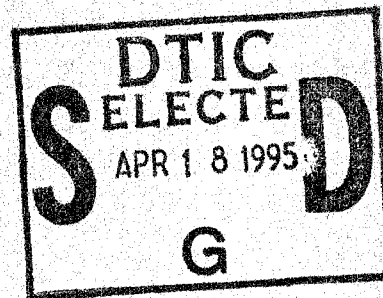
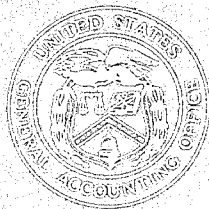


GAO

March 1995

# BALLISTIC MISSILE DEFENSE

## Computation of Number of Patriot PAC-3 Interceptors Needed Is Flawed



19950417 170

PRINTED ON QUALITY RECYCLED PAPER

National Security and  
International Affairs Division

B-259100

March 17, 1995

The Honorable Floyd D. Spence  
Chairman  
The Honorable Ronald V. Dellums  
Ranking Minority Member  
Committee on National Security  
House of Representatives

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At your request, we reviewed the Ballistic Missile Defense Organization's (BMDO) planned production of 1,200 Patriot Advanced Capability-Three (PAC-3) interceptors. Our specific objectives were to assess (1) how the number of interceptors needed was determined and (2) whether the issue of affordability was adequately resolved.

## Background



The theater missile defense (TMD) mission is to protect U.S. forces deployed overseas and U.S. allies and friends from theater ballistic missile<sup>1</sup> attacks. According to BMDO, an improved defense capability is urgently needed because of the increasing proliferation of theater ballistic missile weapon systems and technology to countries with the potential to threaten U.S. and allied theaters of operations. BMDO has established as its top priority a "core program" of improvements for TMD consisting of the Theater High Altitude Area Defense (THAAD), seabased lower tier, and PAC-3.

During the past decade, there have been a series of upgrades to give the Patriot, which was originally designed to destroy aircraft, a capability against theater ballistic missiles. In July 1988, Patriot was modified to give it an initial ballistic missile defense capability, called PAC-1. During Operation Desert Storm in 1991, a new version of the Patriot interceptor, called PAC-2, was deployed to defend against Iraqi Scud missiles. The Army also began the Guidance Enhancement Missile (GEM) program to make interim engineering improvements to the Patriot interceptor. Army plans call for 345 GEM interceptors, with initial delivery scheduled in 1995.

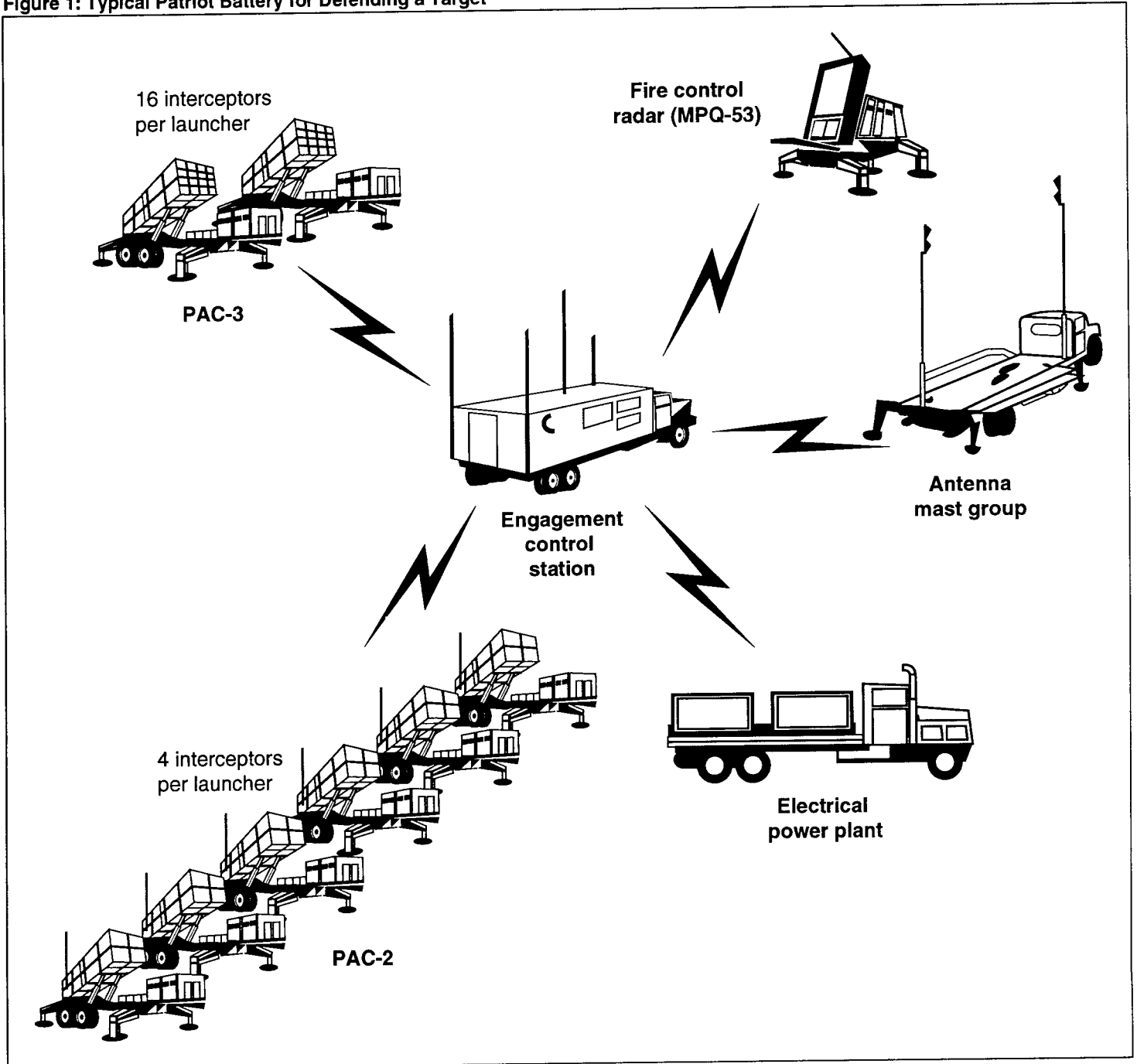
The PAC-3 system upgrade—including improved ground radars, launchers, and battle management hardware and software and new interceptors—is a

<sup>1</sup>Theater ballistic missiles have shorter ranges than strategic ballistic missiles and are expected to be used in major regional conflicts, such as Operation Desert Storm.

\$4.8 billion,<sup>2</sup> 17-year program that will begin being fielded in 1998. The PAC-3 program is expected to increase (1) the defended area and (2) the kill potential against higher performance missiles and chemical and biological warheads. Interceptor production is scheduled to begin in 1997 and end in 2004, at a total cost of \$2.3 billion and expected cost of \$1.5 million for each interceptor. While earlier Patriot interceptors destroyed missiles through explosions, PAC-3 is designed to collide with them. The basic Patriot unit—the minimum configuration that can carry out an engagement—is the battery, and the Army has 54 of them. As figure 1 shows, a Patriot battery normally includes (1) a fire control radar set, (2) an antenna mast group, (3) an engagement control station, (4) an electrical power plant, and (5) eight launchers.

<sup>2</sup>All costs in this report are in then-year dollars. The estimated costs for the engineering and manufacturing development and production phases are \$3.9 billion for fiscal years 1994 through 2004.

Figure 1: Typical Patriot Battery for Defending a Target



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The Army plans to modify three of the eight launchers in each Patriot battery so that they are capable of firing either PAC-3 or earlier Patriot interceptors. Each modified launcher can fire up to 16 PAC-3 interceptors without reloading. All launchers can fire earlier versions of Patriot interceptors, but only four of those interceptors can be loaded on each launcher.

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## DOD's Current Warfighting Requirements

Current policy is that the Department of Defense (DOD) must be capable of winning two nearly simultaneous major regional conflicts (MRC) anywhere in the world. Guidance for determining DOD's capabilities states that, for planning purposes, one MRC in Northeast Asia and another in Southwest Asia should be assumed, each with a duration of 60 to 120 days. Current DOD planning calls for replenishment of ammunition stocks only after hostilities have ended. Therefore, the number of PAC-3 interceptors on hand at the outbreak of hostilities takes on special significance.

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## Results in Brief

Following a recent review of the PAC-3 program, DOD approved a procurement program that would buy 1,200 PAC-3 interceptors. However, the actual number of PAC-3 interceptors DOD needs to buy is uncertain. The analysis that DOD's affordability assessment group had at the time it developed its recommendation to buy 1,200 interceptors and the analysis that the Army made supporting a requirement for 2,200 both contain inaccurate data and invalid assumptions. Adjusting for some of the problems with DOD's analysis could increase its calculation of PAC-3 interceptors needed to about 3,442. Adjusting for the problems we noted with the Army's analysis could reduce its calculation of PAC-3 interceptors needed to 1,670. DOD prepared a subsequent analysis that it believes supported the 1,200 number. We have evaluated the subsequent analysis and found that it used many of the same inaccurate assumptions and contained simple mathematical errors that the analysis used by the affordability assessment group did not have.

If the corrected estimated quantity that is needed is higher than 1,200, then BMDO may not have adequately budgeted for the program. The \$4.8 billion program could be underfunded between \$700 million and \$3.4 billion. To avoid spending on other lower priority programs that may ultimately require more funding than can be expected to be available, it is important that DOD accurately determine the number of interceptors needed and adjust its program within overall ballistic missile defense budget constraints.

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## Number of PAC-3 Interceptors DOD Needs to Buy Is Uncertain

In its mid-1994 review, DOD approved the PAC-3 engineering and manufacturing development phase and the planned production of 1,200 PAC-3 interceptors. A DOD-appointed affordability assessment group concluded, based on its threat-based analysis of requirements, that 1,200 interceptors would provide moderate confidence of supporting two MRCS. Our review indicated that the group's analysis did not adequately determine the number of interceptors needed because it relied on erroneous assumptions about kills by non-PAC-3 interceptors, which reduced the need for PAC-3 interceptors, and it assumed a perfect or near-perfect match between enemy missiles and PAC-3 interceptors, which is not likely to happen. Adding PAC-3 interceptors in DOD's analysis to overcome optimistic assumptions concerning non-PAC-3 interceptors and the effect of the enemy tailoring its attack would increase the number needed to about 3,442. In contrast, Army officials believe that 2,200 interceptors are needed. However, the Army's force-structure based analysis may support a requirement for only 1,670 because it calls for 530 interceptors that may not be needed to meet DOD's two-MRC policy.

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## DOD's Computation Is Flawed

The affordability assessment group recommended that 1,200 PAC-3 interceptors be produced. However, the threat-based analysis it used to develop that recommendation contained inaccurate data and questionable assumptions concerning (1) the contribution of the THAAD system in destroying missiles, (2) the planned capabilities of earlier versions of the Patriot to kill missiles outside the required area called a keepout zone, and (3) the maximum likely attack size against defended targets. Substituting PAC-3 interceptors for the questionable contributions of the THAAD and earlier versions of the Patriot in DOD's analysis increases the number of PAC-3 interceptors needed to about 3,085. Factoring in the effect of the enemy tailoring its attack size further increases this number to 3,442.

First, DOD's computation uses assumptions for the THAAD system that are beyond its planned capabilities. The analysis credits THAAD with killing 225 missiles that have a maximum range too short for THAAD to kill. In addition, not all Patriot batteries will be deployed with THAAD. In a Joint Chiefs of Staff study in December 1993, only 33 percent of the Patriot batteries are deployed with a THAAD battery. Substituting PAC-3 interceptors in DOD's analysis to destroy these 225 missiles and using the analysis' firing doctrine result in an increase in the estimated requirement of about 616 interceptors.

Second, DOD's computation assumes that earlier versions of the Patriot interceptors will have capabilities beyond those planned for them. The analysis assumes that they can kill 463 missiles outside the required area called a keepout zone. However, none of the earlier interceptors will have the capability to do this, even those with the GEM upgrade. According to Army data, the interceptors do not meet the PAC-3 requirement of making the kills outside the required keepout zone. Moreover, they are not as effective as the PAC-3 against chemical and biological warheads, which was one of the reasons for developing PAC-3. To destroy the 463 missiles the study credited the earlier versions of the Patriot interceptors with destroying, about 1,269 additional PAC-3 interceptors would be needed.

Third, DOD's analysis supporting 1,200 interceptors assumed a perfect or near-perfect match of PAC-3 and enemy missiles at each target location without regard to the enemy's ability to tailor its attack. For example, if there are 10 targets to defend and the enemy has 100 missiles for attacking these targets, such an analysis would show a need for only 100 interceptors to defend these 10 targets. Implicit in this analysis is the assumption that the enemy would choose to evenly distribute its missiles among the 10 targets. However, the enemy may choose to tailor its attack and shoot 15 missiles at some targets and 5 at others. If all 10 targets are to be protected, then the Army might decide 15 interceptors are needed to defend each target, which would require 150 interceptors. Therefore, DOD's threat-based methodology should take into account the maximum likely attack size against each defended area. Using the same factor that DOD used in another analysis for what it calls maldistribution, DOD would need another 357 PAC-3 interceptors.

## Army's Computation Is Flawed

The Army's Director of Requirements, Office of the Deputy Chief of Staff for Operations and Plans, told the Strategic Systems Committee<sup>3</sup> that the Army had determined that 2,200 PAC-3 interceptors were required. While never used in BMDO planning or budgeting, the Army established 2,200 as the number of interceptors needed to (1) fight two MRCS (1,728 interceptors), (2) fight one lesser regional conflict (172 interceptors), and (3) accomplish various test objectives (300 interceptors). The 1,728 interceptors the Army says it needs to fight two MRCS is based on fully equipping 2 launchers with 16 interceptors each, in all 54 tactical batteries.

<sup>3</sup>The Strategic Systems Committee coordinated the review of the PAC-3 systems for the Defense Acquisition Board. Formal Defense Acquisition Board reviews are preceded by months of staff review and coordination to identify issues to be presented to Defense Acquisition Board members.

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However, for two reasons, accepting the Army's analysis could result in more interceptors than are actually needed. First, current guidance does not require planning for lesser regional conflicts. Second, according to a Joint Chiefs' December 1993 study, the number of Patriot batteries needed to fight two MRCS, in concert with other theater air defense systems, is only 45. This suggests that the Army might have more Patriot batteries than it needs. If so, it would need only 1,440 interceptors to equip 45 batteries plus 230 for testing, for a total of 1,670, not 2,200.

We also noted that while the Army plans to maintain 54 batteries in active status and equipped with PAC-3 interceptors, it currently staffs only 44. It plans to have the National Guard staff an additional four batteries in the near future.

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## BMDO May Still Have a Major Affordability Problem

Due to the Cost Analysis Improvement Group's unexpectedly high cost estimate for the PAC-3 program, the Defense Acquisition Board was faced with a serious affordability problem that it had to resolve before it could approve the engineering and manufacturing development phase of the program. DOD regulations require a determination that adequate resources to support the program have been, or are committed to be, programmed before approving a system's entry into engineering and manufacturing development. DOD believes it solved this problem by establishing the number of interceptors at 1,200. However, if an accurate analysis indicates a need for hundreds more, then the \$4.8 billion PAC-3 program could be underfunded between \$700 million and \$3.4 billion.

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## DOD's Requirements for Affordability Determinations

To avoid spending money on programs that may require more funding than can be expected to be available, DOD requires a determination, when approving a system for engineering and manufacturing development, that "adequate resources . . . to support the program have been, or are committed to be, programmed." Specifically, the regulations provide that "a program shall not be approved to enter the next acquisition phase unless sufficient resources . . . are or will be programmed to support projected development, testing, production, fielding, and support requirements." According to an official from the Office of the Under Secretary of Defense (Acquisition and Technology), the word "programmed" means budgeted in DOD's Future Years Defense Program (FYDP). The FYDP that was current at the time of the decision covered fiscal years 1995 through 2000.

**DOD's Solution to Affordability Problem**

BMDO had originally allocated funding for the PAC-3 program using 1,500 interceptors as a planning factor. This number was not based on a requirements analysis. In preparation for DOD's review, however, a cost estimate was developed that showed BMDO had not allocated enough money to buy 1,500 interceptors. Consequently, DOD's Strategic Systems Committee established an affordability assessment group to develop recommendations for resolving the problem.

That group recommended reducing the number of interceptors to partially close the affordability gap and shifting funding for the balance. It concluded that 1,200 interceptors would provide moderate confidence that two MRCS could be supported. The Strategic Systems Committee recommended approval of this acquisition quantity. The affordability assessment group determined that this quantity would require \$694 million more than BMDO had previously allocated for fiscal years 2001 and beyond. To cover the shortfall, BMDO agreed to transfer money from other BMDO programs. In July 1994, the Under Secretary of Defense (Acquisition and Technology) approved PAC-3 entering engineering and manufacturing development with the reduced quantity of 1,200 interceptors planned for production.

**Potential Unresolved Affordability Problem**

If the correct quantity is higher than 1,200, then BMDO must increase PAC-3 production funding at some point. The \$4.8 billion program could be underfunded between \$700 million and \$3.4 billion. To avoid spending on programs that may ultimately require more funding than can be expected to be available, it is important that DOD accurately determine the number of interceptors needed and adjust its budget to provide funding for them within overall ballistic missile defense budget constraints.

**Table 1: Computation of Range of Potential Underfunding for PAC-3 Interceptors**

Dollars in billions			
	Adjusted quantity of interceptors	Increase over 1,200	Underfunded amount <sup>a</sup>
Army	1,670	470	\$0.7
DOD	3,442	2,242	\$3.4

<sup>a</sup>Total is based on expected cost of \$1.5 million in then-year dollars for each interceptor.

Because ballistic missile budgets are constrained, solving this problem may entail curtailing other BMDO programs. PAC-3 is part of a core program of three systems: PAC-3, THAAD, and a seabased lower tier. BMDO maintains

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that this core program is its number one priority. In its October 1993 Bottom-Up Review report, DOD endorsed \$18 billion for ballistic missile activities for fiscal years 1995 through 1999, including \$9 billion for the three systems in the core program, saying that this represented a \$21 billion reduction from the previous administration's defense program. Subsequent budget decisions were reported to reduce the \$18 billion by an additional \$1 billion. The administration's request for ballistic missile defense for fiscal year 1996 is \$2.9 billion.

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## Recommendation to the Secretary of Defense

In order to preclude expenditures on other lower priority programs that may ultimately be unaffordable if funds need to be shifted to PAC-3, the Secretary of Defense should direct the Director of BMDO to provide both an accurate estimate of the number of PAC-3 interceptors required and a plan that resolves any resulting affordability problem.

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## Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. The complete text of DOD's comments is in appendix I. DOD agreed with much of the information in our report; and in response to our recommendation, DOD said it was reassessing PAC-3 requirements as part of an ongoing analysis scheduled for completion in late 1995. DOD said that if it is subsequently determined that more than 1,200 interceptors are needed, then it may have to reconsider funding priorities in the post-2000 time frame and extend planned production.

DOD disagreed with the details in our report in two principal areas. First, it said that a subsequent analysis (1) corrected for the shortcomings of the analysis discussed in our report and (2) supported the 1,200 procurement objective. However, we found that the subsequent analysis also used inaccurate data and invalid assumptions, and it contained mathematical errors that if corrected result in a need for only 910 PAC-3 interceptors. Although we had analyzed it in October 1994, after a DOD official had given us a copy, we did not focus our report on it for two reasons—it was not an accurate computation of requirements and the affordability assessment group used the analysis we did discuss.

Second, DOD said that its acquisition procedures require only that funds be programmed through the period covered by the current FYDP before a weapon system can proceed into the next acquisition phase. If it determines that more than 1,200 interceptors are needed, DOD said that it would consider extending the planned production, which would be

outside the FYDP. We note, however, that BMDO's approach to resolving the original affordability problem raised by DOD's Strategic Systems Committee was an adjustment to BMDO's 2001-2004 program plan, which was outside of the 1995-2000 FYDP. The Strategic Systems Committee listed as an open action item the affordability problem of who would pay for the 1,200 interceptors. The problem was resolved before the Defense Acquisition Board met when BMDO agreed to make adjustments to other programs to make available sufficient funds.

Figure 2 illustrates the issue raised by an extension of production as envisioned in DOD's comments. It shows that the currently planned production of 1,200 PAC-3 interceptors would be completed in fiscal year 2004. Thus, if the Cost and Operational Effectiveness Analysis (COEA) shows that any additional interceptors are needed, production would begin in fiscal year 2005. If the correct number turns out to be as high as the highest adjustment for flaws we detected (3,442), then production would not be completed until fiscal year 2013 assuming that DOD continues the annual production rate of 250.

Figure 2: Schedule of Patriot PAC-3 Initial Production and Potential Additional Production

	Fiscal years																			
	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	
FYDP in place at decision point																				
COEA completed	10/95																			
Start low-rate initial production		7/97																		
Start full production			7/98																	
Planned production of 1,200 PAC-3 interceptors																				
Production of an additional 2,242 interceptors at 250 a year																				

According to BMDO, PAC-3 is urgently needed to counter the increasing threat posed by theater ballistic missiles. BMDO has assigned PAC-3 and the other TMD core programs its top priority. The Congress has also recognized

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the urgent need for fielding improved TMD systems. The fiscal year 1994 House Armed Services Committee report said that theater missile defense should receive priority over other programs and that priority should be given to those systems that can be deployed sooner over those that cannot be deployed until later. Finally, DOD indicated that the COEA currently being conducted will provide an accurate estimate of the number of PAC-3 interceptors required. However, if additional quantities are needed, DOD said it may have to extend planned production, delaying procurement of the total number of PAC-3 interceptors to as late as 2013.

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## Matter for Congressional Consideration

In light of the deficiencies in the analyses that supported the determination of the PAC-3 production requirements, the Congress may wish to direct the Secretary of Defense to provide a valid estimate of the number of PAC-3 interceptors required and when he plans to produce them.

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## Scope and Methodology

We examined (1) cost estimates developed by the PAC-3 product office, the Army Space and Strategic Defense Command, the Department of the Army, and DOD; and (2) Army and DOD analyses of requirements for PAC-3 interceptors. In Washington, D.C., we met with officials from the DOD, BMDO, and Department of the Army. In Huntsville, Alabama, we met with representatives from the PAC-3 product office and the Space and Strategic Defense Command.

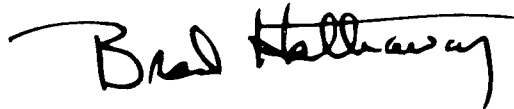
We performed our work between December 1993 and February 1995 in accordance with generally accepted government auditing standards.

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We plan no further distribution of this report until 15 days after its issue date, unless you publicly announce its contents earlier. At that time, we will send copies to the appropriate congressional committees; the Secretaries of Defense and the Army; and the Directors, Ballistic Missile Defense Organization and Office of Management and Budget. We will also make copies available to others upon request.

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If you or your staff have any questions concerning this report, please contact me at (202) 512-4841. The major contributors to this report are listed in appendix II.

A handwritten signature in black ink that reads "Brad Hathaway". The signature is written in a cursive style with a long horizontal line extending from the top of the "B".

Brad Hathaway  
Associate Director, Systems  
Development and Production Issues



# Comments From the Department of Defense

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



ACQUISITION AND TECHNOLOGY

## OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON  
WASHINGTON DC 20301-3000



18 2 JAN 1995

Mr. Henry L. Hinton, Jr.  
Assistant Comptroller General  
National Security and International  
Affairs Division  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Hinton:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "BALLISTIC MISSILE DEFENSE: Computation of Number of Patriot PAC-3 Interceptors is Flawed," dated November 18, 1994 (GAO Code 707021), OSD Case 9815-X. The DoD partially concurs with the report.

Although the Department agrees with much of the information contained in the draft report, the DoD does not agree with two issues raised by the GAO. Specifically, the Department does not concur with the GAO's assertions that (1) the DoD-appointed affordability assessment group, which determined the Patriot Advanced Capability-3 (PAC-3) interceptor baseline number of 1,200 missiles, used inaccurate data and questionable assumptions, and (2) the Ballistic Missile Defense Organization (BMDO) has not adequately budgeted for the program as required by DoD regulations.

The GAO assertion that the DoD-appointed affordability assessment group used inaccurate data and questionable assumptions is not correct. The GAO, operating from early versions of the analysis, apparently assumed that the final DoD analysis incorrectly calculated kills by non-PAC-3 interceptors (PAC-2, Guidance Enhanced Missile (GEM) and Theater High Altitude Area Defense (THAAD)); and assumed a perfect, or near perfect, match between enemy missiles and PAC-3 interceptors. The DoD final inventory number was based on performance traceable to the THAAD Operational Requirements Document and to performance requirements against conventional warheads for the PAC-2 and GEM interceptors. In addition, the DoD assessment group increased the base requirement by 20 percent to account for a potential mismatch of PAC-3 interceptors to the threat.

With regard to the budget concern, DoD acquisition procedures require only that adequate funds be programmed in the



See p. 9.

See pp. 9-10.

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Future Years Defense Program before a program's entry into the engineering and manufacturing development (EMD) phase. Patriot is fully funded for the EMD phase and for the baseline 1,200 PAC-3 interceptors, at a production rate of 250 interceptors per year. Although the DoD has confidence in the 1,200 interceptor number, it is not fixed and will be reconsidered at future production milestone decisions. If it is subsequently determined that more than 1,200 interceptors are needed, then the DoD may have to reconsider funding priorities in the post-2000 time frame and extend planned production.

Finally, the GAO-recommended study to address the PAC-3 inventory requirement is already in progress--a Theater Missile Defense Cost and Operational Effectiveness Analysis to help prioritize future theater missile defense expenditures is being performed. Part of this study will assess missile inventory requirements for current and future systems. Information from that effort, scheduled for completion in late 1995, will influence decisions on PAC-3 interceptor production.

The detailed DoD comments on the draft report findings and recommendation are provided in the enclosure. The DoD appreciates the opportunity to comment on the draft report.

Sincerely,



George R. Schneiter  
Director  
Strategic & Tactical Systems

Enclosure

GENERAL ACCOUNTING OFFICE DRAFT REPORT - DATED NOVEMBER 18, 1994  
(GAO CODE 707021) OSD CASE 9815-X

"BALLISTIC MISSILE DEFENSE: COMPUTATION OF NUMBER OF PATRIOT  
PAC-3 INTERCEPTORS IS FLAWED"

DEPARTMENT OF DEFENSE COMMENTS

\* \* \* \* \*

FINDINGS

**FINDING A: Status of the Patriot Advanced Capability-Three (PAC-3) Interceptors.** The GAO found that the Ballistic Missile Defense Organization (BMDO) has established as its top priority a "core program" of improvements for theater missile defense (TMD) consisting of the Theater High Altitude Area Defense (THAAD), a sea-based lower tier, and the PAC-3. The GAO observed that there have been a series of upgrades to give the Patriot--originally designed to destroy aircraft--a capability against theater ballistic missiles. For example, the GAO noted that, in July 1988, the Patriot was modified to give it an initial ballistic missile defense capability, called PAC-1, and that during Operation Desert Storm, a new version of the Patriot interceptor, called PAC-2, was deployed to defend against Iraqi Scud missiles. The GAO also noted that the Army began the Guidance Enhancement Missile (GEM) program to make interim engineering improvements to the Patriot interceptor, and that current plans call for 345 GEM interceptors, with initial delivery scheduled in 1995.

The GAO also found that the PAC-3 is a \$4.8 billion, 17-year upgrade program that is to begin fielding in 1998, and is expected to increase (1) the defended area and (2) the kill potential against higher-performance missiles and chemical and biological warheads. The GAO observed that interceptor production is scheduled to begin in 1997 and end in 2004, and each interceptor is expected to cost \$1.9 million. The GAO explained that the basic Patriot unit is the battery--and the Army has 54. The GAO further explained that the Army plans to modify three of the eight launchers in each Patriot battery to be capable of firing either PAC-3 or earlier Patriot interceptors. (pp. 1-3/GAO Draft Report)

**DOD RESPONSE:** Partially concur. The statement, "The PAC-3 is a \$4.8 billion, 17-year upgrade that is to begin fielding in 1998..." is not accurate. The wording implies that all costs are interceptor related whereas, in fact, the costs cover the complete PAC-3 system

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Now on pp. 1-4.

See comment 1.

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upgrade. It would be more accurate to state, "The PAC-3 system upgrade, to include ground radar, launcher, BMC3, and interceptor improvements, is a \$4.8 billion, 17-year multi-phase project..."

See comment 1.

In addition, the GAO statement that interceptor production is scheduled to begin in 1997 and end in 2004, and each interceptor is expected to cost \$1.9 million needs clarification. The \$1.9 million represents production average unit costs in then year dollars (\$1.25 million in 1988 dollars). It should be noted, however, that the unit cost figures include costs for the associated ground equipment required to fire the missile, such as the missile canister, the launcher missile management station, and the fire solution computer. Therefore, it would be more accurate to state that "... each interceptor is expected to cost \$1.9 million in then year dollars inclusive of costs associated with ground support equipment (e.g., the missile canister, the launcher missile management station, and the fire solution computer)."

**FINDING B: The Number of PAC-3 Interceptors the DoD Needs to Buy Is Uncertain.** The GAO observed that a DoD-appointed affordability assessment group concluded, based on its threat-based analysis of requirements, that 1,200 interceptors would provide moderate confidence of supporting two major regional conflicts (MRCs). However, the GAO concluded that the DoD analysis did not adequately determine the number of interceptors needed, because it relied on erroneous assumptions about kills by non-PAC-3 interceptors (which reduced the need for PAC-3 interceptors), and it assumed a perfect or near perfect match between enemy missiles and PAC-3 interceptors, which is not likely to happen. The GAO also concluded that substituting PAC-3 interceptors in the DoD analysis to overcome optimistic assumptions concerning non-PAC-3 interceptors would increase the number needed to about 3,085.

The GAO observed that the threat-based analysis contained inaccurate data and questionable assumptions concerning (1) the contribution of the THAAD system in destroying missiles, (2) the planned capabilities of earlier versions of the Patriot to kill missiles outside the required area, and (3) the maximum likely attack size against defended targets. First, the GAO found that the DoD computation uses assumptions for the THAAD system that are beyond its planned capabilities--i.e., the analysis credits THAAD with killing 225 missiles that have a maximum range too short for the THAAD to kill. In addition, the GAO asserted that not all Patriot batteries will be deployed with the THAAD. For example, the GAO noted that in a December 1993 Joint Chiefs of Staff study only 33 percent of the Patriot batteries are deployed with a THAAD battery. The GAO concluded that substituting PAC-3 interceptors in the DoD

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analysis to destroy the 225 missiles and using the firing doctrine results in an increase in the estimated requirement of about 615 interceptors.

Second, the GAO found that the DoD computation assumes that earlier versions of the Patriot interceptors will have capabilities beyond what is planned for them--i.e., that they can kill 463 missiles outside the required area called a keepout zone. However, the GAO found that according to Army data, the earlier interceptors will not have that capability, even those with the GEM upgrade. Moreover, the GAO concluded that the earlier versions are not as effective as the PAC-3 against chemical and biological warheads, which was one of the reasons for developing the PAC-3. The GAO concluded that about 1,270 additional PAC-3 interceptors would be needed to destroy the 463 missiles cited in the DoD study.

Third, the GAO found that the DoD analysis supporting the 1,200 interceptors assumed a perfect or near-perfect match of PAC-3 and enemy missiles at each target location, without regard to the enemy's ability to tailor its attack. For example, the GAO noted that if there are 10 targets to defend and the enemy has 100 missiles for attacking those targets, such an analysis would show a need for only 100 interceptors to defend the 10 targets. The GAO pointed out that implicit in that analysis is the assumption that the enemy would choose to evenly distribute its missiles among the 10 targets. However, the GAO asserted that the enemy may choose to shoot 15 missiles at some targets and 5 missiles at others. In addition, the GAO asserted that the Army might decide 15 interceptors are needed to defend each target, which would require 150 interceptors for the 10 targets. Therefore, the GAO concluded that the DoD threat-based methodology should take into account the maximum likely attack size against each defended area. (pp. 4-6/GAO Draft Report)

Now on pp. 5-6.

See comment 2.

**DOD RESPONSE:** Nonconcur. The DoD does not agree that the threat-based analysis contained inaccurate data and questionable assumptions. The GAO conclusions in that regard may result from the GAO relying on a preliminary version of the analysis rather than the final results which supported the May 1994 Defense Acquisition Board (DAB) review.

See comment 3.

The GAO incorrectly asserted that the THAAD contribution to missile kills was based upon assumptions for the THAAD system that are beyond its planned capabilities. The final DoD results show progressively more tactical ballistic missile kills for the THAAD system in the 1999, 2005, and 2010 time frames, respectively. That

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increase in kills is consistent with the projected deployment schedule for the THAAD system. Also, in the final results, the THAAD system is allocated only against tactical ballistic missiles with ranges consistent with the range requirements of the THAAD Operational Requirements Document.

See comment 4.

The GAO also questioned the assumptions of missile attrition from the THAAD system, pointing out that Patriot batteries are not always deployed with a THAAD battery. In the DoD analysis, based upon a notional deployment for the scenario and time frame used in the study, 33 percent of the Patriot batteries were deployed with overlapping coverage from THAAD units. Since threat projections contain fewer long-range tactical ballistic missiles than the medium- or short-range threats, the Patriot system will not be deployed with the THAAD system (the "enclave" concept) in every case. Joint deployments of the THAAD and the Patriot systems will be determined by critical asset priority and the need for the greater effectiveness of a two-tier, defensive approach. The DoD final results fully accounted for that deployment strategy.

See comment 5.

The GAO questioned the contributions of the PAC-2 and Patriot GEM interceptors due to their performance relative to that of the PAC-3 interceptor. Although the PAC-2 and Patriot GEM interceptors cannot enforce the same defensive zone as the PAC-3 interceptor, operational commanders will use them to destroy tactical ballistic missiles against which they have a high probability of kill. The flexibility of the Patriot system, however, permits the operational commander to allocate the PAC-3 interceptors to the PAC-2 or GEM interceptor target set if intelligence information or other considerations warrant its use.

See comment 6.

Contrary to the GAO assertion, the DoD final results do not assume a near-perfect match of PAC-3 interceptors and enemy tactical ballistic missiles at each target location. The DoD analysis explicitly considers the potential for maldistribution (not having the right number of PAC-3 interceptors at the right place at the right time) in estimating the inventory. The base inventory quantity was increased by 20 percent to account for a potential mismatch of PAC-3 interceptors to the threat. Furthermore, the DoD analysis recognizes that the operational commander, given limited resources, would develop and prioritize a critical asset list to defend. The resulting defense design would reflect numerous factors, including intelligence information on threat intentions and capabilities (e.g., estimated raid size), and accord higher priority assets a more robust defense than those of lesser priority.

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See comment 7.

Finally, while not explicitly part of the DoD analysis, the potential of Navy TMD support to the various theaters was considered when judging the adequacy of the 1200 interceptor quantity. The GAO apparently did not consider that factor, nor did the GAO consider the option of focusing assets on different theaters--for example, Navy systems primarily fighting the Northeast Asia scenario, while Army assets are concentrated in Southwest Asia. Clearly, the potential of support from systems other than the THAAD system affects the PAC-3 inventory requirements. The extent of Navy support is not known at this time, but will be analyzed during the on-going Theater Missile Defense Cost and Operational Effectiveness Analysis. (See also the DoD response to the GAO recommendation).

**FINDING C: The Army Computation Is Flawed.** The GAO found that the Army established 2,200 as the number of interceptors needed to (1) fight two MRCs (1,728 interceptors), (2) fight one lesser regional conflict (172 interceptors), and (3) have a 16-percent increase to accomplish various test objectives (about 300 interceptors). The GAO noted that the 1,728 interceptors the Army needs to fight two MRCs is based on fully equipping 2 launchers with 16 interceptors each in all 54 tactical batteries. However, the GAO concluded that accepting the Army analysis could result in more interceptors than needed for two reasons--(1) current guidance does not require planning for lesser regional conflicts and (2) according to a December 1993 Joint Chiefs study, the number of Patriot batteries needed to fight two MRCs in concert with other theater air defense systems is only 45, which suggests the Army may have more Patriot batteries than it needs. The GAO concluded that only 1,440 interceptors would be required to equip 45 batteries, plus 230 for testing, for a total of 1,670, not 2,200 (or 530 less) established by the Army. The GAO also concluded that, while the Army plans to maintain 54 batteries in active status and equipped with PAC-3 interceptors, the Army currently staffs only 44, and plans to have the National Guard staff an additional four batteries in the near future. (pp. 6-7/GAO Draft Report)

See pp. 6-7.

See comment 8.

**DOD RESPONSE:** Partially concur. The DoD does not agree with the GAO statement that the number of Patriot batteries needed to fight two MRCs in concert with other theater air defense systems is only 45, which suggests the Army may have more Patriot batteries than it needs. The 1993 Joint Theater Air Defense Study, prescribed the 45 battery quantity for the two MRC scenario and time frame assessed in the study. In addition to the 45 batteries needed to fulfill the two-MRC requirement, six batteries are used on a rotational basis in Saudi Arabia and four batteries will be fielded to the Alabama

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National Guard in 1996. Further, since other potential "contributing" systems, such as the Navy Lower-Tier, will not be available until after the PAC-3 first unit equipped date, there may be a near-term possible need for more, not fewer, Patriot batteries.

**FINDING D: The BMDO May Still Have a Major Affordability Problem.**

The GAO reported that, due to the Cost Analysis Improvement Group's unexpectedly high cost estimate for the PAC-3 program, the Defense Acquisition Board was faced with a serious affordability problem before it could approve the engineering and manufacturing development phase of the program. The GAO explained that DoD regulations require a determination that adequate resources to support the program have been, or are committed to be, programmed before approving a system's entry into engineering and manufacturing development. The GAO noted that the DoD believed it solved that problem by establishing the number of interceptors at 1,200. However, the GAO concluded that, if an accurate analysis indicates a need for hundreds more, then the \$4.8 billion PAC-3 program could be underfunded between \$900 million and \$3.6 billion.

The GAO observed that the BMDO had originally allocated funding for the PAC-3 program using 1,500 interceptors as a planning factor. The GAO also observed that the 1,500 was not based on a requirements analysis, and that a cost estimate indicated the BMDO had not allocated enough money to buy 1,500 interceptors. Consequently, the GAO noted that the DoD affordability assessment group recommended reducing the number of interceptors to partially close the affordability gap and shifting funding for the balance. The GAO also observed that the group concluded the 1,200 interceptors would provide moderate confidence that two MRCs could be supported, and would require \$694 million more than the BMDO had previously allocated for fiscal years 2001 and beyond. To cover the shortfall, the GAO indicated that the BMDO agreed to transfer money from other BMDO programs.

The GAO concluded that, if the correct quantity of interceptors is higher than 1,200, the BMDO has not adequately budgeted for the program as required by DoD regulations. The GAO also concluded that the \$3.9 billion program could be underfunded between \$900 million and \$3.6 billion, and because ballistic missile budgets are constrained, solving the problem is likely to entail curtailing other BMDO programs. The GAO also pointed out that the administration's request for \$3.6 billion for ballistic missile defense in FY 1995 was not fully supported, with \$2.8 billion authorized and only \$2.7 billion actually appropriated. (pp. 7-9/GAO Draft Report)

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Now on pp. 7-9.

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See pp. 9-11.

**DOD RESPONSE:** Nonconcur. The inventory objective of 1,200 PAC-3 interceptors was approved at the May 1994 DAB review and is the Acquisition Program Baseline inventory quantity. The DoD acquisition procedures require only that adequate resources be programmed in the Future Years Defense Program before approving the program's entry into engineering and manufacturing development (EMD). In accordance with those procedures, the Patriot program is fully funded through the FYDP for EMD and for a production rate of 250 interceptors per year toward the 1,200 interceptor objective. The missile quantity will be re-examined throughout the development of the system and may be changed as the system evolves and better information becomes available. If it is later determined that more than 1,200 PAC-3 interceptors are needed, then the DoD may have to reconsider funding priorities in the post-2000 time frame to extend the planned production.

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**RECOMMENDATION**

**RECOMMENDATION:** In order to preclude expenditures on lower priority programs that may ultimately be unaffordable if funds need to be shifted to PAC-3, the GAO recommended that the Secretary of Defense direct the Director of BMDO to provide an accurate estimate of the number of PAC-3 interceptors required and a plan that resolves any resulting affordability problem. (p. 9/GAO Draft Report)

See p. 9.

**DOD RESPONSE:** Partially concur. As explained in the DoD response to Finding D, the DoD has adequately programmed for PAC-3 interceptors--no affordability problems are currently anticipated. The DoD will, however, reconsider the PAC-3 interceptor inventory requirement in the ongoing BMDO-led Theater Missile Defense Cost and Operational Effectiveness Analysis (COEA) scheduled for completion in late 1995. The COEA will consider the entire theater missile defense architecture and, unlike the current analyses, address contributions from systems other than the THAAD system, such as the potential Navy lower-tier and upper-tier systems. In addition, the PAC-3 interceptor inventory quantity will be reviewed prior to the PAC-3 low-rate initial production and full-rate production milestone reviews. At those decision points, the DoD will have higher confidence in cost and inventory data and can reprioritize funding, if necessary.

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The following are GAO's comments on DOD's letter dated January 12, 1995.

## GAO Comments

1. The wording on pages 1 and 2 was clarified in line with DOD's comments.

2. During the course of our audit, the affordability assessment group assured us we were reviewing the analysis that it had used to recommend the 1,200 requirement. In October 1994, a representative in the Office of the Secretary of Defense gave us a subsequent version of the analysis, which DOD now calls the "final results." Although we did not focus our report on DOD's "final results" assessment, we did analyze it to see if it provided proper support for DOD's 1,200 PAC-3 procurement objective. It did not. As discussed in comments 3 through 5 below, the "final results" also assumed allocation of enemy missiles to earlier versions of the Patriot (PAC-2 and GEM), which results in less effective protection of our forces. In addition, the "final results" contained several mathematical errors. Correcting for these errors and ignoring potentially offsetting faulty assumptions used in the analysis concerning the contribution of other systems supports a procurement objective of only 910 PAC-3 interceptors, not 1,200. Therefore, our conclusion that DOD needs to make an accurate calculation of PAC-3 requirements is still correct, and DOD has said it is currently conducting a Cost and Operational Effectiveness Analysis that will do this.

3. DOD is correct that the "final results" analysis used THAAD's interceptors only against longer range theater ballistic missiles that THAAD can intercept. Although this corrected one problem, DOD's solution increased another problem because it assumed that the shorter range theater ballistic missiles would be killed by PAC-2s and GEMS. We discuss this problem further in our comment 5.

4. According to the Joint Chiefs' study, only 33 percent of the Patriot batteries may be deployed with a THAAD battery. DOD said its final results fully accounted for that deployment strategy. We believe that it may have partially accounted for this problem. Proper consideration of the maldistribution problem would correct any remaining problem. (See comment 6.)

5. We questioned using PAC-2s and GEMS in lieu of PAC-3s to attack certain short-range theater ballistic missiles because their lesser capability would not meet the operational requirements established for PAC-3. The "final results" analysis also used PAC-2s and GEMS in lieu of PAC-3s. DOD justified

buying PAC-3 because GEM interceptors were not good enough. DOD said that although the PAC-2 and GEM interceptors cannot enforce the same defensive zone as the PAC-3 interceptor, operational commanders will use them to destroy tactical ballistic missiles against which they have a high probability of kill. DOD also said that the flexibility of the Patriot system permits the operational commander to use PAC-3 interceptors if intelligence information or other considerations would warrant their use. The ability of operational commanders to allocate resources during a battle as they believe best is not relevant to the question of using PAC-2 and GEM to reduce PAC-3 requirements. Using interceptors with less capability than PAC-3 simply lowers the degree of protection provided.

6. DOD said that in the “final results” analysis it had added a factor equal to about 20 percent of the procurement objective to account for not having the right number of PAC-3 interceptors at the right place at the right time. We were subsequently told that the 10 percent factor for contingencies in the version used by the affordability assessment group accounted for several factors, including maldistribution. In the “final results” analysis DOD added another 10 percent for maldistribution, raising the total percentage to 20 percent to account for all these factors. Although we recognize that the tailoring of an attack is a problem that DOD should address, our draft report did not include a specific adjustment to DOD’s 1,200 procurement objective for this factor because we had no basis for calculating one. Using the factor DOD used in its “final version,” we have increased the requirement calculated in the version used by the affordability assessment group by another 357 PAC-3 missiles.

7. Contrary to DOD’ comment, the “final analysis” did use a Navy lower-tier system to destroy part of the threat, thereby reducing the missiles PAC-3 must kill.

8. Our report raises the issue of whether DOD needs all 54 operational Patriot batteries because a study by the Joint Chiefs of Staff showed a need for only 45 to meet the two-MRC requirement, which raises a question about the need for the other 9. DOD said that in addition to the 45 batteries needed to fulfill the two-MRC requirement, it needed 10 more—6 batteries for permanent deployment in Saudi Arabia and 4 for the Alabama National Guard starting in 1996. However, the Secretary of Defense’s planning guidance states that peace operations and other small-scale operations “do not impose requirements for additional forces beyond those needed for two MRCS.”

The decision on where to obtain the four batteries needed to equip the Alabama National Guard has already been made, according to Army officials. None of the 54 operational batteries will be transferred to the Guard. In addition to the 54 operational batteries that the Army currently has, it also has another 20 radars, 20 engagement control stations, and 4 information and coordination centers in storage that were originally built for Italy but will not be sold to it. The Army plans to transfer four of the radars and engagement control stations and one of the information and coordination centers to the Guard. The launchers will come from either operational readiness floats or from training and testing assets.

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