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MISSILE DEVELOPMENT

Status and Issues at the Time of the TSSAM Termination Decision

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In May 1994, the Department of Defense (DOD) began restructuring the Tri-Service Standoff Attack Missile (TSSAM) program after a series of flight test failures and unresolved technical problems. This restructuring called for (1) eliminating planned production of the missile's Combined Effects Bomblet (CEB) variant, (2) acquiring up to 15 additional operational test missiles, and (3) extending the development program. This report discusses TSSAM's reliability; increasing unit production costs; changes in the number of variants and quantities to be acquired, including plans to buy more test missiles; and the availability of alternative systems. We provided a draft of the report to DOD on November 18, 1994.

On December 9, 1994, the Secretary of Defense announced plans to cancel the TSSAM program because of significant development difficulties and growth in its expected unit cost. Because this report provides pertinent information on the history and status of the TSSAM program at the time of the Secretary's announcement, we believe that it will be useful to Congress as it reviews DOD's plan to cancel the program.

Background

The TSSAM program has been a $13.7 billion effort to develop and acquire a low observable (i.e., stealthy), conventional, medium-range cruise missile. The TSSAM program began as a tri-service development program in 1986, with the Air Force as the lead service. TSSAM was planned to be a low-cost cruise missile able to deliver several different munitions, some with great accuracy, at a standoff range of over 100 nautical miles. TSSAM was to be carried and launched by Air Force bombers, Navy and Air Force fighter aircraft, and the Army's Multiple Launch Rocket System. Six TSSAM variants were to be developed and produced by Northrop.

The TSSAM program has been marked by significant technical problems, cost growth, and schedule delays. In 1993, we recommended that the Secretary of Defense (1) not allow the TSSAM program to proceed into low-rate initial production until all critical pieces of the CEB variant had been developed and adequately tested and (2) direct that the TSSAM program office demonstrate the more difficult and challenging

performance characteristics of the TSSAM system before approving the start of low-rate initial production.[1]

Subsequently, Congress approved $160.9 million in fiscal year 1994 funding for long lead items in anticipation of a low-rate initial production decision, and the Air Force requested about $373.9 million for fiscal year 1995 to begin low-rate initial production of 48 CEB variant TSSAMs. Successive flight test failures, lingering technical concerns, and continuing manufacturing problems, together with program cost growth and increasing budget constraints, preceded the Air Force's May 1994 decision to postpone TSSAM low-rate initial production until at least 1996. Later that month, the Air Force proposed the restructured TSSAM program.

In 1994, three variants remained in the TSSAM development program. The CEB variant was being developed for the Air Force to attack soft targets in a dispersed area but was not going to be produced. Two unitary warhead variants—one for the Navy and the other for the Air Force—were also being developed and were going to be produced. Four launch platforms, the B-52, B-2, F-16, and F-18, remained in the program, and the B-1B was to be added at a later date. In September 1994, we reported that because TSSAM was still not ready to begin production, the Air Force's $373.9 million fiscal year 1995 procurement request could be denied and its $160.9 million fiscal year 1994 procurement appropriation could be rescinded.[2]

Results in Brief

Unsuccessful flight test results, particularly over the last 2 years, made attainment of TSSAM's very high reliability requirement questionable. The program office and Northrop initiated a reliability improvement program to address this concern, but demonstration of whether problems had been resolved would have taken several years.

The acquisition of more test missiles would have added nearly $300 million to the program's estimated development cost but provided little, if any, assurance of TSSAM performance and reliability before the critical early production decisions. Buying these test missiles in fiscal year 1995 would have been premature. The 1994 reviews of cost reduction measures and

[1]Missile Development: TSSAM Production Should Not Start as Planned (GAO/NSIAD-94-52, Oct. 8, 1993).

[2]1995 Defense Budget: Potential Reductions and Rescissions in RDT&E and Procurement Programs (GAO/NSIAD-94-255BR, Sept. 8, 1994).

alternative systems could have resulted in major design changes or, as the Secretary of Defense recommended, a decision to terminate the program.

The total TSSAM program cost increased from an estimated $8.9 billion in 1986 to $13.7 billion in 1994, and the total number of missiles to be produced decreased by over 50 percent. During the same period, estimated procurement unit costs increased from $728,000 to over $2 million. TSSAM's increasing cost was a factor that convinced the Army to end its participation in the program in February 1994 and had been driving the Navy and the Air Force to reconsider whether they could still afford TSSAM. To address the services' concerns over TSSAM's high cost, DOD directed the Air Force in September 1994 to conduct an analysis of TSSAM's estimated production costs to identify measures that would reduce costs by up to 50 percent.

Declining budgets and changes in threat had prompted the services to consider alternative systems. DOD's March 1994 Cost and Operational Effectiveness Analysis (COEA) concluded that TSSAM was the most cost-effective weapon among several alternatives, principally because of its success in high-threat situations. However, the analysis showed some alternative weapon systems performed well in less demanding situations and might be adequate to meet existing national security requirements.

TSSAM Reliability Was Uncertain

TSSAMs were required to have very high reliability when delivered to Air Force and Navy units and fully integrated into the services' operations. In general, high reliability in cruise missiles is achieved through careful design; meticulous attention to detail during assembly and manufacturing; and exhaustive ground and flight testing to identify weak components, faulty processes, or manufacturing errors. Nearly all TSSAMs launched were expected to fly to and hit their intended targets.

Of the 22 TSSAM flight tests conducted since 1990, 13, or about 59 percent, were considered to be successful; that is, the missile flew the full mission and met its primary test objectives.[3] The eight flight test failures occurred for a variety of reasons, such as a loose screw or a pinched wire. Many of these failures were attributed to faulty components and manufacturing process errors. Since November 1992, only 6 of 12 flight test attempts, or 50 percent, succeeded.

[3]Three flight test aborts were not included in this calculation. Two aborts occurred because of problems with the missiles before launch, and one occurred because of a problem with the launch platform.

In addition, TSSAM flight testing began before the missile system and its subsystems completed qualification testing (i.e., certification that the missile could meet performance requirements for production). As of October 1994, the missile system and 11 of its 27 critical subsystems had not completed qualification testing, and some of the essential reliability improvement ground testing for critical TSSAM subsystems had still not been completed. At that time, the completion dates for subsystem and system qualification testing were May 1995 and December 1996, respectively.

Program officials told us that flight test failures were an expected and necessary part of developing a complex cruise missile weapon system. Early in the test program, the program office predicted flight test success and failure rates using an analysis of the TSSAM design and the experience of other similar programs. The officials pointed out that the program's 59 percent flight test success rate was consistent with program expectations and the success rates of other cruise missile programs for that point in the development process. However, TSSAM's required reliability was much higher than that demonstrated by these other systems. TSSAM's flight test success rate needed to improve significantly before the Defense Acquisition Board's review before low-rate initial production. Approximately 20 flight tests had been scheduled between November 1994 and November 1995, and nearly all would have needed to be successful for TSSAM to meet the program's expectations, duplicate the success of other cruise missile programs, and achieve TSSAM's higher reliability requirement.

DOD, Northrop, and the services expressed concern that TSSAM might not achieve its high reliability requirement. For example, Navy officials told us that they were confident TSSAM would meet its performance requirements, but they were concerned that faulty components and manufacturing process errors would prevent TSSAM from achieving its required reliability. Air Force officials were also concerned that problems with parts would go undetected despite exhaustive tests performed during missile assembly and before each flight. The officials pointed out that, until they saw positive results from many more flight tests, system reliability would remain a concern and be an area of risk for the program.

Independent government and contractor teams examined the TSSAM development program in 1992 and 1993 and concluded that not enough was known about all of the environments in which the missiles had to operate, the inherent reliability of critical subsystems, and the degree of

control maintained over the processes under which the missile had to be manufactured. The teams recommended verifying the flight conditions imposed by TSSAM launch platforms, establishing a reliability improvement program, and conducting more intensive ground testing before flight testing.

In response to these recommendations and the services' concerns, the program office conducted a series of flight tests on each of TSSAM's launch platforms and verified the critical forces to be encountered by the missile. The results showed that the missile's design was appropriate for the flight environments measured. In addition, the program office and contractor established programs to enhance component and subsystem ground testing and improve missile manufacturing and assembly processes. These efforts were intended to identify problem parts and process errors before delivery of the missiles.

Program officials believed these efforts, together with the maturation of the TSSAM design, would improve TSSAM's reliability over the next several years. These officials also believed that the efforts needed to be continued throughout the development program and into production to ensure that TSSAM could meet its high reliability requirement. The program officials cautioned, however, that improvements in flight test success would not be seen immediately, since the improvement program was just getting underway and nearly all of the subcontractor parts were already delivered.

Need for More Test Missiles Was Questionable

Program officials said that the procurement of up to 15 more test missiles would allow them to conduct additional flight testing, which was expected to provide greater confidence in TSSAM's performance and reliability. They also said more test missiles would allow them to use some of the existing operational test missiles for extended development testing and the new missiles for completing operational testing. Buying more test missiles was also expected to provide other benefits, such as avoiding a production break for critical subcontractors and facilitating the transition from development to low-rate initial production.

The program office estimated the cost of an additional 15 test missiles and associated support efforts to be about $300 million. The acquisition would have involved about a 2-year extension to the TSSAM development program and changes to the basic development contract and schedule. Even though the TSSAM Program Director and a Northrop official agreed to these

conditions, the agreement was verbal and, as of November 1994, the contractor had not provided an estimate of the associated costs.

Although more successful flight tests might have helped build confidence in the missile, the TSSAM Chief of Test said that under the existing contract, Northrop was obligated to demonstrate TSSAM performance and that if more missiles were needed to do so, the contractor must manufacture them at no additional cost to the government. Even with the many test failures, the test chief was confident that the missile would meet its performance requirements. The test director also told us that more flight test successes would have helped build confidence in TSSAM's reliability and its readiness for production.

Even if more test missiles had been procured in mid-1995, the test results to be obtained from the new missiles would have not been available until 1999 because it would have taken about 3 years to manufacture them and 1 to 2 years to test them. The TSSAM production program envisioned low-rate initial production to begin in fiscal year 1997, with production continuing for 14 years. By the time operational test results from the additional missiles were available, the government would have procured three production lots of TSSAMs and made a commitment to order the fourth lot. Therefore, the acquisition of more test missiles would have provided little, if any, assurance of TSSAM performance and reliability before the critical early production decisions.

When program officials initially proposed acquiring 15 more test missiles in May 1994, they believed that the missiles, if ordered by September 1994, would benefit several critical subcontractors who were reaching the end of their production effort for the development program and would experience a lengthy break in production before production missile orders were received. Program officials estimated that a production break would result in the loss of expertise and cost about $200 million to restart the program and requalify production processes. They believed acquiring the new test missiles would help sustain some subcontractor expertise until TSSAM production began.

However, acquiring the additional test missiles would not have provided help to most subcontractors, since nearly all parts manufactured by TSSAM subcontractors had already been delivered, and the program office, as of November 1994, did not expect to reach an agreement with Northrop on the new test missile order until June 1995. By the time Northrop had passed orders for parts and supplies to its subcontractors and vendors, a

gap of several months to 1 year would have occurred in the subcontractor base.

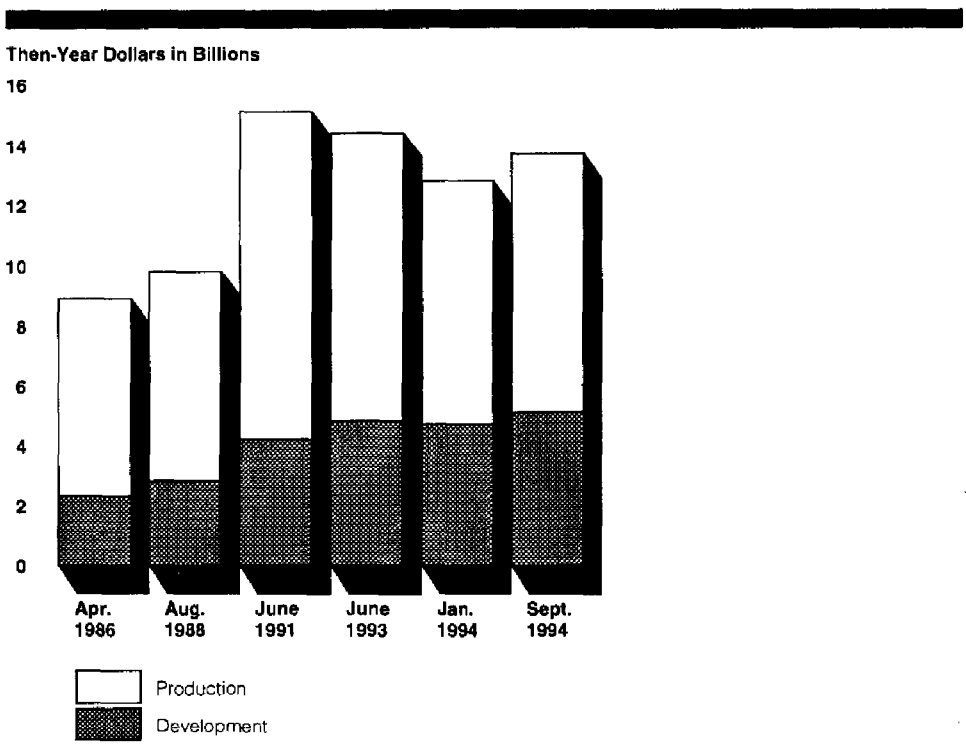
The procurement of more test missiles could have also presented some risks if it was not timed properly. The Air Force was conducting a comprehensive study to reduce TSSAM's production cost. The study was focusing on potential changes to system and subsystem designs to reduce costs. If significant design changes were made after the new test missiles were acquired, those missiles would have been in the wrong configuration and would have needed to be modified at an additional cost. Also, DOD and the services were examining alternative systems that might have been acquired instead of TSSAM.

TSSAM Costs Had Increased

Low cost was a top priority for the TSSAM program when it began in 1986. At that time, DOD estimated that TSSAM engineering and manufacturing development would cost $2.3 billion and that production of 9,050 missiles would cost $6.6 billion, for a total program cost of $8.9 billion (in then-year dollars). TSSAM's initial operational capability for the Air Force was originally to occur in 1990, and all missiles were to be delivered by 1997.

After years of development problems and associated schedule delays, the TSSAM program's cost changed significantly. Development costs had more than doubled, and estimated production costs were 30 percent higher for less than half the missiles originally planned. The September 1994 estimate for TSSAM development increased to $5.1 billion, and production of 4,156 missiles was estimated at $8.6 billion, for a total program cost estimate of $13.7 billion, as shown in figure 1.

Figure 1: Changes in the TSSAM Program's Cost Estimates



The combination of decreased quantities and higher production costs resulted in an estimated 183-percent increase in the TSSAM procurement unit cost, from an estimated $728,000 in 1986 to $2,062,000 in 1994 (in then-year dollars). Figures 2 and 3 show the changes in planned procurement quantity and estimated procurement unit cost, respectively, since 1986.

Figure 2: Changes in TSSAM Planned Procurement Quantity

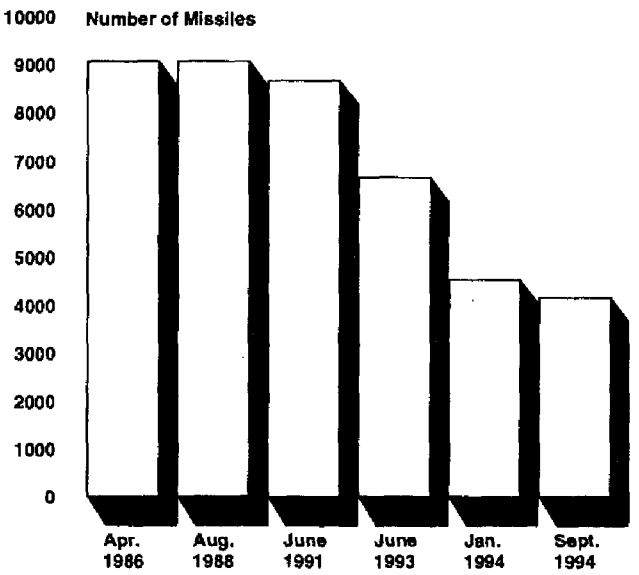
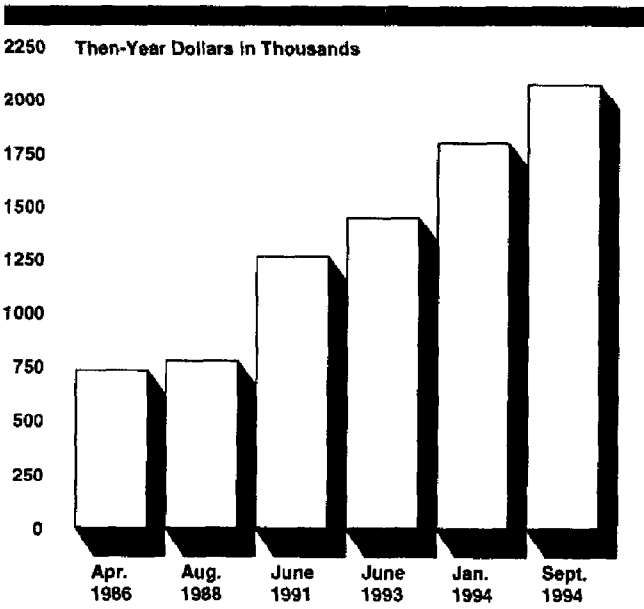


Figure 3: Changes in TSSAM Estimated Procurement Unit Cost



In addition, development delays and cost growth led the services to stretch out the planned production time frame and reduce the content of the program. Under the September 1994 restructured program, the first TSSAM would have been delivered in fiscal year 1999 and the last in fiscal year 2011, about 12 years later than originally planned. Also, of the six original TSSAM variants, only the two unitary variants would have been produced. Table 1 shows the TSSAM program variants, missions, and procurement quantities as of April 1986 and September 1994.

Table 1: Changes in Planned Quantities of TSSAM Variants

		Quantity	
Variant	**Planned mission**	**Apr. 1986**	**Sept. 1994**
Army			
APAM	Anti-personnel, anti-materiel	350	0
BAT	Anti-armor	1,450	0
Navy			
Unitary	Precision land and sea attack	2,250	525
Air Force			
CEB	Attack area or soft targets	1,400	0
BKEP	Runway buster	800	0
Unitary	Precision land attack	2,800	3,631
Total		**9,050**	**4,156**

Representatives from all three services expressed concern about the affordability of TSSAM. In early 1994, the Army terminated its involvement with TSSAM, citing TSSAM's high cost as one of the factors in its decision to terminate. In mid-1994, because of cost growth, schedule slippages, and declining budgets, both the Secretaries of the Navy and the Air Force deleted TSSAM funding from their fiscal year 1996 budget submission to the Office of the Secretary of Defense. However, after the program was restructured, they added funding for TSSAM to their fiscal year 1996 budget requests.

Air Force officials at the Air Combat Command told us that declining procurement budgets in the mid- to late 1990s forced them to choose among the programs they needed to accomplish the command's mission. While the Air Force had a requirement for a weapon having the characteristics offered by TSSAM, they expressed frustration with continuing TSSAM schedule delays and said that TSSAM was expected to cost twice as much as they were willing to pay for it. The officials further stated that, given the cost and uncertainty surrounding the TSSAM program, they

considered B-1 bomber upgrades, the F-22 development program, and the continuation of the F-111 program to be more important.

To address the concerns of the Army, the Navy, and the Air Force over TSSAM's high cost, DOD directed the Air Force in September 1994 to perform a comprehensive, independent analysis of TSSAM's procurement cost. The purpose of this analysis is to identify measures that would reduce TSSAM production costs by up to 50 percent. Among the areas to be examined were requirements and specifications changes, system design, materials, manufacturing processes, and the acquisition plan. The team was to report its results by December 31, 1994. The results were expected to provide a firm basis for either completing the program or pursuing alternative systems.

Services Are Examining Alternatives to TSSAM

DOD's March 1994 COEA concluded that TSSAM was the most cost-effective of several missiles examined for a broad band of potential applications. The missile's cost-effectiveness was largely due to its projected ability to penetrate enemy air defenses in a high-threat environment. Even though TSSAM would have cost more than other systems, it performed better against time-sensitive, well-protected, and defended targets.

Despite the results of the March 1994 COEA, the services began examining alternative weapon systems because of TSSAM's flight test failures, lengthy development delays, high cost, and reduced capabilities. In August 1994, the Deputy Secretary of Defense directed the Air Force and the Navy to propose alternative systems in the event that TSSAM was terminated.

The services identified less capable and apparently less costly systems as an alternative to TSSAM in the near term and expressed support for a future program to meet their long-term requirements. These systems could be effective in less demanding situations and might prove adequate to meet current national security requirements. They also appeared to be more readily available than TSSAM would have been. However, the services did not appear to have adequate data on cost, performance, and availability of the alternative systems. The estimates that were available on cost and the amount of time that would be needed to actually field these systems were not considered to be reliable.

The COEA presented some cost and performance estimates for several of these alternatives, but service officials disagreed with (1) the methodologies to estimate the costs to acquire or modify these systems,

(2) some of the performance estimates, and (3) the threat scenarios. The Deputy Secretary of Defense asked the team that performed the COEA to further examine some of these issues. This examination was to compare more systems, reassess some systems already included in the analysis, and include revised threat scenarios. This examination was to be completed by the fall of 1995, but interim results were expected in the spring of 1995.

The Army has been developing a modified Tactical Missile System to fill the role once identified for TSSAM. Army officials advised us that, even though its range and payload were less than TSSAM's, the existing system could be modified at less cost to meet requirements.

Navy officials were confident TSSAM would perform as expected once the missile was fully developed and the manufacturing process was optimized. They said, however, that TSSAM was more robust and costly than necessary for the conflicts they anticipated for the foreseeable future. Accordingly, they were evaluating a proposed expanded response version of the Standoff Land Attack Missile-Expanded Response (SLAM-ER) to replace TSSAM. They said that even though SLAM-ER might not be quite as capable as TSSAM, it could meet minimum operational requirements at a lower cost. They expected lower production costs largely because existing Harpoon missiles could be modified into the SLAM-ER configuration instead of having to build an entirely new missile. They also believed the SLAM-ER could be fielded sooner than the TSSAM. On December 16, 1994, DOD announced that, because of its plan to terminate the TSSAM program, the Navy would procure additional SLAM missiles in fiscal year 1996 and would retrofit SLAM missiles with SLAM-ER kits in fiscal years 1997 through 2001.

The Air Force has no readily available alternative to TSSAM. However, officials at the Air Combat Command told us the acquisition of a combination of AGM-130 munitions, Joint Standoff Weapons, Have Nap missiles, and modified Air Launched Cruise Missiles could provide near-term alternatives to TSSAM but that a new standoff missile weapon system with TSSAM's characteristics would be needed in the long term. They also said the alternatives might prove to be less capable and more costly than projected.

Agency Comments and Our Evaluation

DOD provided official oral comments on a draft of this report. DOD generally agreed with our findings, but it indicated that the recommendation in our draft to postpone the acquisition of more test missiles was now moot because DOD no longer planned to buy additional test missiles in view of the Secretary of Defense's decision to cancel the program. Accordingly, we dropped our recommendation.

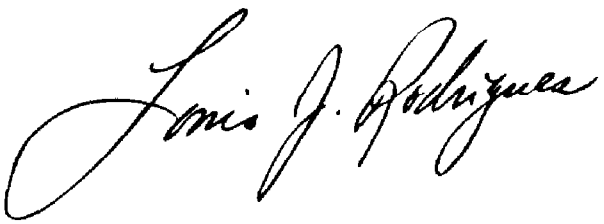
Scope and Methodology

We reviewed TSSAM acquisition plans, results of ground and flight tests, cost estimates, cost and effectiveness analyses, budget requests, and plans to acquire additional operational test missiles. We also reviewed program management directives and status reports, changes to the development contract, and contract performance and funding status reports. We discussed TSSAM's cost, acquisition strategy, and the program's technical, performance, and manufacturing difficulties with Army, Navy, and Air Force officials at the TSSAM Joint Program Office at Wright-Patterson Air Force Base, Ohio. We discussed the TSSAM requirement and alternatives with officials from the Joint Chiefs of Staff and Navy and Air Force Headquarters in Washington, D.C., and the Air Force's Air Combat Command at Langley Air Force Base, Virginia.

We performed our work from December 1993 to November 1994 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Chairmen and Ranking Minority Members of the House Committee on Government Reform and Oversight and Senate Committee on Governmental Affairs; the Secretaries of Defense, the Navy, and the Air Force; and the Director, Office of Management and Budget. We will also make copies available to others on request.

Please contact me at (202) 512-4841 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix I.



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