic nuclear forces consist of submarine-launched ballistic missiles, manned bombers, and land-based ICBMs. Since the 1960s, this Triad of nuclear forces has contributed to the primary objective of the nation's strategic forces—deterrence of nuclear war. In its fiscal years 1992 and 1993 report to the Congress, the Air Force stated that "the Triad ensures sufficient forces survive an enemy attack to successfully retaliate against an aggressor. Each leg of the Triad possesses unique and complementary characteristics which synergistically provide a retaliatory capability no adversary could hope to successfully counter." To counter Soviet nuclear advances, a long-standing national defense goal has been modernization of the ICBM component of the U.S. Triad to improve retaliatory capability and survivability. One such initiative is the Small ICBM program, which is the subject of this report.

ICBM Force Structure

The current U.S. ICBM force consists of 450 one-warhead Minuteman II missiles, 500 three-warhead Minuteman III missiles, and 50 ten-warhead Peacekeeper missiles. Minuteman II missiles were first deployed in 1965; Minuteman III missiles in 1970; and Peacekeeper missiles in 1986. The entire current ICBM force is deployed in underground silos located at various Air Force bases in the continental U.S., as shown in table 1.1.

Table 1.1: Location of the U.S. ICBM Force

		Minuteman		
Air Force Base	**State**	**II**	**III**	**Peacekeeper**
Malmstrom	Montana	150	50	0
Ellsworth	South Dakota	150	0	0
Minot	North Dakota	0	150	0
Grand Forks	North Dakota	0	150	0
Whiteman	Missouri	150	0	0
F. E. Warren	Wyoming	0	150	50
Total force size		**450**	**500**	**50**

ICBM Modernization

In 1972, the Air Force's Strategic Air Command (SAC) articulated the requirement for a new ICBM. It determined that the new missile should be able to destroy hardened targets[1] and should be based in a survivable manner. Subsequently, the Missile Experimental (MX) program (the name was changed to Peacekeeper in November 1982) was initiated. The history of the Peacekeeper program has been one of successful missile

[1]Hardened targets are targets that have been specially designed and constructed to withstand the effects of a nuclear weapon detonation.

development and of an inability to find a way to base the missile that was technically feasible, affordable, and politically and publicly acceptable.

The controversy over Peacekeeper basing led President Reagan to appoint a Commission on Strategic Forces in 1983 to provide advice on ICBM basing options and alternatives to the Peacekeeper. The Commission recommended prompt deployment of 100 Peacekeeper missiles in Minuteman silos; the development of a new, single-warhead Small ICBM; and the investigation of concepts for survivable ICBM basing. The Commission's recommendations were endorsed by the President and approved by the Congress in May 1983.

Subsequently, an ICBM modernization program was established to

- deploy 100 Peacekeeper missiles in Minuteman III silos;
- investigate other survivable basing technologies, such as super-hard silos; and
- develop a Small ICBM weighing about 30,000 pounds and a hard mobile launcher designed to withstand nuclear effects.

Small ICBM Program Evolution

The Small ICBM program began in 1983 with the belief that a small ICBM, possessing the capability to place hard targets at risk, would allow greater flexibility in developing basing concepts that are more survivable than existing Minuteman silos. Through 1987 the Small ICBM program was progressing on schedule to initial deployment in 1992. Concept definition and technology demonstration was conducted from 1983 to 1986 with full-scale development of the weapon system—missile and mobile basing components—beginning in December 1986.

In February 1988, the Secretary of Defense recommended terminating the Small ICBM program, in part, because the program was not cost effective when compared to other strategic alternatives. However, in response to congressional concerns, DOD decided to continue development through fiscal year 1989 so the next administration would have the option to continue the program. Accordingly, in April 1988 the Small ICBM program was partially terminated and the development program restructured. The restructured program consisted mainly of missile development activities and hardware deliveries supporting two flight tests. Program officials advised us that the Small ICBM was no longer in full-scale development after the restructure and initial deployment in 1992 was no longer attainable.

In April 1989, DOD decided to continue with the Small ICBM program because of the operational flexibility offered by a single-warhead missile in a survivable basing mode. Because of funding constraints, however, development during fiscal years 1990 and 1991 was primarily missile related. To date, the Air Force has had two Small ICBM missile test launches—one in 1989 that was destroyed after about 2 minutes of flight and one in 1991 that was successful. In fiscal year 1992, $548.2 million is being requested to continue missile development and resume full-scale development of mobile basing components. The Small ICBM full-scale development program is now paced to support potential initial deployment in 1997—5 years later than initially planned. Additional information on the evolution of the Small ICBM program is contained in appendix I.

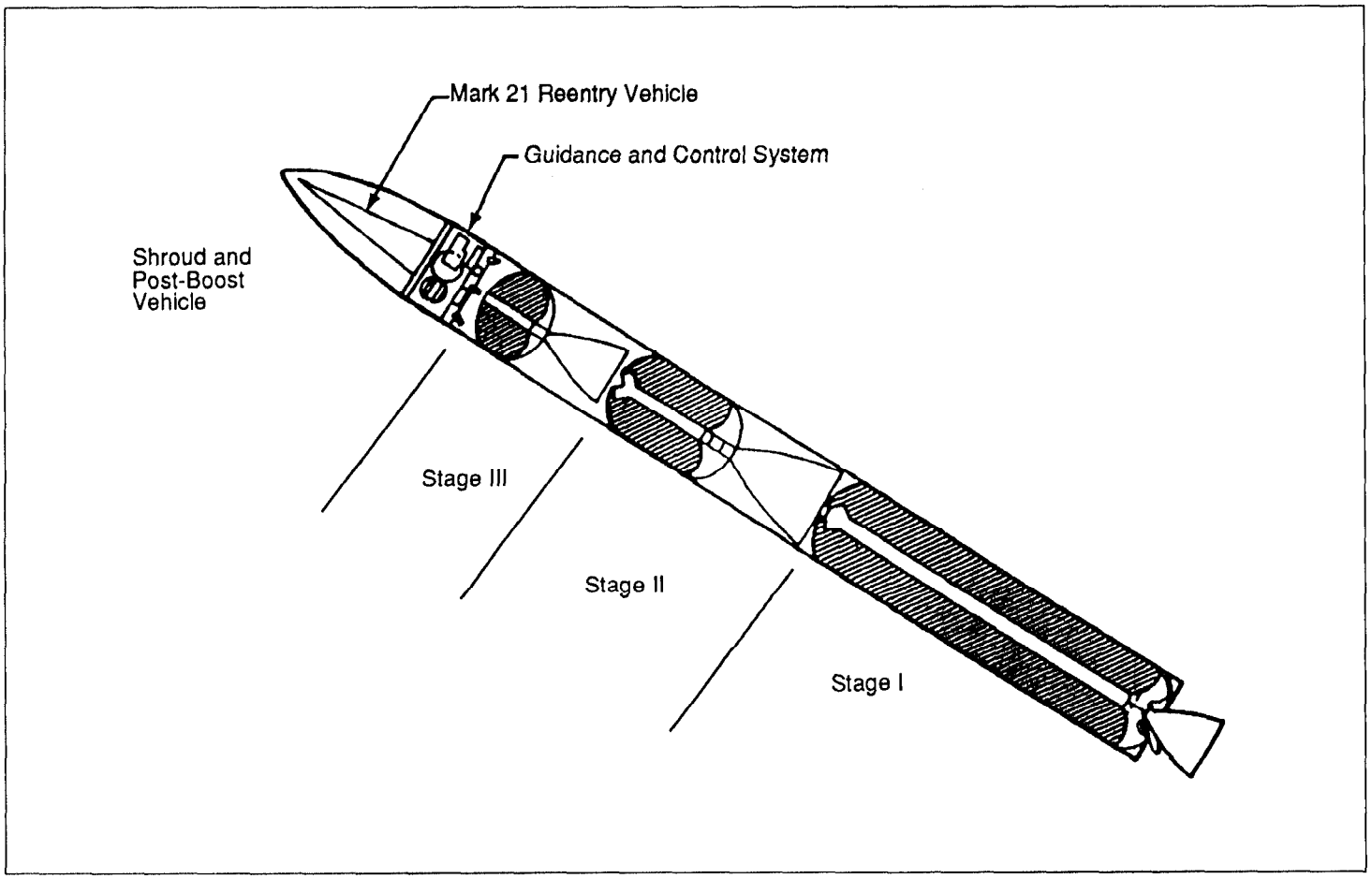
Small ICBM Weapon System Description

The Small ICBM weapon system consists of three basic elements: the missile and payload, the hard mobile launcher, and the weapon control system.

The three-stage solid-propellant missile weighs approximately 37,800 pounds and is 53 feet long and 46 inches in diameter (see figure 1.1). It is capable of delivering its single Mark 21 reentry vehicle to at least a range of 6,000 nautical miles. The guidance and control system's inertial measurement unit and the Mark 21 reentry vehicle[2] are also being used on Peacekeeper missiles.

[2]The reentry vehicle is that portion of the missile that carries the nuclear weapon and reenters the earth's atmosphere to reach its target.

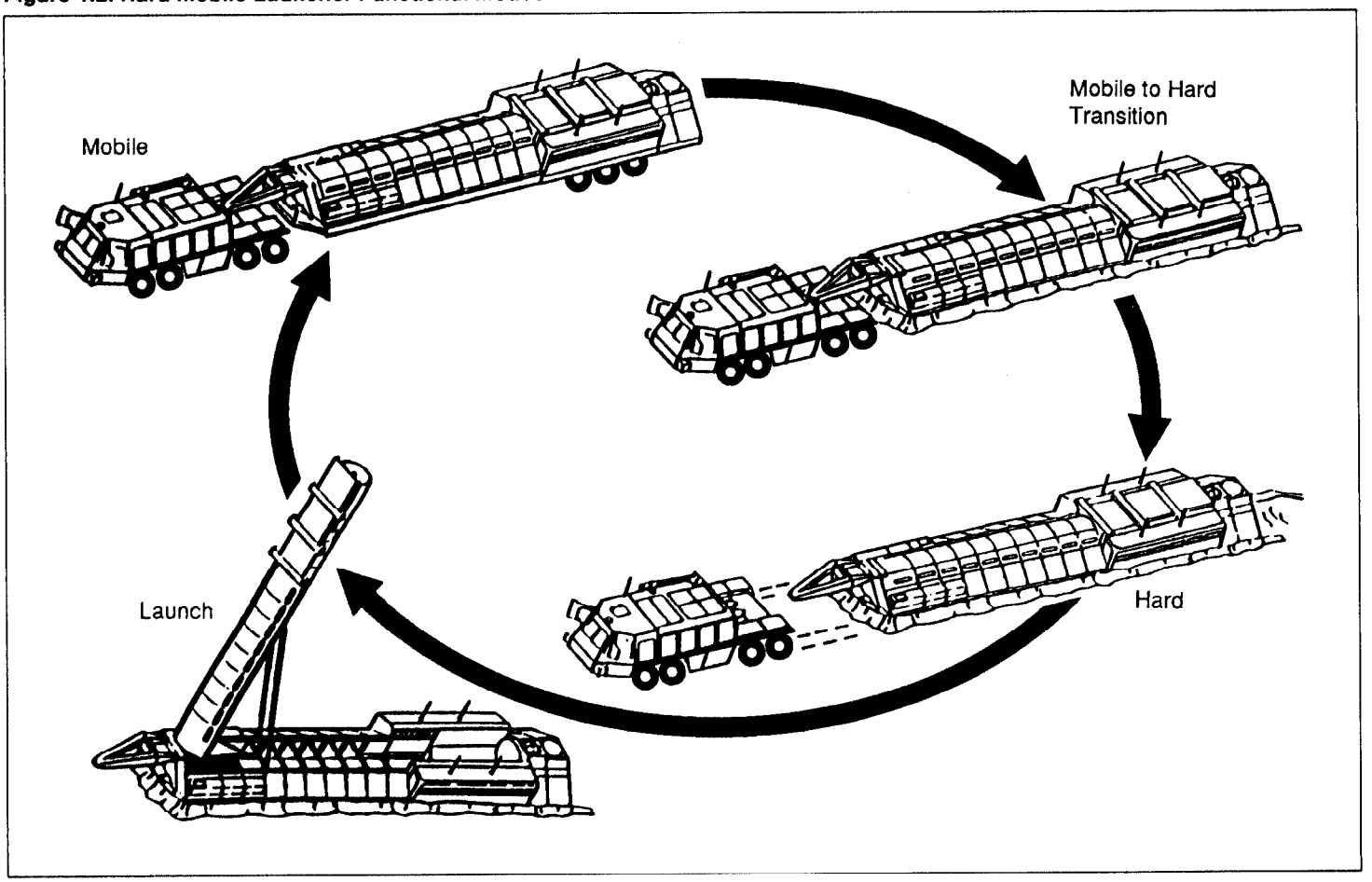
Figure 1.1: Small ICBM



The hard mobile launcher,[3] consisting of a manned tractor and unmanned missile launcher, is about 106 feet long and 14 feet wide and weighs about 240,000 pounds. The hard mobile launcher is capable of both on and off-road travel. Upon tactical warning, the two-member crew uses the diesel-powered tractor to move the launcher, which carries and protects the missile within a canister. On launch command from a remote launch control center, the launcher pivots the canister to a vertical position and ejects the missile (see figure 1.2).

[3]The Small ICBM mobile launcher is designed to resist the effects of nuclear weapons—i.e., a hard mobile launcher.

Figure 1.2: Hard Mobile Launcher Functional Modes



The weapon control system design includes a fixed launch control center at each operational base. To ensure command and control survivability, the fixed launch control centers will be backed up by existing Minuteman/Peacekeeper airborne launch control centers and Small ICBM ground mobile launch control centers. In event of war, the primary mode of communication to and from higher authority is by radio through the airborne or ground mobile launch control centers.

The current operational concept calls for basing the Small ICBM single-warhead missiles on hard mobile launchers deployed at Minuteman launch facilities. Survivability will be enhanced by rapid dispersal from the launch facilities on tactical warning of attack.

Prior GAO Reports

In the past, we have reported on several of the Small ICBM program issues discussed in this report. A synopsis of these previous reports follows.

- In July 1985, we reported in Status of the Intercontinental Ballistic Missile Modernization Program (GAO/NSIAD-85-78, July 8, 1985) that four major issues had to be resolved before the success of the Small ICBM could be assured. They were (1) life-cycle costs, (2) technical feasibility, (3) land availability, and (4) operational effectiveness. With regard to technical feasibility, the issues of concern were the development of a lightweight missile and an affordable guidance and control system that could achieve high accuracy in a mobile environment. The missile's ability to achieve the 6,000 nautical mile range requirement was one of several operational effectiveness issues highlighted in the report.
- In September 1986, shortly before the program entered full-scale development, we reported in ICBM Modernization: Status, Survivable Basing Issues, and Need to Reestablish a National Consensus (GAO/NSIAD-86-200, Sept. 19, 1986) that progress had been made, but that development and deployment challenges still remained. Issues discussed included uncertain life-cycle costs, increasing hard mobile launcher weight, and uncertain availability of land on military installations in the southwestern United States.
- In June 1988, shortly after the program was partially terminated, we reported on the cost, schedule and performance status of 23 defense acquisition programs in DOD Acquisition Programs: Status of Selected Systems (GAO/NSIAD-88-160, June 30, 1988). The Small ICBM segment of the report outlined the revised cost, schedule, and performance parameters of the program after partial termination.
- In July 1988, in ICBM Modernization: Selected Funding Options (GAO/NSIAD-88-193, July 7, 1988), we responded to a request from Senator Warner for information about four funding options available for continuation of Small ICBM development to preserve a program decision on the Small ICBM for the next administration.
- In August 1990, we reported on issues concerning the long-term costs of 12 strategic weapon systems in Strategic Weapons: Long-Term Costs Are Not Reported to the Congress (GAO/NSIAD-90-226, Aug. 10, 1990). Concerning the Small ICBM program, we reported that, at the time of our review, DOD had not estimated total Small ICBM program costs because it had not determined the basing mode or the total number of Small ICBMs to be produced.

Objectives, Scope, and Methodology

The Chairman, House Committee on Armed Services, asked us to review the status of the Small ICBM program. Our work included a review of February and March 1991 congressional testimony by DOD and Air Force officials related to the program. The purpose of this effort was to determine whether there appeared to be a sound basis for continuing the development of the Small ICBM weapon system as currently structured and paced without a present commitment of procurement and construction funds needed to deploy the system.

We also reviewed the adequacy of the acquisition cost estimate, the outlook for meeting future schedule milestones, the ability of the missile to meet operational requirements, and the progress of weapon system and warhead development. We generally limited our review of weapon system development to missile development. Our rationale for this focus is that since 1988, the Small ICBM program has concentrated primarily on missile development, with only limited development of basing technologies.

We interviewed appropriate officials and examined pertinent documents at the Ballistic Missile Organization, Norton Air Force Base, California; Strategic Air Command Headquarters, Offutt Air Force Base, Nebraska; the Office of the Secretary of Defense and Air Force Headquarters, Washington, D. C.; and the Albuquerque Operations Office, Department of Energy, Kirtland Air Force Base, New Mexico. In addition, we visited several Small ICBM contractors, as listed in appendix III, to discuss their particular weapon system component.

We discussed the details of this report with officials from the Office of the Secretary of Defense, Air Force Headquarters, and the Ballistic Missile Organization. Their comments have been incorporated as appropriate. As agreed with your office, we did not obtain official DOD comments. We performed our work from April 1990 to July 1991 in accordance with generally accepted government auditing standards.

The Future Structure and Pace of the Small ICBM Program Are Uncertain

The Small ICBM full-scale development program is currently structured and paced to support initial deployment in 1997 of single-warhead Small ICBMs on hard mobile launchers at Minuteman launch facilities. However, initial deployment in 1997 cannot be achieved at the funding levels contained in DOD's fiscal years 1992-97 funding plan, primarily because there are no Small ICBM production or construction funds in that plan.

Development of the mobile Small ICBM is continuing as a hedge against future requirements, but DOD plans for fielding the system are uncertain at this time. DOD plans to conduct reviews of U.S. ICBM programs within the context of future threats and mission requirements in late 1991. According to a DOD official, these reviews are expected to result in the Secretary of Defense either reaffirming or changing the structure and pace of the Small ICBM program.

Program Is Currently Structured and Paced to Support Initial Deployment of a Mobile Small ICBM Force in 1997

The Small ICBM full-scale development program is structured and paced in accordance with the direction DOD provided in 1989 when it decided to continue the program at a pace to support initial deployment in 1997 of single-warhead Small ICBMs on hard mobile launchers at Minuteman launch facilities. The intent of deploying the Small ICBM, as defined at the beginning of full-scale development, was to provide an ICBM weapon system with increased retaliatory capability and survivability. In that regard, the highest priority requirement in the validated Small ICBM operational needs statement is for a high probability of target damage. The second priority is for survivability, with mobility the means selected by the Air Force for achieving survivability.

During full-scale development, the program office will conduct developmental and operational ground and flight testing of individual components and of the entire weapon system to verify that the weapon system has been successfully designed and built to satisfy operational requirements. The capability to survive and retaliate with appropriate force and to operate in a mobile environment are critical operational issues to be addressed during testing.

Initial Deployment in 1997 Cannot Be Achieved With the Small ICBM Funding Contained in DOD's 1992-97 Budget

For fiscal year 1992, DOD is requesting $548.8 million for complete resumption of Small ICBM full-scale development. However, DOD's fiscal year 1992-97 budget plan does not contain the Small ICBM funding necessary to support achievement of initial deployment of the system in 1997. In particular, DOD's budget plan does not contain any construction or procurement funds for the Small ICBM program. To begin deployment in 1997, however, construction and procurement funds will be needed beginning in fiscal years 1993 and 1994, respectively, according to the program office.

Compared to the funding profiles associated with the Air Force's approved program cost estimate in the December 31, 1990, SAR, the fiscal years 1992-97 DOD budget plan has about a $6.1 billion Small ICBM funding shortfall—$5.4 billion for procurement, $0.6 billion for construction, and $0.1 billion for research and development. The annual funding shortfall increases every year ranging from $6.6 million in fiscal year 1992 to about $2.4 billion in fiscal year 1997. Table 2.1 identifies the annual Small ICBM funding shortfall, and appendix II contains additional detail.

Table 2.1: Annual Small ICBM Funding Shortfall in the DOD Fiscal Years 1992-97 Budget Based on the Program Office's Estimate of Funding Needed to Achieve Initial Deployment in 1997

Then-year dollars in millions

	Funding shortfall			
Fiscal year	Development	Procurement	Construction	Total
1992	$(6.6)	$0	$0	**$(6.6)**
1993	(9.2)	0	(11.1)	**(20.3)**
1994	(98.9)	(157.9)	(34.3)	**(291.1)**
1995	(106.5)	(1,094.6)	(218.7)	**(1,419.8)**
1996	(29.5)	(1,780.5)	(167.6)	**(1,977.6)**
1997	142.7	(2,378.7)	(174.2)	**(2,410.2)**
Total	**$(108.0)**	**$(5,411.7)**	**$(605.9)**	**$(6,125.6)**

Note: Estimate is based on deployment of 500 Small ICBMs on hard mobile launchers at Minuteman facilities beginning in 1997 and ending in 2008.

Factors Used in Defining the Current Structure of the Small ICBM Program Have Changed

In February and March 1991, in congressional hearings on the fiscal year 1992 DOD budget, DOD and Air Force officials announced that development of the Small ICBM weapon system will continue, but there are no plans at the present time to deploy the missile. In this regard, the Under Secretary of Defense for Policy announced that the ICBM force structure shortly after the year 2000 would be 50 Peacekeepers and 500 Minuteman IIIs. No Small ICBMs are in that force. The SAC Commander-in-Chief stated that continuing Small ICBM development provides a hedge

against long-term requirements to replace the Minuteman III or to introduce mobility into the ICBM force. The Secretary of the Air Force also stated that continuing Small ICBM development protects a choice of a silo or mobile basing mode when changes in the strategic balance become clearer. DOD and Air Force officials cited changes in the international environment, the reduced threat in a post-Strategic Arms Reduction Talks (START) environment, and the high cost to procure and operate mobile ICBMs as the basis for deciding not to commit to Small ICBM deployment at the present time.

The rationale provided by the DOD and Air Force officials for deferring a deployment decision represents changes to the planning assumptions previously used for defining the need for the Small ICBM program. Observations showing the changes in planning assumptions are as follows:

- The decision to advance the Small ICBM program into full-scale development was based, in part, on the "Small ICBM System Threat Assessment Report" that was validated in 1986. However, according to DOD and Air Force statements during fiscal year 1992 budget hearings, the Soviet threat has become less severe, particularly in a post-START environment. DOD and Air Force officials stated that the reduced threat is allowing reductions in U.S. strategic forces.
- The Small ICBM employment concept, as described in the 1986 "SAC System Operational Concepts for Small Single Reentry Vehicle (Hard Mobile Basing)," was based on a U.S. strategic force that is now being reduced. For example, Small ICBM mission needs were originally described assuming a force of 100 Peacekeepers, 500 Minuteman IIIs, and 450 Minuteman IIs. However, in presenting the fiscal year 1990 budget, the Secretary of Defense announced that the number of deployed Peacekeepers would be reduced from 100 to 50. In presenting the fiscal year 1992 budget, the Secretary of Defense announced that the Minuteman II force would be retired beginning in 1992. In addition, Small ICBM mission needs were described within the context of a bomber and submarine force that will also be reduced. According to testimony by DOD officials during DOD's fiscal year 1992 budget hearings, U.S. strategic force reductions reflect changes in U.S. defense strategy and strategic targeting policy and assume a START agreement.

Concerning START, the terms of that agreement, which remains to be ratified, limit the number of warheads on U.S. submarine-launched ballistic missiles and ICBMs to 4,900. Currently, the U.S. ICBM force is comprised of 2,450 warheads—50 ten-warhead Peacekeepers, 450 single-warhead Minuteman IIs, and 500 three-warhead Minuteman IIIs. Deployment of

500 single-warhead Small ICBMs would increase the number of U.S. ICBM warheads to 2,950. Under START warhead limitations, however, the Air Force can only deploy an ICBM force with 1,444 warheads, assuming that 18 Trident submarines are deployed with each having 24 eight-warhead missiles, as currently planned. Therefore, even with the retirement of all Minuteman II missiles, some further reductions in U.S. ICBM warheads will be necessary, either by reducing the number of operational Peacekeeper or Minuteman III missiles, by removing warheads from Peacekeeper or Minuteman III missiles, or by deploying fewer than 500 Small ICBMs.

- The Small ICBM, with its improved capabilities, was initiated to augment rather than replace the Minuteman force in the early 1990s. In March 1991, however, the SAC Commander-in-Chief stated that one need for continuing Small ICBM development is for a hedge against long-term requirements to replace the Minuteman III. In that regard, GAO reported in 1990[1] that the Air Force is planning to maintain the Minuteman III in a launch ready state with a high probability of launch, flight, and target destruction through fiscal year 2008. Therefore, Small ICBM deployment might not be needed as a replacement for Minuteman III until 2008.
- A fundamental premise in initiating the Small ICBM program was to allow greater flexibility in developing basing modes more survivable than existing silos. Missile survivability was the second highest priority requirement in SAC's 1986 validated needs statement. In this regard, during fiscal year 1991 DOD budget hearings, the Secretary of Defense stated that silo-basing for the Small ICBM is possible from a technical standpoint, but silo-basing would defeat the purpose of the President's plans to increase the survivability of the U.S. ICBMs through mobility. In fiscal year 1992 DOD budget hearings, however, the Secretary of the Air Force announced that development of the Small ICBM was continuing to protect an option for deployment in silos.

  Concerning this option, the program office has been directed by Air Force Headquarters not to make any missile design changes that would preclude basing the missile in existing Peacekeeper or Minuteman silos. In this regard, a program office official stated that no specific silo-related development effort is planned. Program office officials also stated that maintaining parallel development efforts for silo and mobile basing would be prohibitively expensive.

[1]Strategic Forces: Minuteman Weapon System Status and Current Issues (GAO/NSIAD-90-242, Sept. 28,1990).

- In 1983, in recommending the single-warhead missile, the President's Commission on Strategic Forces believed there was a need to begin deploying a highly survivable single-warhead missile in the early 1990s. Mobility was the means selected by the Air Force to achieve survivability. During 1992 budget hearings, DOD and Air Force officials acknowledged the need for ICBM mobility but only as a possible requirement in the long term. During these hearings, the SAC Commander-in-Chief stated that a modernized Triad will sustain the capability to execute national strategy for the foreseeable future without a mobile ICBM force.

DOD Plans to Reconsider Future Structure and Pace of the Small ICBM Program

In late 1991, DOD's Defense Acquisition Board and the Board's Strategic Systems Committee plan to conduct separate reviews of a broad range of land-based ICBM issues in the context of future threats and mission requirements: Minuteman II deactivation, Peacekeeper Rail Garrison termination, Minuteman III life extension, and Small ICBM development and deployment. The Defense Acquisition Board is expected to reaffirm the present ICBM modernization program or recommend specific changes. A DOD official stated that, based on advice from the Defense Acquisition Board, Secretary of Defense direction reaffirming or changing the current structure and pace of the Small ICBM program is anticipated, although it has not been specified when that direction will be announced.

Small ICBM issues that are planned to be reviewed include the following:

- Cost estimates and annual funding requirements for the Small ICBM program assuming initial deployment in the fiscal year 1997-98 time frame. Estimates will be provided for force structures of 150, 300, and 500 Small ICBMs. Estimates will also be provided for Small ICBM deployment in (1) mobile launchers as currently planned, (2) Minuteman silos, or (3) Minuteman silos followed by deployment in mobile launchers.
- Program impacts and feasibility of incorporating a low-maintenance, high-reliability guidance system into the current missile design.
- Capability of the Small ICBM to deliver future payloads other than the current single-warhead configuration.
- The feasibility of using the Small ICBM, or a variant of the Small ICBM, as a Minuteman III replacement.

In addition, DOD will review preliminary plans for an advanced development program leading to production and deployment of a mobile-based ICBM paced (1) by initial deployment in 2004 with full deployment of 500

missiles by 2010 or (2) by initial deployment in 2010 with full deployment of 500 missile by 2016.

Conclusions

As a hedge against future requirements, the Air Force is requesting $548.8 million for fiscal year 1992 to continue full-scale development of the mobile ICBM program at a pace to support initial deployment in 1997. At present, DOD deployment plans are uncertain and DOD has also not included any procurement or construction funds in its fiscal years 1992-97 budget plan to support fielding the system in 1997. To achieve initial deployment in 1997, about $6.1 billion would have to be added to DOD's budget plan. DOD's planned reviews of U.S. ICBMs in late 1991 could result in the Secretary of Defense reaffirming or changing the current structure and pace of the Small ICBM program. Until the Secretary provides updated direction on Small ICBM program content, future program funding needs are uncertain.

Matters for Congressional Consideration

The Congress may wish to consider directing the Secretary of Defense to provide a report to the Congress on his decisions regarding the future structure and pace of the Small ICBM program when the Secretary presents the fiscal year 1993 DOD budget. The report should (1) include the cost and key schedule milestones for the Small ICBM acquisition program as defined by the Secretary; (2) identify the annual funding profiles necessary for the development, procurement, and construction actions necessary to complete the program; and (3) confirm the affordability of the defined program.

Several Unresolved Issues Preclude a Meaningful Estimate of Acquisition Costs

In December 1990 the Air Force's planning estimate of acquisition costs for a force of 500 Small ICBMs was about $41.9 billion in then-year dollars. That estimate, however, may not be meaningful. It is based on uncertain assumptions regarding missile quantities, basing locations, and warhead configuration. It may also not adequately reflect the cost impacts of the many programmatic and weapon system design changes that have occurred since the beginning of full-scale development in 1986. In support of the late 1991 DOD reviews of ICBM programs, the Small ICBM program office is preparing a new cost estimate using the same assumptions as the December 1990 estimate concerning force size, weapon system configuration, and initial deployment. This cost estimate will be reviewed by DOD's Cost Analysis Improvement Group to ensure the level of consistency and accuracy that is needed to formulate alternatives and support decisions.

Uncertain Cost Estimating Assumptions

Estimated acquisition costs for the approved Small ICBM program as presented in that program's SAR dated December 31, 1990, were about $41.9 billion. That estimate was developed for planning purposes and assumed the deployment of 500 single-warhead Small ICBMs on hard mobile launchers at three Minuteman bases, with initial deployment in 1997 and full deployment in 2008. Table 3.1 separates the Small ICBM estimated acquisition costs by appropriation account.

Table 3.1: Small ICBM Estimated Acquisition Costs as of December 1990

Then-year dollars in billions

Appropriation	Amounts prior to fiscal year 1992	Amounts from fiscal year 1992 to completion	Total
Research and development	$3.5	$3.6	**$7.2**[a]
Missile procurement	0	31.3	**31.3**
Military construction	0	3.4	**3.4**
Total	**3.5**	**38.3**	**41.9**[a]

[a]Does not add down or across due to rounding.

The December 1990 acquisition cost estimate is, however, subject to change since final decisions remain to be made concerning force size, basing locations, and whether the missiles will have one or two warheads. In addition, there are other uncertainties that could increase or decrease costs. For example, as discussed in chapter 5, concerns have been expressed by a congressional panel about the safety of nuclear weapon systems in the U.S. arsenal. One of the panel's concerns was the acceptability of the combination of the nuclear warhead and high-

energy propellant used by the Small ICBM propulsion motors. That issue is now being evaluated by DOD. An Air Force review of the safety of the Small ICBM design concluded that the Small ICBM missile design is acceptable, and the results of the Air Force review have been submitted to DOD. A final decision by DOD on the safety of the Small ICBM within the context of the full arsenal of U.S. nuclear weapons, however, is not expected until the end of 1991. According to the program office, changing the propellant would increase costs.

Additionally, in the National Defense Authorization Act for fiscal year 1991, the Congress stated that the Air Force should retain the options for both silo-basing of the Small ICBM as well as hard-mobile-launcher basing. A substitution of silo-basing for hard mobile launcher basing would reduce costs. However, according to the program office, costs would increase for either a later change to hard mobile launcher basing or parallel development of silo and hard mobile launcher basing.

Another uncertainty is the number of Small ICBM missiles needed for follow-on operational test and evaluation flight testing.

- For cost estimating purposes, the program office planned to acquire 108 Small ICBMs for SAC's follow-on operational test and evaluation flight test program, as was initially planned for the Peacekeeper program. SAC, however, has reduced its annual Peacekeeper flight testing requirements. Accordingly, as of December 1990, the Air Force was planning to acquire only 49 Peacekeeper missiles for follow-on operational test and evaluation flight testing. The reduction in Peacekeeper test missiles from 108 to 49 may not be final, however, pending actions which could follow a report that the Congress directed the Air Force to prepare concerning the effects of Peacekeeper flight test reductions on the ability to assess system performance. Any change in the number of Peacekeeper missiles needed for operational flight testing could also cause a change in the number of Small ICBMs needed for operational flight testing.
- In addition, the Small ICBM follow-on operational test and evaluation flight test program was based on a 15-year Small ICBM design life. However, the 1986 Small ICBM operational needs statement specified that the Small ICBM must have a minimum 20-year operating life. For a 20-year life, additional missiles would be needed, assuming no change in the required number of annual flights. The number of missiles needed for a 20-year life is dependent upon a final decision on the number of required annual Peacekeeper operational flight tests.

Cost Estimate May Not Fully Reflect Programmatic and Design Changes That Have Occurred

The acquisition cost estimate in the December 31, 1990, Small ICBM SAR was derived from an earlier estimate prepared by the program office in July 1987. The July 1987 estimate of $29.8 billion in base-year 1984 dollars [1] was reviewed and found reasonable by an Air Force independent cost analysis team. Further, it was supported by documentation showing the estimated costs for the individual elements of the weapon system, such as missile components (propulsion stages, guidance and control system components), basing components (hard mobile launcher, weapon control system), and support costs (logistics support, systems engineering). The documentation also identified estimating assumptions, estimating methodologies, and estimating risks for each weapon system component.

Since July 1987, the program office has made several adjustments that have reduced acquisition costs, as of December 31, 1990, to about $24.2 billion in 1984 dollars. (With inflation adjustments, this equates to $41.9 billion in then-year dollars.) To a large extent, the cost reductions reflect a decrease in risk mitigating measures, such as reducing the number of development test flights from 22 to 16. In making adjustments to its July 1987 estimate, the program office revised the estimate for the total amounts required for development, procurement, and construction. It did not, however, make corresponding revisions to the supporting documentation, in particular, the estimated costs for individual elements of the weapon system. As a result, there is no evidence identifying the costs of the individual elements of the weapon system comprising the estimate in the SAR. Without that data, we could not fully analyze that estimate.

On the basis of the information that was available, we believe it is questionable whether the program office's estimate accurately reflects the cost impacts of the many programmatic and weapon system design changes that have occurred since the beginning of full-scale development in 1986.

- The program office estimates that the interruption of the full-scale development program in 1988 will increase development costs about $189 million in 1984 dollars. We wanted to test the adequacy of that estimate through comparisons with the amounts negotiated for major contracts. However, we could not make those comparisons because the program office could not separate its estimated cost of interruption and

[1] Estimates expressed in base-year dollars allow analysis of cost changes without inflationary growth.

extension of full-scale development by the amounts applicable to each of the major development contracts.

- Several changes to the missile design are discussed in chapter 6 of this report. There is no evidence showing that these changes were considered in preparing the estimate of missile development and procurement costs reported in the SAR, or what cost impact these changes had, if any.
- The period between initial and full deployment has been extended from 7 to 11 years, which means that costs could grow because the time for production and delivery of the missiles will be lengthened and the annual production quantities will be reduced. The program office's track of changes to the total estimate of procurement costs does not indicate that this extension had any cost impact.
- Since December 1986, the guidance and control system repair depot has greatly increased its estimate of the amount of depot support equipment and facilities it will need to support the Small ICBM program. In the absence of supporting documentation, we could not determine if the costs of these increases are included in the May 1989 estimate.

Program officials believe the estimate in the SAR is adequate based on their visits to individual Small ICBM weapon system contractors to assess the adequacy of the estimate. Program officials, however, did not have documentation identifying the details of those assessments. The program office also briefed the SAR estimate to DOD Cost Analysis Improvement Group officials, and those officials raised no issues. Nevertheless, to support the late 1991 ICBM programmatic reviews by the Defense Acquisition Board and its Strategic Systems Committee, the Small ICBM program office is preparing a new cost estimate using the same estimating assumptions as the SAR estimate concerning force size, weapon system configuration, and initial deployment.

Conclusions

The cost of the Small ICBM program within the context of other weapon system funding priorities has historically been a major issue affecting the progress of the Small ICBM program and, therefore, should be an essential consideration in deciding to continue the program. To support an assessment of the affordability of the Small ICBM program within the context of other funding priorities, we believe that a current, fully documented, and independently verified Small ICBM cost estimate is necessary.

At the time we prepared this report, the adequacy of the Air Force's Small ICBM acquisition cost estimate was questionable. The program

office was preparing a fully documented revised Small ICBM baseline program acquisition cost estimate to be used during the upcoming ICBM reviews later this year. The reliability of that estimate as a basis for a credible affordability assessment will depend on the extent to which the estimate addresses the cost issues discussed in this report and the results of a planned review of the estimate by DOD's Cost Analysis Improvement Group.

Schedule Contains Some Risk

The Small ICBM program is paced to initial deployment in December 1997. To accomplish that objective, the program office has developed a schedule with some risk, which it believes is manageable.

Acquisition Schedule Milestones Have Been Extended

In December 1986, when full-scale development began, the Small ICBM was paced to initial deployment in December 1992. In April 1988, the Small ICBM program was restructured in response to DOD plans to terminate the program by the end of September 1989 because DOD believed the Small ICBM was not cost effective when compared with other strategic alternatives. The program restructure involved halting full-scale development but continuing some missile-related development necessary to support two flight tests before termination. In April 1989, however, the Secretary of Defense decided to continue with the Small ICBM program because of the operational flexibility offered by a single-warhead missile in a survivable basing mode. Because of funding constraints, however, development during fiscal years 1990 and 1991 was primarily missile-related. The Air Force does not plan to restart full-scale development of the hard mobile launcher and weapon control system until fiscal year 1992. The full-scale development program is currently paced to support initial deployment of the weapon system in December 1997, a 5-year delay. According to Air Force officials, initial deployment in December 1997 is the earliest date achievable within DOD funding constraints. Table 4.1 identifies changes in selected schedule milestones.

Table 4.1: Comparison of Selected Key Schedule Milestones at the START of Full-Scale Development With Present Schedule Milestones

Milestone	Start of development	Present schedule
Begin full-scale development	Dec. 1986[a]	Dec. 1986[a]
Complete system design review	May 1987[a]	May 1987[a]
Complete preliminary design reviews[b]	June 1988	Mar. 1993
Third flight test[c]	—	Apr.-June 1993
Start construction	—	Mar. 1993
Complete critical design reviews	Nov. 1989	Aug. 1994
Initial production contract awards	Jan. 1990	Jan. 1995
Initial operational capability	Dec. 1992	Dec. 1997
Full operational capability[d]	June 1999	Dec. 2008

[a]The actual date the milestone was achieved.

[b]In April 1988, when full-scale design development was interrupted, some but not all preliminary design reviews for weapon system components had been completed. For example, preliminary design reviews for the hard mobile launcher and weapon control system were not completed.

[c]The first flight test after restart of full-scale development of the entire weapon system in fiscal year 1992. It is also the first missile flight incorporating most of the missile components redesigned to correct early development problems. One test flight of the earlier missile design was conducted and failed after launch because of a faulty stage II propulsion motor exit cone. A second flight of the earlier missile design, but with a redesigned stage II exit cone, was successfully conducted in April 1991.

[d]The full operational capability date for a deployed force of 500 Small ICBMs on hard mobile launchers at three Minuteman bases.

The above schedule milestones, however, are subject to change. Alternative Small ICBM deployment schedules, with initial deployment delayed to as late as 2010, will be considered by DOD during its late 1991 reviews of ICBM programs.

Acquisition Schedule Contains Some Risk

The program office schedule leading to initial deployment in 1997 contains some schedule risks. Examples of the risks are discussed below.

- According to the program office, starting missile development 2 years before restarting full-scale development of the hard mobile launcher and weapon control system adds risk to the acquisition schedule because it does not allow for the proper phasing of missile and basing development.
- Because of funding constraints, resumption of full-scale development of the weapon control system was delayed until fiscal year 1992. Yet, according to the program office, weapon control system development is the program's greatest challenge. Furthermore, weapon control system development lags the development of other weapon system components, and significant development efforts remain.

- There is some concurrency—overlap between development and production activities—in the acquisition schedule. For example, development will continue through the 1990s with production beginning in 1995. In addition, production begins in January 1995, about a year before the scheduled first weapon system flight—the first missile launch from a hard mobile launcher.

Program officials acknowledged that, to accommodate available funding, the current acquisition schedule leading to initial deployment in 1997 does include risks, such as concurrency, but they believe those risks are manageable, if funding needs are met. Further, the future pace of the Small ICBM program is subject to change pending the completion of late 1991 reviews of land-based ICBM programmatic issues. Consequently, schedule risks may change.

Challenges Remain in Meeting Target Damage and Range Capability Needs

The Small ICBM missile must have the capability to effectively attack soft to super-hard targets and the range to cover the designated target base. The capability to meet these goals is uncertain as missile development resumes. Having the capability to effectively attack hardened facilities, such as silos, depends on the future implementation and success of missile improvements under consideration. Meeting the range requirements partially depends on successfully controlling missile weight. While the Air Force is confident of meeting these needs, the Small ICBM SAR does not provide sufficient information to permit meaningful congressional oversight.

Meeting the Need for Effective Target Damage Capability Will Be Challenging

Target damage capability is a function of missile accuracy, target hardness, missile warhead yield, and the height of warhead detonation. Whether the Small ICBM missile will have the capability to effectively damage hardened facilities is uncertain, and achieving that objective will be challenging.

First, while progress has been made in evaluating the capability of a mobile Small ICBM to meet its accuracy specification, further testing is required to demonstrate fully that the design specification can be met:

- The current estimate for operational accuracy being achieved by the Peacekeeper missile,[1] as reported in the Peacekeeper program's SAR dated December 31, 1990, is a little better than the Small ICBM design specification. However, Peacekeepers are launched from fixed silos. The challenge for the Small ICBM program is demonstrating the capability to achieve the accuracy specification after mobility.
- According to program officials, initial Small ICBM program testing of the inertial measurement unit showed that the effect of mobility on accuracy can be mitigated, and the Small ICBM accuracy specification can be achieved after mobility. Land mobile accuracy studies were stopped, however, when full-scale development ceased in 1988. Related Peacekeeper Rail Garrison mobility testing of the inertial measurement unit, however, has since been conducted and has given the Small ICBM program office added assurance that specification accuracy could be restored after mobility within prescribed time frames. Program officials stated, however, that more conclusive testing is needed and planned. Land mobile accuracy studies of the complete guidance and control

[1]The Small ICBM guidance and control system currently uses the same inertial measurement unit as the Peacekeeper missile. The inertial measurement unit provides the data used by the guidance and control computer to guide the missile to its target. Air Force officials presently gauge the potential for achieving Small ICBM accuracy based on Peacekeeper experience.

system in a laboratory environment will resume when the contract is awarded in 1991 for restarting development of the Small ICBM guidance and control system. Testing of a guidance and control system installed in a missile on a hard mobile launcher is planned during 1995. The purpose of this testing is to verify the capability of the guidance system to restore accuracy within specified times after mobility in an integrated weapon system operational environment.

Second, at the levels of target hardness used in defining the target damage requirement in 1986, better missile accuracy than the design specification or better height-of-burst accuracy will be required to achieve the target damage requirement, and the following improvements are being considered:

- The Peacekeeper program office is planning a guidance and control accuracy improvement program with the objective of achieving about a 25-percent improvement in accuracy. Small ICBM program officials advised us that the scope of that program should be defined by 1992, with hardware and software changes to follow. The extent of missile accuracy improvement will not be known with reasonable confidence, however, until 1994. If 25 percent better accuracy is achieved, the Small ICBM damage requirement can be met.
- Concerning height-of-burst accuracy, the Small ICBM program office is considering a warhead fuze modification, as discussed in chapter 6, that could achieve a more exact height-of-burst detonation. A decision whether to implement the modification is expected by early 1993. If that modification is made and achieves the expected improvement in height-of-burst accuracy, the target damage capability can be met at the missile accuracy design specification.

Finally, DOD has substantially increased its assessment of the hardness of the targets used in defining the target damage requirement in 1986. To maintain the required level of target damage against this increased target hardness, further improvement in accuracy and other factors would be necessary, assuming no increase in warhead yield, in order to meet the requirement for target damage. Program officials stated that the combination of a 25-percent improvement in accuracy and the improvement in height-of-burst accuracy expected from the proposed fuze modification will allow the target damage requirement to be met against the target hardness as currently assessed.

Sustaining the Capability to Meet the Missile Range Requirement Depends on Limiting Future Missile Weight Growth

The Small ICBM missile currently must have a range of about 6,000 nautical miles to cover the entire Soviet target spectrum from basing locations in the southwestern United States. As of January 1991, the missile, with a single reentry vehicle and penetration aids, had an estimated range of about 6,165 nautical miles. Sustaining the capability to meet the range requirement depends, at least in part, on limiting future missile weight growth. As of January 1991, the projected missile weight with penetration aids was 37,767 pounds—897 pounds greater than the July 1986 design specification. Additional weight growth ranging from 30 to 350 pounds, depending on the affected missile component, can be accommodated without reducing range below the 6,000 nautical mile requirement. On the basis of our past reviews of the Peacekeeper program, we believe the potential for continued weight growth and possible range reduction will exist until the missile design has been proven through additional test and evaluation. Program officials, however, expressed confidence in being able to meet the range requirement.

In addition, nuclear weapon safety concerns discussed in a report by the Committee on Armed Services, House of Representatives, dated December 1990, raise questions about the safety of the combination of a nuclear warhead and the high-energy propellant used in the Small ICBM propulsion motors. We were told by Department of Energy officials that the Small ICBM warhead design has all the improvements recommended in the House report. Further, an Air Force review of the safety of the Small ICBM missile design concluded that the design was acceptable, and the results of the Air Force review have been submitted to DOD. A final decision by DOD on the safety of the Small ICBM within the context of the full arsenal of U.S. nuclear weapons, however, is not expected until the end of calendar year 1991. According to the program office, a change to an alternative propellant would greatly increase missile weight and/or substantially reduce range below the 6,000 nautical mile requirement (more of the alternative propellant would be needed to boost the missile to the same range).

Target Damage and Range Performance Parameters Are Not Being Fully Disclosed in the Small ICBM SAR

SARs are submitted by DOD to the Congress to provide information on the status of major defense weapon system acquisition programs, including information on selected weapon system technical and operational characteristics. The December 31, 1990, Small ICBM SAR, however, does not provide sufficient information to permit meaningful congressional oversight of the progress made in developing the capability to meet target damage and range requirements.

In reviewing the Small ICBM SAR, dated December 31, 1990, we noted the following limitations:

- Target damage, accuracy, and range capability were reported in the SAR, but the capabilities being reported were only the level required by the weapon system specification. Target damage, accuracy, and range capabilities representing technical progress to date and/or the capabilities expected at the completion of development are not being reported. As discussed earlier in this chapter, accuracy and range capabilities expected at the completion of development and/or representing current progress to date are available. Since target damage is partially a function of accuracy, current or future projections of target damage using available accuracy data could also be reported.
- Missile weight is also reported in the SAR, but only a generalized weight of 37,000 pounds. The estimated missile weight, with penetration aids, which in December 1990 was about 37,800 pounds was, however, not reported.

Conclusions

The ability of the Small ICBM weapon system to effectively damage hardened facilities, such as silos, depends on the future implementation and success of programs to improve accuracy and to redesign the warhead fuze. Likewise, the system's ability to meet its range requirements is dependent upon the Air Force's success in controlling future weight growth of the missile. Program office officials are confident that the system's capability to meet target damage and range capability needs will be proven before the decision to begin production, which is currently scheduled in January 1995. In the meantime, however, congressional oversight and DOD's monitoring of progress would be better served through more comprehensive reporting in the Small ICBM SAR.

Recommendation

We recommend that the Secretary of Defense direct that target damage, accuracy, range, and weight information in the Small ICBM SAR be expanded to show the capabilities being achieved in the development

and testing program to date and the latest forecast of expected performance.

Agency Comments and Our Evaluation

Officials in the Office of the Secretary of Defense and the Air Force reviewed a draft of this report and provided informal comments. Regarding our recommendation, these officials stated that the data currently being reported in the Small ICBM SAR meets reporting requirements. We do not disagree. However, SAR reporting guidance also allows for additional information to be reported, as we recommend, if that information would provide a better understanding of the program. The information that we are recommending be included in the Small ICBM SAR is available and, in our view, would enhance oversight of the progress being made on the program.

Status of Missile Design

Progress has been made in designing and developing the Small ICBM missile, but unresolved issues remain. First, the success of design changes to correct technical and producibility problems with the missile's propulsion system components remains to be conclusively demonstrated. The first flight of the Small ICBM with most of the design improvements is planned for the second quarter of calendar year 1993. Second, the success of changes to improve the reliability of the guidance and control system's inertial measurement unit will not be conclusively demonstrated until December 1992. Third, a modification needed to meet the requirement for a reliable proximity fuze remains unfunded. Fourth, warhead development has yet to resume, and availability of a particular nuclear component is uncertain.

Missile Design Issues

According to the Air Force, the Small ICBM pre-full-scale development effort successfully demonstrated the viability of critical missile technologies. However, after about the first year of full-scale development, as missile technologies were integrated and tested in complete system environments, technical problems began occurring. Also, some contractors were experiencing difficulties in producing certain missile components. These problems were causing some cost growth and schedule delays at the time when full-scale development was interrupted in April 1988.

In addition, missile design problems delayed the successful launch of a Small ICBM. In calendar year 1989, the Air Force planned to have two Small ICBM test flights. In May 1989, the first missile was launched but was destroyed after about 2 minutes into the flight because the stage II exit cone failed. The second flight was scheduled for 6 months later but was delayed until November 1990 because of the first flight failure. However, the second flight did not occur in November 1990 because the missile failed to properly transition from ground to airborne battery power. Subsequent investigations revealed that the source of the problem was a failure in the battery used to power the flight safety system that is used only on test flight missiles. The second flight test was successfully conducted on April 18, 1991. According to the program office, all mission objectives were achieved, and the missile demonstrated accuracy better than the Small ICBM specification.

The program office stated that the problems encountered to date represent the normal evolution of a design during full-scale development. Nevertheless, the interruption of full-scale development has given the Small ICBM program office an opportunity to reevaluate the missile design and make technical, producibility, and other improvements to

several missile subsystems to correct problems known in April 1988 and problems that have subsequently been identified. However, the effectiveness of the improvements remains to be fully tested. Numerous ground tests are planned during 1991-93. Those tests will lead to the first flight of a missile with most of the design improvements. That test flight is scheduled for the second quarter of calendar year 1993. The program office, however, is confident that, based on the evaluation and ground testing it has already conducted, the current missile design is producible and will meet performance requirements.

The following sections discuss issues related to the Small ICBM's propulsion system, the guidance and control system and the reentry vehicle.

Propulsion System

The Small ICBM propulsion system is made of three propulsion motors, a post-boost vehicle, and an ordnance firing system. The three propulsion motors each contain high-energy propellant, which provides the thrust necessary to launch the payload to its 6,000 nautical mile range requirement. The post-boost vehicle contains the warhead, as well as other equipment, and once guided to the desired position, it deploys the payload. The ordnance firing system is used to ignite the propellant, as well as to initiate various other events involved in missile launch and flight.

The Air Force is currently implementing several redesigns to the propulsion system to correct various performance and producibility problems identified during the Small ICBM ground and flight test program. That program was designed to test the design and identify design problems as early as possible. Implementing these redesigns now, instead of further along in the program, has increased the program office's confidence in the maturity of its propulsion system design.

Propulsion Motors

Redesigns of components for each of the three propulsion motors are being made as discussed below.

- The thrust vector actuator, when signaled by the guidance system computer, moves the exit cone assembly, which in turn changes the missile's flight path. The original designs were chosen because of their light weight; however, they were not strong enough to provide the performance required.
- For stage I, canister launch testing revealed that the pressure in the bottom of the canister, generated to launch the missile, was greater than

expected. However, the actuator was not strong enough to withstand the higher pressure.

- For stages II and III, simulated subscale firing and separation testing revealed that more force was being exerted on the exit cones than had previously been calculated. This condition precluded the actuators from adequately moving the exit cone assemblies.

  The three propulsion motor contractors are currently redesigning the actuators. The new designs will strengthen the actuators and allow them to handle the worst-case pressure and force characteristics that would be encountered in an operational environment. The new actuators will first be flown on the third flight test, scheduled for 1993.

- After test firings of the stage I motor, the Air Force found that as the propellant burned it created some excess aluminum oxide, that collected at the bottom of the motor. The additional aluminum oxide was not considered a serious problem until after the first flight test. The amount of aluminum oxide, calculated after the first flight test, was found to be approximately 300 pounds. This concerned the Air Force because this amount of excess aluminum oxide could potentially cause some control problems during an operational flight. As a result, the Air Force has decided to redesign the stage I motor to allow the aluminum oxide to flow out the exit cone as the propellant burns, rather than collect at the bottom of the motor. The new design will first be flown on the third flight test in 1993.
- A faulty stage II exit cone caused the first flight test missile to be destroyed after launch because it disintegrated. The Air Force believes the material used to make the cone differed from previously tested exit cones and did not have the material property characteristics necessary to deliver the best performance. The program office has decided to replace the stage II exit cone with one made of heavier, Peacekeeper-proven material. The new exit cone was successfully flown on the second flight test in April 1991.
- The casting of the second flight proof test motor, in March 1988, indicated a very low propellant-to-insulator bond peel strength—a measure of the quality of a motor case loaded with propellant is the strength of the bond between the propellant and the case insulation. A subsequent investigation pinpointed the problem to be the rubber formula used in the insulator. In 1991, after studying alternative corrective actions, the program office directed the contractor to change the insulator formulation and install a liner between the insulator and the propellant, as is done on the Peacekeeper motors. Program officials stated these are proven technologies and expect no further problems.

Post-Boost Vehicle

The post-boost vehicle is undergoing two producibility simplifications to its original design. First, the design of the skirt, an external shell that encases the various items housed in the post-boost vehicle, had to be changed. The original design, chosen because of its light weight, was not easily producible. The contractor has opted for another configuration for the skirt, which is simpler to produce. The second redesign involves the payload deck, the platform on which the reentry vehicle rests. In order to improve producibility, the contractor is changing from a 43 piece-part design to casting the center spool of the deck as a single item. The two new designs will first be flown on the third flight test in 1993.

Ordnance Firing System

The Small ICBM laser ordnance firing system was a completely new and innovative approach to ICBM ordnance firing systems and was chosen because of its light weight. The laser system began having producibility problems, however, when the contractor started developing and integrating hardware in full-scale development. The major cause of the problems stemmed from the built-in test capability, particularly the technique of optical splitting of the laser beams. Due to these problems, at the time of partial termination of the program, the contractor was estimating a cost overrun of about $11 million at contract completion. In addition to the cost overrun, the contractor was also behind schedule in delivering the completed firing systems. For example, the delivery of the system for the first flight test was delayed 5 months.

The laser ordnance firing system used on the first test flight performed well; however, the laser firing unit, used to ignite the propellant, was essentially handmade, and future producibility of the unit was a big concern to the Air Force. As a result, the Air Force directed the contractor to conduct a producibility study to suggest other design options for the laser firing unit to make it more producible. After completing the study, Hercules suggested a simpler design that combines both proven electrical ordnance designs with the new laser technology. Optical splitting of laser beams was eliminated. The Air Force plans to fly the new design on the third flight test in 1993.

Guidance and Control System

The Small ICBM guidance and control system, housed in the post-boost vehicle, controls the missile prior to and after launch. It is primarily responsible for monitoring missile functions, as well as keeping the missile on its designated flight path. The major components of the guidance and control system include the electronic computer assembly, the inertial measurement unit, and the airborne power supply. The electronic

computer assembly contains the operational ground and flight programs, while the inertial measurement unit provides inertial acceleration and attitude data used in the navigation, guidance, and control of the missile. Guidance and control design improvements that are underway and unresolved issues are discussed below.

Electronic Computer Assembly

Due to the 5-year stretch-out of the Small ICBM program, the program office determined that its electronic computer assembly design might not be supportable in the late 1990 and early 2000 time frame. They were concerned that the technology used on the assembly was not current with the present industry standard. The program office did not want to move forward with an unsupportable design; therefore, it decided to upgrade the electronic computer assembly.

According to a program official, the upgraded assembly will utilize newer miniaturized electronic circuitry technology that will decrease weight and reduce costs. Additionally, the newer miniaturized electronic circuitry is much less susceptible to upset in a nuclear environment. The program office can now plan for an operate-through capability, which means the memory and the central processing unit will not be disturbed during a nuclear event. Because of the change to the newer miniaturized electronics, the program office was also able to take advantage of memory technology advancements and has changed to a more compact, and lighter, memory type.

The advanced electronic computer assembly, which incorporates the above changes, will first be flown on the sixth flight test, currently scheduled for the fourth quarter of 1994. Most other design changes to the missile will first be flight tested on the third flight test in 1993. The reason for the delay in flight testing the new computer assembly is the time involved in developing and testing electronic components.

Inertial Measurement Unit

The Small ICBM will use the same guidance and control system inertial measurement unit as the already deployed Peacekeeper weapon system. Greater than expected failure rates of inertial measurement units in operational Peacekeeper missiles has been a Peacekeeper program concern since initial operational capability was attained in 1986. Although recent corrective actions have increased reliability, further improvement is needed. The Air Force is currently implementing another corrective action that is expected to further improve reliability. However, it will not be conclusively known if the Peacekeeper inertial measurement unit reliability goal will be met until approximately December 1992. The

reliability specification for stationary operation of the Small ICBM inertial measurement unit is the same as the Peacekeeper specification. Given the potentially large number of Small ICBMs to be deployed, less than specified reliability could have significant operation and maintenance cost implications.

Another inertial measurement unit issue is the availability of electronic components needed to produce those units for the Small ICBM program. Because DOD has decided to deploy only 50 Peacekeeper missiles, production of the inertial measurement unit for the Peacekeeper will cease before production for the Small ICBM begins. As a result, suppliers for some electronic components may no longer be available for the Small ICBM program. The program office evaluated this condition and identified the components of most concern. In October 1991, the Small ICBM program plans to award contracts to ensure the availability of electronic components for the Small ICBM production program.

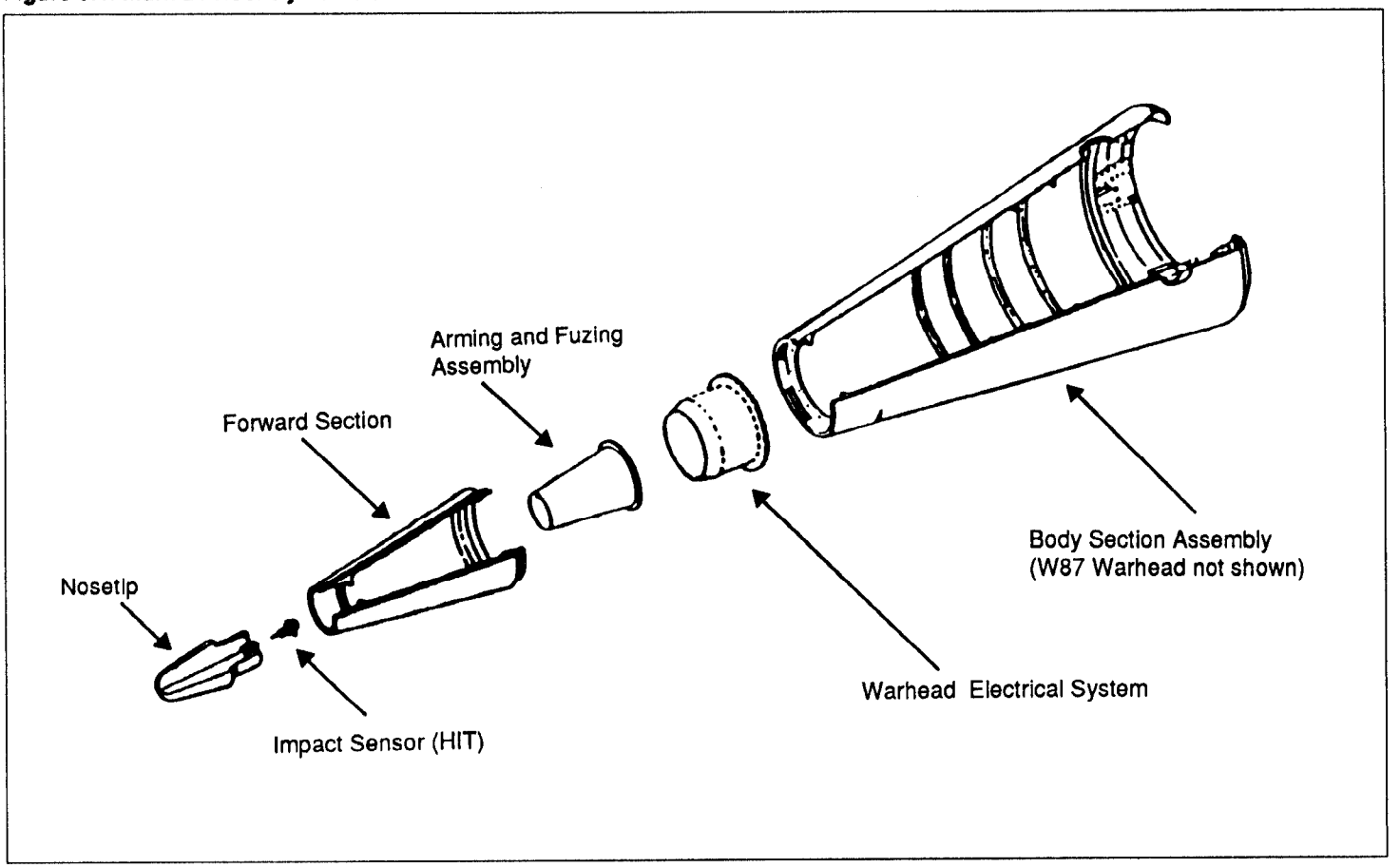
Guidance and Control Power Supply

The supplier of the battery used to supply airborne power for the guidance and control system, as well as other missile components, went out of business after partial termination of the program. This action left no other qualified sources available to supply the program with the needed lithium batteries. The program office is aware of the problem and is currently looking both at alternative lithium battery suppliers and at different battery configurations. After studying and testing the various alternatives the program office plans to choose either a new lithium battery supplier or a new battery type in March 1992.

Reentry Vehicle

The Small ICBM will use the same reentry vehicle to deliver its warheads as the Peacekeeper. The reentry vehicle is a cone shaped assembly designed to protect the internally located warhead in the various environments it will encounter during reentry. A key component of the reentry vehicle is the arming and fuzing assembly, which is responsible for detonating the warhead (see figure 6.1).

Figure 6.1: Mark 21 Reentry Vehicle



Arming and Fuzing Assembly

The production of Peacekeeper arming and fuzing assemblies will cease before the production of Small ICBM arming and fuzing assemblies begins. Because of this stoppage, as well as the break in inertial measurement unit production, suppliers of some electronic components may no longer be available for the Small ICBM program. This issue is being studied by the program office. One alternative being considered is maintaining the current design and requalifying suppliers. Another alternative being considered is redesigning the fuze both to resolve the parts availability issue and to improve the ability of the fuze to detonate the warhead at the most optimum altitude. The program office expects to complete its study of alternatives in early 1992 and decide on the fuze design by early 1993. If the program office decides to modify the fuze to improve performance, the first scheduled missile flight test with the modified fuze would be in the second quarter of calendar year 1995.

An unresolved fuzing issue is the need for a proximity fuze as an alternative for terrain and reentry conditions where the contact fuze may not be suitable. In October 1989, the Air Force directed the Peacekeeper program office to develop a reliable proximity fuze and the Small ICBM program office to retain the ability to use that fuze. Department of Energy officials advised us that a reliable proximity fuze is needed for both the Peacekeeper and Small ICBM missiles. The feasibility of a modification to the current fuze that provides improved reliability has been demonstrated by the Peacekeeper program office. Further development of this modification has, however, been suspended awaiting funds from SAC. SAC officials stated they are still assessing the need for a reliable proximity fuze.

Warhead

According to Department of Energy officials, Small ICBM warhead development effort stopped when full-scale development of the missile ceased in 1988. At that time, the Department of Energy had not yet done any component testing to evaluate the ability of the warhead to survive the stresses associated with a mobile environment and still be safe and effective. As of July 1991, the Department of Energy has not been directed to resume warhead development. However, Department of Energy officials stated that warhead development must be restarted in fiscal year 1993 to support initial deployment in 1997.

A current unresolved issue is the lack of the assured availability of a particular nuclear component for the warhead. According to Department of Energy officials, the only Department of Energy facility that manufactures that component has not been in operation for over a year. It was expected to resume operations during 1990, but now it is not expected to resume operations until January 1992.

Small ICBM Program Evolution

The Small ICBM program began as a result of recommendations made by the President's Commission on Strategic Forces in 1983. The Commission believed that a Small ICBM, possessing a capability to place Soviet hard targets at risk, could allow greater flexibility in developing basing concepts more survivable than existing U.S. silos. The Commission's recommendations were endorsed by the President and approved by the Congress in May 1983.

Evolution Prior to the Beginning of Full-Scale Development

In 1984, the Air Force validated the "Statement of Need, Small Single Reentry Vehicle ICBM." This document, prepared by SAC, describes a single reentry vehicle ICBM as essential to satisfy targeting requirements. Further, the flexibility afforded by a single reentry vehicle would permit more efficient targeting than a multiple reentry vehicle ICBM. The needs document also stated that a single-warhead Small ICBM system must have the capability to attack fixed targets, relocatable targets, and time-urgent targets throughout the spectrum of conflict. In addition, the 1984 statement of need stipulated that the Small ICBM must begin deployment not later than 1992.

During the period 1983 to 1986, the Air Force developed and demonstrated technologies for a 30,000-pound, single-warhead Small ICBM and a hard mobile launcher with initial deployment at DOD and/or Department of Energy installations planned for 1992.

In December 1986, DOD approved advancement of the Small ICBM weapon system into full-scale development. The system configuration selected was a single-warhead, 37,000-pound Small ICBM on hard mobile launchers deployed at Minuteman launch facilities. The weight of the missile was increased from 30,000 pounds to 37,000 pounds to allow greater payload flexibility, particularly the ability to carry penetration aids.[1] Initial deployment was still scheduled for 1992.

Alternative configurations considered and rejected in deciding on the Small ICBM configuration to advance into full-scale development were a two-warhead missile, hardened silos, and random movement basing of hard mobile launchers at DOD and/or Department of Energy installations.[2]

[1]Penetration aids are items, such as decoys, carried on a missile specifically to assist the reentry vehicle get through ballistic missile defense.

[2]Stationing the Small ICBMs at DOD and Department of Energy installations involves randomly moving the Small ICBMs on mobile launchers to different locations on those installations.

- A two-warhead missile was rejected, in part, because it could not be deployed in 1992.[3]
- Hardened silos were rejected because DOD believed the Soviets could develop missile technologies that could destroy them.
- Random movement basing at southwestern military and Department of Energy installations was rejected for cost reasons, but the Air Force was directed to protect the capability for random movement basing, if necessary to counter future threat changes.

As required by DOD and the Air Force, the threat and system operational concept for a single-warhead mobile Small ICBM were defined in 1986 for use in deciding whether to advance the Small ICBM program into full-scale development. These decision parameters were presented in "Small ICBM System Threat Assessment Report" and "SAC System Operational Concept for Small Single Reentry Vehicle ICBM (Hard Mobile Basing)" documents. In addition, SAC updated the Small ICBM statement of need. The statement of need listed 34 operational and support requirements for the Small ICBM. The highest priority requirement was for the capability to achieve a high probability of target damage. The second priority was for survivability, with mobility being the means of achieving survivability. The sixth priority was for the system not only to survive but to have an enduring capability to maintain launch capability for a period of time after attack. The needs statement also reaffirmed the need for initial deployment in 1992 but as a goal rather than a requirement.

Evolution Since the Beginning of Full-Scale Development

Through 1987, 1 year after it began full-scale development, the Small ICBM program was on track to initial deployment in 1992. Subsequently, however, affordability concerns slowed the pace of development and delayed initial deployment to potentially 1997. Full-scale development was stopped in 1988 and partially resumed in 1990. During 1988-91, development was primarily missile-related. In 1992, the Air Force plans to complete the process of resuming full-scale development of the entire Small ICBM weapon system by restarting full-scale development of the hard mobile launcher and weapon control system. The development program is currently paced to support potential initial deployment in 1997.

A discussion of Small ICBM program redirection and/or restructures that have occurred since the beginning of full-scale development follows:

[3]Equipping the Small ICBM missile with two warheads is being reconsidered by the Air Force with a decision on Small ICBM warhead configuration expected in fiscal year 1992.

- In December 1987, the program received a fiscal year 1988 appropriation of $700 million, about $1 billion less than was needed. Therefore, in January 1988, the program office restructured its activities. It continued the missile and basing portions of the program, delayed some development activities or deferred them until later in the program, and deleted a few tasks. In restructuring the program, the program office assumed that the Congress would appropriate approximately $1 billion in fiscal year 1989. Program officials stated that, although this restructure increased concurrency due to deferred development, initial deployment in 1992 was still attainable.
- In presenting the fiscal year 1989 DOD budget to the Congress in February 1988, the Secretary of Defense recommended terminating the program. In discussing the rationale for this recommendation during congressional hearings, DOD and Air Force officials stated that the Small ICBM was not cost effective when compared with other strategic alternative, such as the Peacekeeper Rail Garrison basing concept. The Assistant Secretary of the Air Force for Acquisition stated that the Rail Garrison basing mode met the majority of Air Force needs, met them sooner, and at a price that allowed the pursuit of other defense priorities.

  Warning time was an issue explored in depth in deciding whether or not to go forward with the Small ICBM. One of the advantages of the Small ICBM compared to Rail Garrison is the ability to survive a "bolt-out-of-the-blue" (surprise) attack scenario. Both DOD and Air Force officials testified that, considering other U.S. strategic force capabilities, the Small ICBM was not needed for that scenario.

  In response to congressional concerns, however, DOD requested $200 million for fiscal year 1989 so the next administration would have the option to continue the program. Accordingly, on April 1, 1988, the Air Force restructured the program again. This restructured program consisted mainly of missile development activities and hardware deliveries supporting two flight tests, with program termination planned by the end of fiscal year 1989. Program officials advised us that the program was no longer in full-scale development after the restructure and initial deployment in 1992 was no longer attainable.

- In presenting the revised fiscal year 1990 budget to the Congress in April 1989, the Secretary of Defense announced that President Bush had decided to go forward with both the Peacekeeper Rail Garrison and the Small ICBM systems. In discussing the rationale for this action during congressional hearings, DOD and Air Force officials cited the need for the

operational flexibility offered by a single-warhead missile in a survivable basing mode. Also, the Under Secretary of Defense for Policy stated that continued development of the Small ICBM was needed as a hedge against a bolt-out-of-the-blue attack scenario.

Because of the immediacy of the threat, the maturity of the technology, and the fiscal situation, 50 Peacekeepers in Rail Garrison basing would be deployed first, with Small ICBM deployment deferred until fiscal year 1997. Due to funding constraints, Small ICBM weapon system development during 1990 and 1991 was principally missile-related. The Air Force does not plan to restart Small ICBM basing-related full-scale development until fiscal year 1992.

- In February and March 1991 congressional hearings on the fiscal year 1992 DOD budget, DOD and the Air Force announced that plans to rebase 50 Peacekeepers in the Rail Garrison basing mode have been dropped but development of the Small ICBM weapon system would continue as a hedge against future requirements. DOD has no plans at present, however, to deploy the Small ICBM. The SAC Commander-in-Chief stated that a modernized Triad would sustain the capability to execute national strategy for the foreseeable future without a mobile ICBM force. DOD and Air Force officials cited changes in the international environment, the reduced threat in a post-START environment, and the high cost to procure and operate mobile ICBMs as the basis for the restructuring of ICBM modernization.

  Concerning the Small ICBM, the SAC Commander-in-Chief stated that continuing Small ICBM development provided a hedge against long-term requirements to replace the Minuteman III and/or to introduce mobility into the ICBM force. The Secretary of the Air Force stated that a choice of a silo or mobile basing mode for the Small ICBM could be made when changes in the strategic balance become clearer.

  At present, the Small ICBM development program is structured to support the initial deployment of Small ICBMs on hard mobile launchers in 1997; however, DOD has no plans at the present time to deploy the Small ICBM. In late 1991, DOD plans reviews of land-based ICBM programs. The structure and pace of the Small ICBM program is expected to be redefined after the completion of those reviews.

Comparison of the Program Office's Estimate of Funding Needs With Amounts in DOD's Fiscal Years 1992-97 Budget Plan

Then-year dollars in millions

	Development			Procurement			Construction			
Fiscal year	Program office	DOD	Variance	Program office	DOD	Variance	Program office	DOD	Variance	Total variance
1992	$555.4	$548.8	$(6.6)	$0	$0	$0	$0	$0	$0	**$(6.6)**
1993	598.9	589.7[a]	(9.2)	0	0	0	11.1	0	(11.1)	**(20.3)**
1994	703.4	604.5[a]	(98.9)	157.9	0	(157.9)	34.3	0	(34.3)	**(291.1)**
1995	735.9	629.4	(106.5)	1,094.6	0	(1,094.6)	218.7	0	(218.7)	**(1,419.8)**
1996	609.7	580.2	(29.5)	1,780.5	0	(1,780.5)	167.6	0	(167.6)	**(1,977.6)**
1997	298.1	440.4	142.3	2,378.7	0	(2,378.7)	174.2	0	(174.2)	**(2,410.6)**
Total	**$3,501.4**	**$3,393.0**	**$(108.4)**	**$5,411.7**	**$0**	**$(5,411.7)**	**$605.9**	**$0**	**$(605.9)**	**$(6,126.0)**

Note: Program office amounts are part of the approved program estimate presented in the December 31, 1990, Small ICBM SAR. That estimate is based on deployment of 500 Small ICBMs on hard mobile launchers at Minuteman facilities beginning in 1997 and ending in 2008. The program office amounts in then-year dollars were updated by GAO using DOD's January 1991 inflation indices, since the amounts in DOD's fiscal years 1992-97 budget plan are based on those same indices.

[a]Figures do not include $125 million each year that DOD included in its budget plan as a contingency for a possible change in missile propellant. (See chapter 5 for additional details.)

Contractors Visited

Contractor	Component(s)
Aerojet-General Corp. Aerojet Solid Propulsion Sacramento, CA	Stage II
Hercules Inc. Aerospace Products Group Bacchus Works Magna, UT	Stage III and Ordnance Firing System
Martin Marietta Corp. Denver, CO	Post-Boost Vehicle, Systems Support, and Test Support
Rockwell International Corp. Autonetics ICBM Systems Div. Anaheim, CA	Guidance and Control Integration
Thiokol Corp. Wasatch Division Brigham City, UT	Stage I and Flight Termination Ordnance System
Boeing Aerospace Electronics Seattle, WA	Hard Mobile Launcher and Weapon Control System

Major Contributors to This Report

National Security and International Affairs Division, Washington, D.C.	Norman J. Rabkin, Associate Director Steven F. Kuhta, Assistant Director Samuel N. Cox, Assignment Manager
Los Angeles Regional Office	James F. Dinwiddie, Evaluator-in-Charge Lisa Rodely, Evaluator

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