

BY THE COMPTROLLER GENERAL

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# Report To The Congress

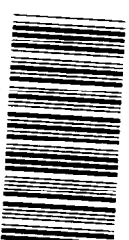
OF THE UNITED STATES

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## DOD Needs To Provide More Credible Weapon Systems Cost Estimates To The Congress

DOD's cost estimates for weapon systems programs are of major concern when the Congress is deciding to allocate billions of dollars to defense programs. GAO found DOD cost estimating guidance needs improvement and stricter implementation to ensure that cost estimates are uniform, consistently developed, and well documented. GAO also found that using more reasonable assumptions and independent cost estimates would result in more accurate reporting to the Congress.

This report contains numerous recommendations for improving DOD cost estimating and reporting. In addition, GAO believes that the Congress may want to consider requiring DOD to certify that estimates on major systems are based on sound cost estimating guidelines and represent the full cost of the weapon systems program.



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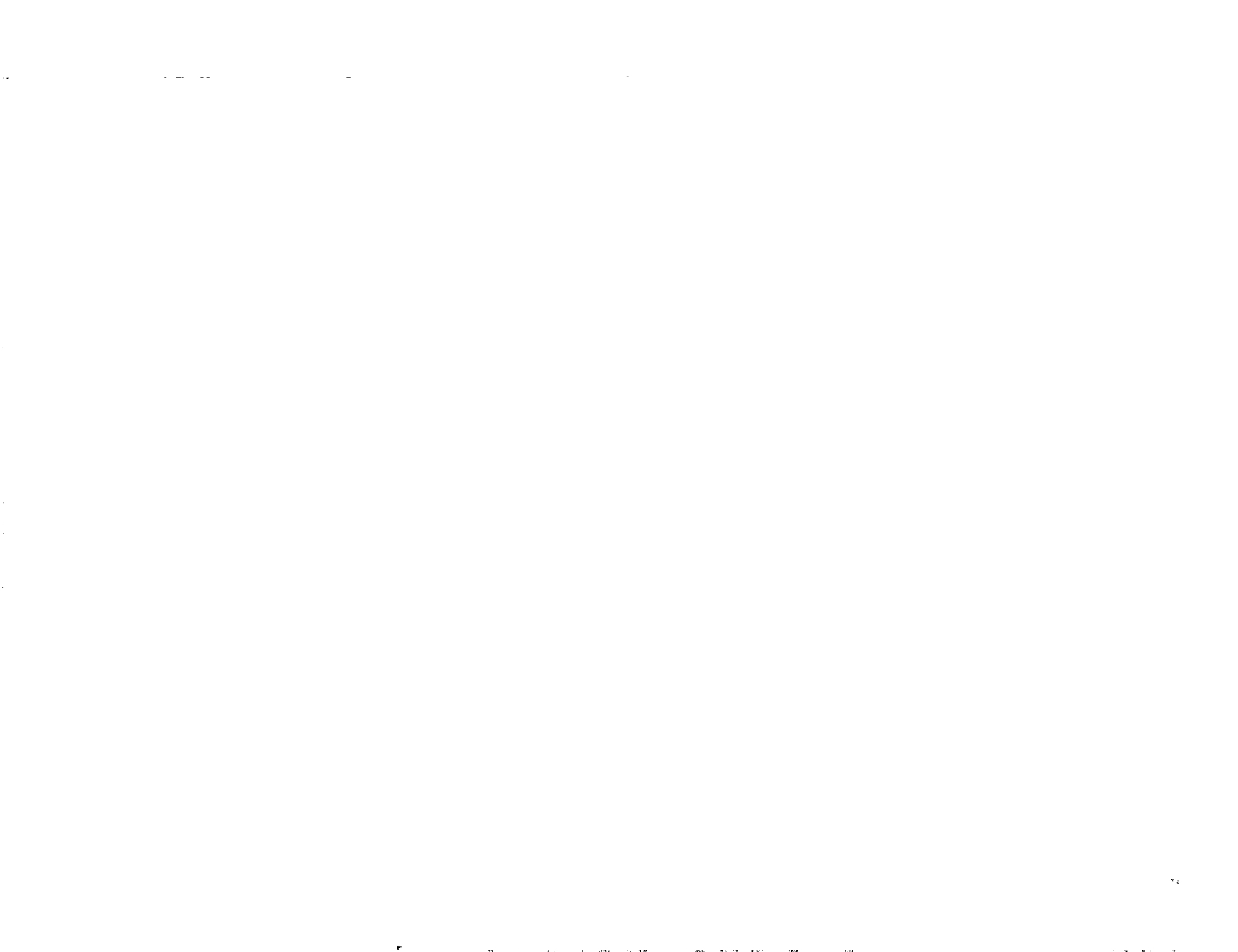
To the President of the Senate and the  
Speaker of the House of Representatives

This report describes the Department of Defense's process for developing and reporting weapon systems cost estimates to the Congress. It also discusses our views and recommendations regarding how the accuracy, completeness, and timeliness of these estimates can be improved. We made this review at the request of the Chairman, Senate Committee on Governmental Affairs.

We are sending copies of this report to interested congressional committees; the Director, Office of Management and Budget; and to the Secretary of Defense.

A handwritten signature in cursive script, reading "Charles A. Jones".

Comptroller General  
of the United States



D I G E S T

The Department of Defense's (DOD's) cost estimates for weapon systems programs are of major concern when the Congress is deciding to allocate billions of dollars to defense programs. The accuracy, completeness, and timeliness of DOD's cost estimates need to be improved to give the Congress more reliable data for its decision process.

The Congress has expressed considerable concern over the years about the effectiveness of DOD's cost estimating processes. In response to the request by the Chairman of the Senate Committee on Governmental Affairs, GAO reviewed DOD's cost estimating and reporting procedures.

GAO reviewed the DOD cost estimating process on seven selected weapon systems. GAO's sample includes three Army systems and two each from the Navy and the Air Force. While GAO's sample does not permit projection of the results servicewide or DOD-wide, GAO believes these cases illustrate the types of problems that have hampered effective cost estimating for weapon systems, and the lessons learned from these systems can serve as guidelines for improving the cost estimating process.

In the past 2 years, DOD and the services have initiated efforts to improve cost estimating and reporting. DOD's Acquisition Improvement Program includes several initiatives which, if implemented, should improve cost estimating. These initiatives address program budgeting, inflation indexes, and program restructuring. The services, especially the Army, have also begun to update guidance and improve estimating procedures. All these efforts are needed to help ensure the most effective estimating possible. (See pp. 46 to 49.)

COST ESTIMATES COULD IMPROVE WITH  
BETTER GUIDANCE, ASSUMPTIONS,  
AND METHODOLOGIES

GAO found that DOD could improve its cost estimating on the selected systems by  
(1) strengthening and implementing its

guidance for estimating, (2) introducing more realism into the assumptions and methodologies used, and (3) more fully using the recommendations of DOD's independent estimating groups.

#### GUIDANCE

Some guidance provided in DOD and service instructions is vague and conflicting. DOD and Air Force instructions, for example, allowed differing interpretations of what costs to include in the B-1B program estimate. As a result, some estimates included the cost of flight simulators and some did not. (See pp. 8 and 9.)

Guidance must be more strictly implemented to ensure estimates are properly structured and documented and consistently developed. GAO found that in some cases not all required costs were included in the estimates and all estimates were not updated as required.

On the Army's Apache helicopter, for example, \$350 million was excluded from the production decision program cost estimate for items that should have been included under applicable guidance. Two Navy programs did not properly document estimates as required by Navy regulations. (See pp. 9 to 13.)

#### ASSUMPTIONS AND METHODOLOGIES

Assumptions and methodologies used to prepare estimates can greatly affect the cost outcome. Assumptions regarding program risk are one aspect GAO noted in its assessment of the selected weapon systems. By assuming low risk, costs can be held to a minimum. On the Hellfire missile program, technical engineering risks of production were considered low and estimates were prepared accordingly, and not adjusted for higher risk. GAO's January 1983 report on the program, however, pointed out higher risk associated with several significant technical shortcomings in the missile which could affect production schedules and costs. (See pp. 14 and 15.)

The treatment of inflation in estimates is another area where the assumptions used are important. DOD regulations require use of the Office of Management and Budget's (OMB's)

developed inflation rates, but some estimates used other rates. (See pp. 15 and 16.)

A frequently reported estimating problem, and one which was also illustrated by GAO's case studies, is the use of overly optimistic assumptions relating to such things as construction schedules, allowances for uncertainties, fitting the estimates to the services' budget constraints, and excluding certain relevant program costs.

While DOD instructions call for the use of realistic factors and assumptions, management's desire to keep cost estimates as low as possible sometimes led to optimistic estimates. For example, the estimate for the Apache helicopter was reduced by \$72.6 million in March 1982 to conform to fiscal year 1983 budget guidance. Estimates are kept low by using the most optimistic assumptions regarding such factors as technical risk, development and production problems, and schedule and design disruptions. (See pp. 17 to 22.)

#### INDEPENDENT ESTIMATES

The Office of the Secretary of Defense and the services have established independent cost estimating groups to help ensure that cost estimates are more reliable and valid. GAO found some cases in its sample in which estimates by the independent estimators were more accurate than the official DOD estimates, but the independent estimators' recommendations were not used. In one case, an independent estimate pointed out that the fire control costs for the Apache helicopter could be significantly understated. This was not incorporated into the program estimate. The next year the contractor's estimate for the fire control system rose by about \$340 million--nearly a 60-percent increase. The 1984 DOD Authorization Act now requires the Secretary of Defense to consider independent estimates and report to the Congress regarding the use of these estimates in making decisions on major acquisition programs. (See pp. 22 to 24.)

While the services should not arbitrarily accept the recommendations of the independent estimators, GAO believes that their recommendations should be thoroughly considered and if they are not used, the services should document the reasons for not accepting the independent estimates.

DOD REPORTS PROVIDED TO THE  
CONGRESS NEED MORE REALISM

DOD reports its estimates to the Congress through reporting mechanisms such as the Selected Acquisition Reports (SARs), which are quarterly status reports of the cost, schedule, and performance of the major weapon systems, and the unit cost exception reports, which show when a system is in danger of exceeding unit cost thresholds established for that system. The Congress has expressed its dissatisfaction with the lack of timely and complete data in DOD's reports. The Special Panel on Defense Procurement Procedures noted in its February 12, 1982, report that:

"the SAR is inadequate in its reporting on major weapon systems to the Congress, thus inhibiting proper oversight. The SAR system does not consistently provide timely and complete information. The present SAR system provides quarterly updates that do not always reflect substantive fact-of-life changes that may have occurred in the program since the December 31 SARs." (See pp. 84 and 85.)

GAO found that while these reports provide much useful information to the Congress, DOD can improve them by expeditiously recognizing total anticipated program acquisition costs and reflecting them in the reports. For example, the TOW missile system has been a part of the Bradley Fighting Vehicle System requirements since June 1979. Costs for this missile system were known by the Bradley program office in 1982, but were not included in the SAR to the Congress until December 1983 when they were officially approved. (See pp. 38 and 39.)

The SARs also need to show the total planned acquisition objectives being considered for the weapon systems. In one case, total anticipated quantities did not appear sound; in others the quantities changed annually. For the Navy's LSD-41 ship program, for example, reports to the Congress indicated



a buy of 10 ships while internal Navy documents indicated a planned buy of 16 ships. In the case of Hellfire missiles, DOD has been purchasing about 6,000 each year and raised the total planned quantity to be purchased, reported in the SARs, by 6,000 each year. (See p. 39.)

GAO believes it is important that DOD's reports to the Congress on weapon systems include the most current and realistic estimates of program cost and status. Cost elements and quantities that are clearly anticipated to be incurred as part of the program should be disclosed as early as possible, even though they may not yet be fully approved within DOD. Such disclosure, perhaps in the form of footnotes or attachments to the SARs, would give the Congress a better idea of the complete program, and still allow DOD flexibility to change details of the program as it progresses.

#### RECOMMENDATIONS

GAO recommends that the Secretary of Defense improve weapon system cost estimating and reporting by (1) revising its cost estimating guidance and basic data used for estimating and ensuring stricter implementation of the guidance, (2) making fuller use of the recommendations of DOD's independent estimating groups, and (3) introducing more realism into weapon systems cost estimate reports that are provided to the Congress.

GAO's specific recommendations appear at the end of chapters 2 and 3. (See pp. 26 to 28 and 42.)

#### MATTERS FOR CONGRESSIONAL CONSIDERATION

GAO believes that better weapon systems cost estimates are possible and that earlier estimates of the realistic cost expectations for weapon systems can provide the Congress with a better basis on which to make resource allocation decisions among competing programs. In a recent case, the Congress and its oversight committees required the Secretary of Defense to certify the validity of DOD's cost estimates. Such certification could give the Congress greater assurance that the estimates

it receives are the most complete and realistic projections available. The Congress may want to expand this concept and require the Secretary to certify that the cost estimates which DOD provides on all major systems are prepared according to sound cost estimating guidelines and represent the full cost of the program. (See p. 42.)

#### DOD COMMENTS AND GAO RESPONSE

DOD reviewed a draft of this report and provided oral comments. Overall, DOD did not concur with GAO's findings and related recommendations on cost estimating and on the sufficiency of reports to the Congress. DOD was especially concerned with what appeared to DOD to be a fundamental misunderstanding by GAO of the criteria for cost estimating, budgeting, and cost reporting. DOD stated that GAO did not recognize DOD's long-standing agreements with the Congress that allow DOD to present certain costs in budget lines separate from the weapon systems budget line. DOD also stated that its criteria for cost estimating, budgeting, and cost reporting are different to meet specific needs of the congressional oversight committees.

In the draft, GAO proposed that DOD prepare new instructions for cost estimating to provide overall structure and to help ensure consistency. GAO has clarified and revised that proposal to recognize that DOD has volumes of instructions, and what is needed are improvements in that guidance, not more guidance. The examples noted in these case studies indicate that DOD cost estimates are not always complete and consistent, and GAO believes improved guidance and better implementation of it will result in better cost estimates.

DOD stated that its reports to the Congress are consistent with long-standing agreements with the congressional committees. While some of DOD's reporting procedures have been agreed to by specific congressional committees, the issues discussed in this report show that DOD's reports are still not fully meeting the Congress' needs for complete, accurate cost estimates. This view is indicated by the many

clear signals in congressional committee reports, hearings, and other sources that show dissatisfaction with the information the Congress gets from DOD on weapon systems cost estimates. This dissatisfaction has continued despite legislation attempting to achieve better reporting--attempts that include SAR reporting, Congressional Data Sheets, and the Nunn/McCurdy amendments, which established the unit cost exception reports. (See pp. 37 to 45 and app. VI item 4.)

DOD also stated that the criteria for cost estimating are different from those for budgeting and reporting. The examples drawn from GAO's selected weapon systems illustrate there are significant differences between the costs DOD estimates internally for its weapon systems, and the costs DOD budgets and reports to the Congress. While there are sometimes good reasons for such differences, these differences should be disclosed in DOD's reports and made clear to the Congress so the Congress has a better understanding of potential system costs.



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#### ABBREVIATIONS

ASARC	Army Systems Acquisition Review Council
DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
GAO	General Accounting Office

## ABBREVIATIONS

LAMPS MK III	Light Airborne Multi-Purpose System
LSD-41	Landing Ship Dock
OSD	Office of the Secretary of Defense
OMB	Office of Management and Budget
SAR	Selected Acquisition Report
TOW	tube-launched optically tracked, wire guided missile

## GLOSSARY

Cost Analysis Improvement Group (CAIG)

The principal advisory body to the DSARC on matters of cost. Organizationally located in the Office of the Secretary of Defense, Director of Program Analysis and Evaluation.

Cost estimating relationship

A mathematical relationship that defines cost as a function of one or more parameters such as performance, operating characteristics, physical characteristics, etc. For example, past aircraft acquisitions may show that the cost of electronic components for aircraft tends to be X dollars per pound.

Decision Coordinating Paper (DCP)

The principal document to record essential system program information for use in support of the Secretary of Defense decision making process at the major acquisition milestones.

Defense Systems Acquisition Review Council (DSARC)

An advisory body to the Secretary of Defense on major system acquisitions. The Council members are the service secretaries and the OSD staff principals.

Engineering estimate

Sometimes referred to as "grass-roots" or "bottoms-up" estimate. An industrial engineering based approach relying on detailed simulation of all the operations and an exhaustive list of all the materials required.

Five-Year Defense Program (FYDP)

The Five-Year Defense Program summarizes all approved programs of the entire Department of Defense. Resources or inputs for 5 years are combined with military outputs or programs



	for the same period. FYDP is expressed in terms of programs, program elements, and resource categories.
Independent estimate	An estimate of program cost developed outside normal advocacy channels by a team which generally includes representation from the functional areas of cost analysis, procurement, production management, engineering and program management.
Parametric estimate	A cost analysis which involves the development and use of estimating relationships between historical costs and other program variables such as system physical/performance characteristics, contractor output measures, manpower loading, and facility floor space.
Production decision	The last of the major milestone decision points. At this point the Secretary of Defense decides whether a weapon system is to proceed into final production and be deployed in the field.
Program Objectives Memorandum (POM)	A memorandum in prescribed format submitted to the Secretary of Defense by the Secretary of a Military Department or the Director of a Defense Agency which recommends the total resource requirements within the parameters of the Secretary of Defense fiscal guidance.
Selected Acquisition Report (SAR)	The standard, comprehensive, summary status report on major defense acquisition programs which reflects the

system program manager's current "best estimate" of key performance, schedule, and cost goals, compares these estimates with baseline parameters (established at the time the program was approved for full-scale development), and explains all variances from the baseline.

#### Unit Cost Report (UCR)

A report on the status of (1) program acquisition unit cost (total program cost divided by the total quantity), (2) current procurement unit cost (current fiscal year procurement cost divided by quantity to be procured in the current fiscal year), (3) contract costs, (4) schedule, and (5) performance. The UCRs are also to include any known, expected, or anticipated changes from the schedule milestones or operational and technical characteristics shown in the baseline program. It is submitted by the program manager on each SAR program at the end of each calendar quarter or when the program manager expects the unit costs to breach the thresholds described in the UCR legislation.

## CHAPTER 1

### INTRODUCTION

Cost estimates for major weapon systems are a crucial part of the acquisition process, especially in a resource-scarce environment. If decisionmakers are to exercise sound judgment about the affordability of weapon systems, high quality estimates of weapon systems' costs must be generated by the Department of Defense (DOD) and the services. For the estimates to be credible and useful to decisionmakers, they must be developed under clearly consistent and precise guidance which specifies the estimates' purpose, basis, and methodology.

### CONGRESSIONAL REQUEST

In May 1982, the Chairman, Senate Committee on Governmental Affairs, requested us to assess the effectiveness of DOD cost estimating processes for major weapon systems. The Chairman expressed concern over the cost estimating process, the use of contractor data, and the development of DOD's official cost estimates. The Chairman asked us to examine several actual examples of how the cost estimating process worked for specific major acquisitions. (See app. I.)

We selected seven weapon systems as case studies--two Air Force, two Navy, and three Army acquisition programs. We selected some weapon systems in early development and some in production. To meet the Chairman's request, we reviewed the estimating process from the estimates of the program office cost estimators, through the DOD hierarchy, to the reporting of those estimates to the Congress.

### THE PURPOSE OF DOD COST ESTIMATES

Various regulations and directives of the Office of the Secretary of Defense (OSD) and the services govern the cost estimating process. They are intended to specify which organizational element develops estimates for what purpose, how the estimates are to be reviewed and validated, and how they are to be reported to the Congress. (See app. II.)

The directives emphasize affordability, priority, and availability of fiscal and manpower resources. At each acquisition milestone, the investment the service is willing to commit and the program priority is reconciled with overall capabilities, priorities, and resources. Directives specify that system acquisition planning shall be based on adequate program funding. Programs are not to proceed into concept exploration or demonstration and validation unless money is available. Approval to proceed into full-scale development or production also depends on the availability of money at those times.

To ensure a maximum cost/benefit in systems acquisition, each service strives for the same ultimate objective--to have high quality cost estimates available to decisionmakers. In line with this objective, service regulations have specified the role and function of cost estimating.

DOD Directive 5000.4 assigns to the Cost Analysis Improvement Group under the Director, Program Analysis and Evaluation, the primary responsibility in OSD for cost estimating. This group provides the Defense Systems Acquisition Review Council (DSARC) with an evaluation of service independent and program office cost estimates. (See app. III.)

#### CRITERIA BASIC TO AN EFFECTIVE ESTIMATING PROCESS

Our last comprehensive review of DOD cost estimating policies and practices resulted in a July 24, 1972, report to the Congress entitled Theory and Practice of Cost Estimating for Major Acquisitions (B-163058). The report's principal findings and conclusions were that uniform DOD guidance on cost estimating was lacking. We also found documents to be inaccurate, and readily retrievable cost data for computing estimates was lacking. We suggested nine criteria for effective estimating:

- Clearly identify the task.
- Ensure broad participation in preparing estimates.
- Ensure valid data is available.
- Standardize the structure for estimates.
- Provide for program uncertainties (risks).
- Properly recognize inflation.
- Recognize excluded costs.
- Independently review estimates.
- Revise estimates when significant program changes occur.

These criteria are explained in appendix IV.

OSD and the services have taken steps to improve their cost estimating. OSD's efforts are part of the DOD Acquisition Improvement Program. The services, particularly the Army, also have efforts underway to improve their cost estimating as discussed in detail in chapter 4. (See pp. 46 to 49.)

#### CRITICISM OF DOD COST ESTIMATING

DOD has been widely criticized for the increasing cost growth in major weapon systems acquisition. For instance, the American Defense Preparedness Association report of The Results

of a Cost Discipline Conference, held July 21 to 22, 1982, concluded:

"Cost estimates on weapons systems development programs are not well done, are not updated with sufficient frequency, and are characterized by being overly optimistic, particularly at the early stages of the program. Many of these problems stem from the competitive nature of the DOD budget, defense industry competition, and the contracting process."

In another view, the U.S. Army Audit Agency report HQ 82-709, of April 30, 1982, on four missile command programs states:

"Program cost estimates for the Hellfire, Pershing II, and Viper understated future costs of producing the systems.

"The cost estimating process for development and production contracts was not adequate.

"Overall guidance on preparation of independent government cost estimates is lacking.

"For the Hellfire, Multiple Launch Rocket System, and Pershing II, breaches to cost thresholds were either not reported or not reported promptly in revised decision coordinating papers to Army/Defense Systems Acquisition Review Councils for their required review and approval. . . . Long delays were also experienced in reporting large cost increases in the Selected Acquisition Reports."

The February 12, 1982, report of the Special Panel on Defense Procurement Procedures of the House Armed Services Committee (McCurdy Panel) found:

"The factors contributing to cost growth are unrealistic inflation estimates, poor cost estimates, program stretch-outs, changes in specifications, inadequate budgeting, high risk system design, poor management, and lack of competition . . . . (Emphasis Supplied.)

"The present SAR [Selected Acquisition Report] system provides quarterly updates that do not always reflect substantive fact-of-life changes that may have occurred in a program since the December 31 SARs."

#### OBJECTIVES, SCOPE, AND METHODOLOGY

Cost growth on major weapon systems has been recognized as a long-standing problem by all the players involved, including

DOD, the Congress, military contractors, the Congressional Budget Office, our office, and so forth. The estimating process is frequently cited as a significant contributor to understated costs.

We took a broad approach to this review of the estimating process. Our objectives were to look for instances where occurrences or factors causing cost growth should have been anticipated by the program office, the services, or OSD, but were not, or where such items were purposely not considered, or where actions were directed to create the appearance of reduced program costs. We did not limit our review to instances of cost growth directly attributable to cost estimating methodologies. Our review included all cost growth contributors to determine why they were not recognized earlier in the life of the program. Our approach was to examine DOD's cost estimating process to determine what improvements can be made regarding estimating techniques and processes, management of the process, and the environment in which the estimates are made.

Our conclusions and recommendations are based on the problems observed in DOD's cost estimating process on seven selected weapon systems. We selected these systems beginning with the B-1B bomber because our previous work on the B-1B brought the issue of DOD cost estimating to the attention of the Chairman, Senate Committee on Governmental Affairs. We decided that the other systems in our sample would be selected to include:

- systems from all three services;
- different types of weapon systems, that is missiles, aircraft, tracked vehicles, and ships;
- systems in different phases of the acquisition process;
- systems which were major and nonmajor--as defined by the SAR reporting requirements in effect at the time of our review; and
- systems that were not the subject of ongoing reviews by us or the audit agencies of OSD or the services.

We selected the following systems:

System name	Service	Weapon type	Phase of acquisition
Apache Helicopter	Army	Aircraft	Production
Bradley Fighting Vehicle System	Army	Tracked vehicle	Production
Hellfire Missile	Army	Missile	Production
Light Airborne Multi-Purpose System (LAMPS) MK III Helicopter	Navy	Aircraft	Production
Landing ship dock (LSD)-41	Navy	Ship	First three ships under contract
T-46A Trainer	Air Force	Aircraft	Development
B-1B Bomber	Air Force	Aircraft	Development

Descriptions of these systems appear in appendix V.

While our conclusions, and hence our recommendations, result from our review of a relatively small, nonscientific sample of weapon systems which does not permit projection of the results servicewide or DOD-wide, we believe that the problems we observed on those systems are consistent with the findings of other studies and illustrate the types of problems that have hampered effective cost estimating for weapon systems. Appendix VI is a listing and brief synopsis of pertinent studies, reports, and other writings we reviewed during our study that address similar cost estimating problems. Appendix VII lists our past reports that address the area. Our examples--drawn from the in-depth review of the cost estimating process for seven<sup>1</sup> systems--serve as illustrations of problems that have been discussed in these studies. While those broad-based studies indicate a problem exists, our in-depth analysis provides concrete examples of the problems and the lessons learned from these examples that can serve as guidelines for improving the cost estimating process. These examples show problems in all three services, and we have not attempted to compare the services or evaluate which is doing a better estimating job.

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<sup>1</sup>The T-46A is in the early stages of the acquisition process. Therefore, a cost history was not available on the T-46A, and for this reason, it was not used as an example of cost estimating problems in this report.

In doing our review, we obtained and reviewed applicable DOD, service, and major command regulations, directives, instructions, guides, pamphlets, circulars, policy and procedure statements, memorandums, and correspondence to describe the cost estimating process. We also interviewed cognizant OSD, service headquarters and commands, and program office representatives.

To trace the most recent major costing effort and identify all the major costing efforts, we interviewed representatives of OSD, the service headquarters and commands, the program office, contractors, the service plant representative offices, and the Defense Contract Audit Agency at contractor locations. We also obtained, reviewed, and compared applicable cost estimates, validations, analyses, briefing charts, studies and reports, decision and position papers and memorandums, system specifications, minutes of meetings, correspondence, and supporting documents.

We obtained, reviewed, and compared applicable SARs, unit cost reports, and applicable unit cost exception reports. We reviewed applicable guidance and compared the reports to current cost estimates. Also, we interviewed representatives of OSD, service headquarters and commands, and the program offices to evaluate the reports.

To assess the status of recent service cost estimating initiatives, we obtained and reviewed service audit agency reports, special study reports, a service Memorandum of Understanding, recent command circulars, and service headquarters and command letters of instruction. We also interviewed service headquarters and commands, and program office representatives.

The audit work for this review required visits to contractor locations, program offices, testing facilities, command and service headquarters, DOD Headquarters, and OSD. (See app. VIII.)

DOD comments are discussed at the end of the relevant chapters. We also asked the American Defense Preparedness Association to review our draft report. Their written comments are presented in appendix IX. While the American Defense Preparedness Association questioned whether our examples were too old to demonstrate the current situation, it still agreed with the overall message of our report.

Appendix X includes analyses of the December 1982 SAR reports for the 36 programs for which the impact of the production decision could be identified in past SARs. Four of our selected systems--the Hellfire missile, the Apache Helicopter, the Bradley Fighting Vehicle System, and the B-1B Bomber--are included in these analyses. An explanation of our methodology for these analyses is included in the appendix.



Our review was performed in accordance with generally accepted government auditing standards. The review was initiated in July 1982, and fieldwork completed by March 31, 1983. The information in this report has been updated to take into account changes since the completion of fieldwork.

## CHAPTER 2

### DOD NEEDS BETTER GUIDANCE,

#### ASSUMPTIONS, AND METHODOLOGIES FOR ESTIMATING

Logically, cost estimators should prepare their estimates by using basic source data and working within the structure provided by OSD and service guidance. Although many of the criticisms of cost estimating are aimed at the cost estimators, some of the factors with the greatest effect on cost estimates are beyond their control. The DOD hierarchy tells them what to estimate and what techniques and basic data to use in developing their estimate. The examples provided by our selected weapon systems show that:

- In some cases, OSD and the services need to improve their cost estimating guidance.
- OSD and the services need to improve the implementation of their cost estimating guidance. On some of the seven systems we reviewed, estimates were not structured as required under current regulations; others were not documented as required to verify how the estimates were developed, and to trace from one estimate to the next.
- Improvements are needed in the assumptions and methodologies used to develop an estimate.
- Improvements are needed in the assumptions often recommended by DOD management.
- Independent cost estimators' estimates and recommendations are not always adequately used.

#### DOD NEEDS TO IMPROVE ITS COST ESTIMATING GUIDANCE

The services have developed their own cost estimating guidance. In some cases, we found the service guidance was vague and in other cases it conflicted with OSD guidance.

Vague cost estimating guidance is shown by the Army's costing guides. For example, these guides, in addressing the question of what costs should be attributed to a specific system, state

"if a given component would not exist if the system did not exist, then that component must be included in the definition of the materiel system."

Such a broad generalization appears to us to be subject to varying interpretations.

Conflicting service guidance has a severe effect on program office estimates, particularly when these problems affect the definition of the system to be estimated. The Air Force's B-1B bomber program has suffered from some of these problems.

The B-1B program office was told by the Secretary of Defense to exclude certain items (e.g. the simulator<sup>1</sup>) from the B-1B program so that the President could certify that the program costs would not exceed \$20.5 billion. The B-1B program office estimate excluded these items, but the independent Air Force estimate and OSD Cost Analysis Improvement Group estimates included them. The B-1B SAR does not include these items or their costs, but lists them as related programs.

On July 22, 1982, we testified before the Defense Subcommittee of the House Appropriations Committee on the differences in the B-1B program office estimate, the independent Air Force estimates, and the OSD Cost Analysis Improvement Group estimates. One of the problems we noted was conflicting guidance on what is to be included in the program. For example, DOD Instruction 5000.33 indicates that some costs can be excluded from the program office estimate when funded by a separate budget line. In contrast, Air Force Systems Command Regulation 500-18 indicates that the program office estimate is to include all directed effort for which the program office has management responsibility, regardless of the source of funds. We believe this guidance allows too much latitude to the program manager and it is not definitive enough to ensure uniformity of cost estimates presented to the Congress.

#### IMPLEMENTATION OF GUIDANCE IS WEAK

DOD needs to improve the implementation of its cost estimating guidance. Our selected weapon systems provided illustrations of problems resulting from poor implementation, including

- a lack of definite and consistent cost estimate structure and
- inadequate documentation of cost estimates.

#### Cost estimates lack definite structure

If cost estimates are to be useful to decisionmakers, they must have a definite and consistent structure. Such a structure would ensure that all costs associated with a weapon system are

<sup>1</sup>We were told that the current Air Force policy is to fund simulator development under the Simulator System Project Office program element, excluding this cost from the program office estimate.

included in the estimate, and that the estimates consistently include all associated costs from one period to the next. However, we found that in some cases what is included in the weapon system estimate is not consistent between estimates.

#### Lack of consistent program definition

DOD and service guidance establish and define the work breakdown structures to be used for cost estimates of major weapon system acquisitions. A work breakdown structure is a detailed description of the tasks to be accomplished to achieve a specified product. Military Standard 881-A establishes the work breakdown structure, uniform definitions, and a way to develop the upper three work breakdown structure levels. The Air Force Systems Command Manual 173-1 and Army Pamphlets 11-2 through 11-5 also establish the basic pattern for estimates and give work breakdown structure matrices of cost structures to be used. Despite this guidance, problems occur regarding what is included in the program definition, and the program cost estimates are not consistent.

An example that illustrates these problems occurred on the Army's Apache helicopter. The production decision program cost estimate for the Apache, although based on Military Standard 881-A, excluded \$291 million in research, development, and investment costs associated with the combat mission simulator, (required under 881-A element 40.2.2.1 app. A) and \$59 million in costs associated with aircraft survivability equipment (required under 881-A elements 40.2.1.7 and 40.2.1.15 app. A).

Another example occurred on the Army's Bradley Fighting Vehicle System. Different structures were used to develop the 1979 and 1982 program cost estimates for the Bradley:

	(millions)
1982 program office estimate	\$13,358.7
1979 program office estimate	7,742.0
Difference	<u>\$ 5,616.7</u>

The two estimates were not prepared at the same work breakdown structure level and were not consistent in the cost elements included. The 1979 program office estimate was used to support the production milestone decision, and the 1982 program office estimate was developed for the Army's new Program Management Control System. Both estimates are based on contractor data, but in 1979 the contractor used the approved work breakdown structure (that is, hull, suspension, power package, etc.). However, in the 1982 estimate, the contractor's manufacturing costs were broken out by the contractor's internal reporting structure, not by the work breakdown structure used in the 1979 estimate. Thus, the two estimates are not comparable. Without consistently structured estimates, the Bradley Fighting Vehicle System program office cannot explain why costs increased \$5.6 billion between these two estimates.

### Systems not defined

The services often change their total program cost estimates by adding or deleting costs. Program "restructuring" has become an acceptable reason for changing the program's total cost. Although restructuring is done for legitimate reasons in some cases, in others it simply presents a lower total cost. The following example illustrates how program costs are added to a program estimate and then deleted from a later estimate.

The September 1979 vehicle investment estimate for the Bradley Fighting Vehicle System excluded several product improvements identified earlier in the June 1979 system requirements on which the estimate was based. These same product improvements were later added to the program cost estimate in the December 1980 SAR with a projected cost increase of \$740.9 million as shown below:

	(millions)
Low profile antenna	\$ 9.982
Heading reference unit	49.244
Thermal driver viewer	221.303
Laser rangefinder	154.458
Swim barrier	30.890
Biological/chemical protection	275.187
	<u>\$740.900<sup>a</sup></u>

<sup>a</sup>Does not add due to rounding by fiscal year in the SAR.

These same items, although they were included in the March/July 1982 program office estimate, were deleted from the December 1982 SAR estimate because they are no longer part of the approved program, and a cost reduction of \$982.1 million, including inflation, was reported.

Similarly, the ammunition costs for the Bradley System were reported inconsistently. The 1979 program estimate showed ammunition costs of \$423.2 million. This figure was increased by \$542.8 million in the December 1980 SAR estimate. In 1982 DOD decided to report ammunition costs as a separate budget item because the 25mm ammunition was not unique to the Bradley. Ammunition costs were totally deleted from the December 1982 Bradley SAR, resulting in a cost reduction of \$1,160.2 million. No explanation was provided for the mathematical inconsistencies in the figures.

### Estimate documentation is insufficient

DOD and service regulations require documented cost estimates to allow traceability from one estimate to the next, allow verification, and maintain cost discipline. An earlier edition of DOD Instruction 5000.2, for example, stated:

"Traceability of successive cost estimates . . . shall be maintained starting with the program cost estimates approved at Milestone I."

The current version of DOD Instruction 5000.2 does not include this statement. DOD Instruction 5000.2 has been shortened from 20 pages to 7 pages, and the new version deletes many of the specifics concerning cost estimating. Similarly, Air Force Regulation 550-18 states that the program office estimate has two main objectives:

"(1) to establish and maintain program cost discipline and

"(2) to provide an unequivocal cost track."

Our 1972 report discussed problems in DOD's documentation of data sources, assumptions, methods, and decisions basic to the weapon systems cost estimates. We found similar problems on some of our selected weapon systems. The following examples are of systems with documentation that could not be used to evaluate the estimating procedures or explain the reasons for cost growth from one estimate to the next.

The Navy's LSD-41 and LAMPS MK III  
helicopter programs

The Navy programs we reviewed did not document their estimates as required by Navy regulations. The principal Naval Sea Systems Command, Naval Material Command, and Chief of Naval Operations and staff cost estimating regulations mandate a "Cost Estimate Documentation Summary" (Naval Material Command Form 7000/2) which summarizes weapons system characteristics, procurement quantity, and assumed production quantity. A Navy Decision Coordinating Paper and a statement about the estimator's confidence in the estimate are also required.

A Cost Estimate Documentation Summary was not prepared on the LSD-41 program. The only documentation for the multi-billion dollar program estimate was the budget backup material which included little of the required information. Cost and program information in the Navy Decision Coordinating Paper was outdated. No statement regarding the confidence the Naval Sea Systems Command has in the estimate was included except for the assertion that the program was low risk.

Navy regulations further state that, "documentation of estimates is the key to tracking of weapon systems costs." The Chief of Naval Operations Instruction 7000.17A requires a cost profile track for each program that traces the history of costs involved in the program, from concept formulation to the present time. This also displays funding changes and their rationale.

No such cost profile track was available on the LSD-41 program. Estimate tracking has been done through budget documents since the program entered production in fiscal year 1981. The LSD-41 program office had difficulty providing documents for tracking program cost estimates because of changes in cost estimating staffs.

The Navy used an iterative approach to its cost estimates on the multibillion dollar LAMPS MK III helicopter program. Whenever new information was developed, the previous estimate was updated. The Navy did this even for the production decision which took place in September 1981. The tracking system for these iterations is informal, consisting largely of internal file folders. Whether the tracking can or cannot be reproduced depends on the recordkeeping of the individual estimator. We found no formal documents to tie the Decision Coordinating Paper and SAR cost estimates into a work breakdown structure explaining how estimates were made, or referral to specific pricing data inputs.

#### The Army's Bradley Fighting Vehicle System program

Again, the purpose of documentation is to provide the means for tracking program cost estimates and enforcing cost discipline. Without such documents, tracking of estimates over the period of the system development span is impossible, and changes to the estimate due to quantity, engineering, and schedule cannot be explained.

For the Bradley Fighting Vehicle System, the 1979 program cost estimate was the cost projection used to support the production milestone decision. It was not the bench mark for tracking and controlling system costs. It had no other apparent purpose than to meet the Army Regulation 11-18 requirement that a program cost estimate be prepared in support of the Army Systems Acquisition Review Council (ASARC) and the DSARC for the production milestone decision.

Officials of the Bradley's program management division stated that they used the budget figures reported in the SAR to track costs rather than the program cost estimate developed for the DSARC process. For instance, they say the budget for the fiscal year 1982 approved program appearing in the December 1980 SAR was, in essence, a revised program cost estimate. Officials maintain that the SAR variance analysis provides a cost track back to the December 1979 SAR (fiscal year 1981 approved program), and that this is all that is necessary for cost tracking.

The result is that the program office can track costs only in general terms and only from SAR to SAR. They cannot track or explain in detail the \$5.6 billion increases from the \$7.7 billion estimate of 1979 to the \$13.3 billion estimate of 1982. (See p. 10.)

ASSUMPTIONS AND METHODOLOGIES  
NEED IMPROVEMENT

Examples from weapon systems we reviewed illustrate weaknesses in the assumptions and methodologies used to develop cost estimates with regard to

- the recognition of program risk and
- consistency of inflation recognition.

Recognition of program risk

Estimators should identify the risks, determine their probability, and increase the amount of the estimate by the magnitude of the risk. We found that cost estimators base their estimates on the information available to them at the time. Early estimates are often optimistic, or success oriented, and the risk factor included in them to provide for uncertainties is probably too low. Thus, when the early cost estimates are compared to later estimates, one typically sees large cost increases. This is illustrated by the SAR data displayed in appendix X. Cost estimators assume that the system they are estimating will not suffer from typical changes in scheduling, funding, engineering, or the threat.

The February 9, 1983, Air Force report--the Affordable Acquisition Approach--comes to a similar conclusion. It shows that most weapon systems will suffer from these kinds of changes. The Affordable Acquisition Approach concludes that early program estimates need to include provisions for historically proven growth such as changes, unknown development problems, overly optimistic baselines, and so forth.

Army estimators told us the most difficult cost estimating job is to make sure that estimates remain synchronized with changing requirements. However, frequently changing requirements make it very difficult to keep them in line. The Army is trying to provide for changes in programs through a system called Total Risk Assessing Cost Estimating. (See p. 48.)

Army's Hellfire missile program

The Hellfire production estimate provides an example that shows some estimates do not include all the necessary provisions for risk. The program and independent estimates do not include technical analyses addressing engineering risk. Army officials told us they did not perform an engineering risk analysis for the production phase because at that time it was not required and they stated that technical risks during the production phase



are low. However, in our January 1983 report<sup>2</sup> on the Army's Apache helicopter and Hellfire missile programs, we reported that there were still significant shortcomings in some major Hellfire components. Because the Army decided not to conduct the technical analyses, the risks associated with these shortcomings were not considered in the Hellfire production estimate.

Another example of insufficient consideration for risk relates to the Apache helicopter discussed on page 23.

### Consistency of inflation recognition

The cost estimates for weapon systems must be consistent for the Congress to make comparisons between them. DOD often did not recognize inflation consistently in the weapon systems we reviewed. For example, in some cases we found (1) contractor inflation indexes were used to calculate inflation, (2) different inflation indexes were used for estimates of the same weapon systems, and (3) inflation was used as a device to hide other cost increases.

#### Use of contractor indexes

DOD cost estimates are required to use the Office of Management and Budget (OMB)-mandated inflation rates--the December 1980 SAR estimate for the Bradley did not. The December 1980 SAR (fiscal year 1982 approved program) for the Bradley Fighting Vehicle System reported a \$2,748 million increase in the baseline vehicle estimate over the September 1980 SAR (fiscal year 1981 approved program). According to program officials, most of this increase, \$2,541 million, reflected contractor projections of inflation. These projections were significantly higher than the OMB mandated indexes that were supposed to be used.

#### Different indexes used on same program

The August 1981 program office estimate and the independent estimate for the Army's Hellfire used different OSD/OMB inflation indexes. The program office estimate used March 1981 inflation indexes but the independent estimate used July 1981 indexes. Since the July indexes projected lower inflation factors than the March ones, the independent estimate was lower than it would have been otherwise. The result of using different inflation indexes was that the difference between the two estimates was about \$55 million less than it would have been if the same index had been used for both estimates.

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<sup>2</sup>The Army's AH-64 Helicopter and Hellfire Missile Retain Risks as They Enter Production. (Unclassified digest.)  
(GAO-C-MASAD-83-9, Jan. 26, 1983.)

Inflation used to hide other costs

The treatment of inflation and the practice of some program managers to attribute cost increases to inflation was discussed in an April 1982 Comptroller of the Army report. The report states:

"Program Managers tend to define inflation in different terms. Often any change other than a programmatic change that occurs in a system is attributed to inflation. As an example, the Pershing II Program Manager has developed inflation indices based on contractor labor rates and material prices to account for 'inflation' in the Pershing II program. This is in direct contradiction to the definition of inflation described in [DOD 7000.3 G]. For cost estimating, programming, budgeting, and reporting, the Army must employ a definition of inflation based on national statistics."

According to program office officials and the Secretary of Defense Decision Memorandum issued in conjunction with the production decision, the Army's Apache helicopter production estimate of March 1982 included an adjustment of \$72.6 million to conform to the President's budget. Strict application of OMB's January 1982 inflation index would have resulted in a production cost estimate of \$7,453.4 million--the estimate required to conform to the President's budget was \$7,380.8 million. This \$72.6 million adjustment was explained to us as an inflation adjustment. However, the program office accounted for this change by reducing the base program by \$56.5 million in recurring production costs, \$16 million in the costs for spares, and \$.2 million in other costs. In addition, in the SAR report, this reduction is spread among the various cost variance categories--it cannot be specifically identified.

The Army's Bradley System showed a \$2.5 billion increase because contractor indexes were used in calculating inflation in its December 1980 SAR. (See p. 15.) A subsequent cost analysis by the program office indicates that the increase was not purely inflation, but included some real cost growth.

Cost per vehicle

Real	\$543,000 to \$639,000 = 17.7%
Inflation	\$639,000 to \$818,000 = 32.9%
Total	\$543,000 to \$818,000 = 50.6%

The real cost increase per vehicle is \$96,000 (\$639,000 minus \$543,000). The total real cost growth for 6,882 vehicles is, therefore, \$660.7 million. This increase was included in the \$2.5 billion inflation increase (calculated using contractor indexes) reported in the December 1980 SAR. The program office

analysis pertained to rollaway cost, which excludes some major program components; therefore, the figures in the above chart do not explain the entire \$2.5 billion increase.

IMPROVEMENTS NEEDED IN THE DIRECTION  
PROVIDED BY DOD MANAGEMENT

Cost estimates are not made in a vacuum. DOD management officials tell estimators what to estimate and how, in terms of the physical and performance characteristics of the system and the techniques and assumptions to be used. Once a cost estimator has prepared the figures on what a system should cost, based on the system definition and program assumptions provided, the estimate must progress through the successive layers of DOD management. One problem has been that such a hierarchical organization tends to influence estimators to use the most optimistic assumptions possible because they result in lower estimates which are seen as making a greater contribution to program approval.

This problem has been addressed in past studies, including The Air Force Cost Estimating Process: The Agencies Involved and Estimating Techniques Used, (see app. VI item 1) and Defense Acquisition: A Game of Liars Dice? (see app. VI item 7).

When estimators are encouraged to use optimistic assumptions regarding system design requirements, number of units, length of time for procurement, financial considerations regarding contractors, and so forth, it results in an overly optimistic estimate of what the system could cost if the acquisition strategy goes perfectly. However, history shows that system acquisitions rarely go according to plan--a myriad of influences determine their ultimate cost and performance. These influences have resulted in systems exceeding original and revised cost estimates.

Management direction is often optimistic

On March 22, 1982, the Assistant Secretary of the Navy for Shipbuilding and Logistics issued guidance that the ship construction budget for fiscal year 1984 be repriced using less conservative estimating assumptions to produce a more optimistic estimate. Although the guidelines of the March 22 memorandum were not implemented, the Navy did develop more optimistic estimating assumptions. These assumptions were incorporated in the April 9 guidelines used in the subsequent repricing of, and attendant \$2.7 billion reduction in, the Navy's Five-Year Shipbuilding Plan.

In the March 22 memorandum, the Assistant Secretary stated that high estimates are a self-fulfilling prophecy--estimates should be kept low to force constraints on contractors. Among

the major cost driving assumptions that were to be reestimated optimistically, were:

- Assume that the shipyard with the lowest labor rates will receive the contract award where more than one yard is competing.
- Assume no growth beyond target cost where a 50/50 share line<sup>3</sup> for cost overruns exists.
- Eliminate all future characteristic changes (this is a budgeted reserve for changes to ship design and technical specifications).
- For competitive procurements, assume 10 percent maximum profit.
- Eliminate change order margins or identify magnitude and rationale. Change order line for repeat construction must be less than for prior years. Do not use percentage of basic construction costs to calculate change order allowances, but reduce the amount to no more than the absolute value of the first program year, escalated to the current year.
- Shorten all construction periods 1 month; for 50/50 share lines reduce the period by 2 months.
- Reduce labor hours and material costs by 10 percent.
- Eliminate program managers' growth<sup>4</sup> as a percentage of government-furnished equipment costs. Substitute an absolute value equal to the first program year and escalate to the current year.

These guidelines were not implemented. Officials of the Naval Sea Systems Command determined the March 1982 guidelines to be overly optimistic and on April 9, 1982, the guidelines were revised as follows:

- Where competition is expected, use the cost factors supporting the lowest cost estimate when preparing the Program Objective Memorandum.

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<sup>3</sup>Any cost overruns beyond target cost are to be shared equally between the government and the contractor.

<sup>4</sup>A funding category for unforeseen contingencies.

- No guideline for growth beyond target cost was established because growth was never assumed beyond the target cost.
- The future characteristics changes should be specifically determined by the Chief of Naval Operations sponsor with a specific change in mind.
- For situations where real opportunity for competition exists, estimates should include a 10-percent profit factor.
- Ten percent of the basic ship cost and planning cost is allowed for the lead ship change order line. Five percent of the basic cost is allowed for follow-on ship change order lines.
- Scheduled construction times for planning will be determined by the office of the Naval Sea Systems Command Principal Deputy Commander for Acquisition. Ships in fiscal year 1985 and beyond will be scheduled considering the source time factors as used for the fiscal year 1984 line where each ship's time was reduced at least 1 month.
- The March 22, 1982, direction to reduce labor hours and materials by 10 percent was considered unrealistic.
- The allowable amount for program manager's growth was set at 10 percent of government-furnished equipment costs.

The guidelines in the March 22, 1982, Navy memorandum are an example of optimistic direction by higher management. Although they were not implemented, the excessively optimistic March 22 guidelines moved the Navy toward more optimistic assumptions. This resulted in the guidelines issued on April 9. The optimistic character of the April 9 guidelines is shown by the \$2.7 billion reduction in the subsequent repricing of the Navy's Five-Year Shipbuilding Plan. Other examples of optimistic direction are

- use of optimistic contractor data,
- forcing cost estimates to conform to the service budgets, and
- the exclusion of relevant program costs.

Contractor cost data sometimes inaccurate or optimistic

DOD cost estimators told us the competitive nature of business drives optimistic contractor estimates. They also told us contractors may underbid to "sell" a program to the service and the Congress. Program offices sometimes base their estimates on this overly optimistic contractor data.

This problem has been discussed in a number of past publications, including the report of the Special Panel on Defense Procurement Procedures, House Committee on Armed Services (see app. VI item 4), A Game of Liar's Dice by Dr. Walter B. Laberge (see app. VI item 7), Cost Overruns in Major Weapon Systems: Current Dimensions of a Longstanding Problem by the Congressional Research Service (see app. VI item 11), and our report, Cost Growth in Major Weapon Systems (see app. VII item 4).

Two of the weapon systems in our sample provide illustrations of this type of problem--the Hellfire missile program and the Apache helicopter program.

The Hellfire cost estimates were based on the March 1981 contractor design-to-unit production cost data. The data was used even though the project office did not consider that data to be reliable because of the contractor's history of understated cost reports--the contractor's missile cost goal increased from \$3,448 to \$5,710 per unit between October 1976 and March 1981.

On the Apache helicopter program, the accuracy of the contractor's (Hughes) cost data also appears questionable. Problems and inaccuracies with Hughes' cost data were cited by representatives of the Army Comptroller, the program office, the Defense Contract Audit Agency, and Hughes. The contractor cost data the Apache program office used to prepare its February 1980 cost estimate was optimistic and inaccurate. The \$1.55 billion cost increase in the September 1981 estimate was attributed largely to higher contractor costs.

Army Comptroller and program office representatives told us that Hughes lacked experience in building a complex aircraft like the Apache. Hughes' cost data base is built on industry standards reportedly adjusted for Hughes' experience on its commercial product line. Army representatives said, however, that Hughes' data base was inaccurate and did not reflect actual experience. This resulted in unrealistically low cost estimates. A Hughes spokesperson stated that Hughes was optimistic in its early estimating. Hughes hired new management officials who recognized the problems and adjusted the data base, which resulted in a large increase in Hughes' labor hour and cost estimates as reflected in the September 1981 program office estimate. Although Hughes representatives said the company had taken corrective actions, Defense Contract Audit Agency representatives told us that the practices still exist.

Program cost estimates are forced to conform to the budget

In some cases, weapon system cost estimates are forced to fit under the fiscal constraints of the DOD budget by arbitrarily reducing the estimate. The services' total program cost

estimates are prepared, reviewed, and validated under a ceiling; according to DOD Instruction 7000.3, the cost estimate appearing on the December SAR must correspond to the President's budget. One example of the budget constraint on an estimator's best estimate is the fiscal year 1984 repricing directive for Navy shipbuilding explained previously. Another example identified during our review occurred in March 1982 when the DSARC production review on the Apache helicopter reduced the estimate by \$72.6 million to conform to the fiscal year 1983 budget guidance. To achieve the lowest estimate possible, the most optimistic assumptions are used regarding technical, risk, development, and production problems, and schedule and design perturbations.

As illustrated by the example of the Apache helicopter, the budget process sometimes forces estimates down artificially to get all programs approved. According to DOD officials, in this environment if tasks scheduled for the current fiscal year cannot be paid for in the current budget, those tasks are postponed until future years. Similarly, the effects of problems in developing the system, requirements changes, funding and schedule changes, increases in units, and so forth, which cannot be funded in the current budget are postponed to future budget years--the "out years"--which are essentially unconstrained. These tasks tend to be separate from the budgeted costs initially associated with them in a phenomenon known as "requirements uncoupling".<sup>5</sup> The result has been significant cost growth when the "out years" become the current year and the postponed costs begin to exceed the budget projections.

#### Relevant program costs are excluded from cost estimates

Relevant program costs are often excluded from systems' cost estimates by omitting costs associated with changes to the original requirements. Examples of these excluded costs were identified in the following systems:

- The September 1979 program office estimate for the Bradley System excluded product improvements specified in the June 1979 approved system requirement. These improvements added \$740.9 million to the program 1 year later.
- Costs for a seeker to meet an Army requirement for the Hellfire missile were excluded from the systems' cost estimates. Projections for those costs range up to \$1.1 billion. In addition, the program office and the Department of the Army disagree over the estimates for the missiles' storage facilities in Europe.

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<sup>5</sup>W. M. Allen, Causes of Weapons Cost Growth: Three Perspectives, Resource Management Journal, spring 1982.

--The September 1981 program office production estimate for the Apache helicopter did not include \$291.4 million for combat mission simulators or \$59 million in aircraft survivability equipment. The July 1982 estimate included the survivability equipment.

Force objectives for some estimates are undecided

The cost estimates reported to the Congress are suppose to represent the cost of the entire weapon system program. Some of those estimates, however, are reporting costs based on total numbers of units that are different from the numbers used in internal DOD force projections. Examples of systems where total force requirements are undecided are:

--The Army has not decided on procurement quantities for the Hellfire. After the August 1981 program office estimate was made, the planned quantity increased from 24,600 to 35,756 units. The Army has increased this to 42,332 missiles in December 1982 and to 48,696 in December 1983. Project officials told us they do not know how many units will be eventually procured. They indicated the number of Hellfire missiles will probably increase by 6,000 each year as long as the budget allows.

--The September 1979 SAR for the Bradley System showed 9,261 vehicles at a cost of \$6.5 billion. At the same time the September 1979 program office estimate for the Bradley showed 6,882 vehicles at a cost of \$7.7 billion.

--The number of Navy LSD-41s has ranged from 3 to 16 in the period from the lead-ship authorization in 1981 until now. Only 10 ships are reflected in the Navy's December 1983 SAR, 6 ships less than indicated by internal planning documents.

FULLER USE OF INDEPENDENT COST ESTIMATORS'  
RECOMMENDATIONS WOULD MAKE COST ESTIMATES  
MORE RELIABLE AND VALID

Although OSD and the services have established independent cost estimating groups to help ensure that cost estimates are more reliable and valid, efforts by such groups have not always been effective. We found some independent cost estimators' estimates did not appear to be fully considered by DOD decision-makers and their recommendations were not accepted.

Recently the Congress has placed increased emphasis on the use of independent estimates. The 1984 DOD Authorization Act states

"the Secretary of Defense may not approve the full-scale engineering development or the production and deployment of a major defense acquisition program unless an independent estimate of the cost of the program first has been submitted to (and considered by) the Secretary of Defense."



The Secretary is also required by May 1, 1984, to submit a written report to the Congress on the use of independent estimates in the planning, programming, budgeting, and selection process for major defense acquisition programs. These congressional actions may encourage solutions to some of the problems outlined below. Progress will be shown when program cost estimates include the recommendations of independent estimators and the resulting estimates are more accurate.

### Army's Apache helicopter

The independent cost estimators' estimate and recommendations for the Apache program production decision were not fully accepted by ASARC and DSARC.

The independent cost estimating team<sup>6</sup> determined that the Apache estimate should be \$576 million higher than the program office estimate, and also, that an additional \$562.9 million in risk money should be added for production risks unique to this program.

The Comptroller of the Army accepted the program office estimating methodology and the lower program office estimate, but recommended to the ASARC that the risk money be added to the program. ASARC also accepted the program office estimate and the recommendation for risk money but reduced the production quantities from 536 aircraft to 446 aircraft, and reduced the risk money from \$562.9 million to \$528.1 million. In January 1982, the Apache office prepared an amended estimate to reflect the ASARC approved program quantity and risk money.

The OSD Cost Analysis Improvement Group then recommended approval of the amended program estimate to DSARC. DSARC and the subsequent Secretary of Defense decision essentially approved the ASARC recommended production quantity and risk money, but reduced the total cost estimate by \$72.6 million to agree with the fiscal year 1983 budget.

Although the production estimating and decision process identified production risk and set aside money for it, the production risk money did not last long. The program was restructured to use the risk money to buy 69 more aircraft for a total production quantity of 515, thereby effectively doing away with the independent estimator's recommendation. This decision to delete the risk funding provisions was made even though the production risk situation had not changed between time of the ASARC decision and the decision to delete the risk funding.

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<sup>6</sup>This team consisted of representatives from the Office of the Comptroller of the Army, the Army Materiel Development and Readiness Command, and the Army Aviation Research and Development Command.

## Army's Bradley Fighting Vehicle System

An OSD analysis of the September 1979 Bradley estimate pointed out that the fire control portion of the estimate could be understated by as much as 30 percent. No change was made to the estimate. The next year the Hughes Aircraft Company's estimate for the fire control system rose significantly--from \$597.8 million to \$934 million.

## Air Force B-1B Bomber

On November 1, 1981, the Cost Analysis Improvement Group (CAIG) issued a report on the B-1B in which it recommended the Air Force add allowances to its estimate to provide for a full cruise missile capability, not include multiyear contracting savings until actual contractor bids are in hand, and add allowances for simulators. The Cost Analysis Improvement Group recommendation on cruise missile capability was adopted by the Air Force resulting in a total program estimate of \$20.5 billion. The \$1.1 billion provisions regarding multiyear contracting and simulators were not adopted.

## COST DISCIPLINE NEEDS TO BE ENFORCED

SARs show that total program costs increase year after year--indicating that total cost is not a real constraint on weapon system programs. The December 1983 SAR reports show that the costs for the 73 major weapon systems have grown from \$339.8 billion to \$618.5 billion. Appendix XI shows the average increases in program cost, excluding inflation, for 36 production programs included in the December 1982 SARs, are \$13 million per month before production and \$18 million per month after production. These increases in total program costs have become the accepted pattern--no one is held accountable for them. Cost estimates have represented a threshold that is broken year after year without significant consequences to DOD, the services, or the weapon system programs.

As discussed on page 21, it is the budget that is the main program constraint. Tasks not affordable in the current budget year are postponed to future years ("out years")--which are essentially unconstrained.

Examples drawn from our selected weapon systems illustrate that the cost estimates presented at the milestone decision points are not effective cost constraints. On the Bradley, the estimate used for the production milestone decision, scheduled for January 1980, showed a total program cost of \$7,742 million. Eleven months later the December 1980 SAR showed a total program cost of \$12,686.7 million. On the Apache the full-scale development milestone estimate (Milestone II) showed a total cost of \$3,758.1 million for 536 aircraft. The Apache production milestone decision showed a total cost of \$7,380.8 million

for 446 aircraft. The Hellfire's estimate for the full-scale development decision in March 1976 was \$735 million. In March 1982 the production milestone estimate was \$2,047.6 million. For the Navy's LAMPS MK III program, the cost estimate in March 1978 (full-scale development) was \$3,907.6 million; in June 1982 (production milestone) the estimate was \$6,745.6 million; and in December 1982 the estimate was \$8,261.6 million.

OSD needs to enforce cost discipline by making the services more accountable for staying within their cost estimates. Program design and operational requirements, schedule, numbers of units, economically efficient production rates, and other assumptions critical to cost estimates should be firmly established. Changes to these requirements should be minimized, and approved only on the basis of an urgent need, and only after considering the cost effect of such changes. These estimates would then be established as not-to-exceed thresholds. Any program in danger of breaching this threshold would be rigorously evaluated and assessed to determine whether it should be restructured, discontinued, or permitted to proceed as planned.

#### CONCLUSIONS

We found several weaknesses exist in the guidance, assumptions, methodologies, and data used to develop cost estimates:

- The quality and completeness of cost estimating guidance varies among OSD and the services. Some of the guidance is too general; in some cases it is conflicting.
- Implementation of OSD and service guidance is poor. This leads to problems of inconsistent estimate structure and content, and inadequate estimate documentation.
- Cost estimates do not always include adequate provisions for program risk. Cost estimators seem to assume that their weapon systems will not suffer from the risk factors that can occur on weapon programs.
- Inflation is not always calculated consistently.
- Cost estimators are sometimes directed to use optimistic assumptions regarding the weapon systems to be estimated. These assumptions--system design requirements, number of units, length of time for procurement, financial considerations regarding the contractors, and so forth--are frequently optimistic when compared to the experience of past acquisitions.
- Some cost estimates are based on contractor data which may be optimistic and could lead to inaccurate DOD estimates.

- Program costs are constrained by the program's annual budget, not by the total cost estimates established at major program milestones, which hinders cost discipline and accountability.
- Estimates are sometimes kept low by using less than anticipated numbers of units, and omitting costs associated with changes to the original requirements.
- More fully considering and accepting the recommendations of independent estimators would make DOD cost estimates more valid and reliable.

#### RECOMMENDATIONS

We recommend that the Secretary of Defense revise OSD and service cost estimating guidance to ensure that it is clear and consistent.

The Secretary should develop measures that will ensure the cost estimating guidance is properly implemented. Appropriate implementing of guidelines is necessary to obtain better estimates. We also recommend that the Secretary ensure that

- all costs associated with a weapon system are included in the estimate,
- all estimates are fully documented,
- appropriate methodologies are used to develop the estimate, and
- the estimate is updated when significant changes occur in the program.

In addition, the Secretary should ensure that:

- Program risks and uncertainties be fully identified in DOD cost estimates. Cost estimators should be directed to structure their estimating assumptions to consider proven historical cost growth drivers, such as technical changes due to engineering problems and added requirements, schedule changes, and funding instability.
- Inflation should be calculated consistently and in accordance with DOD procedures.
- Cost estimates be based on realistic assumptions rather than optimistic assumptions.

- Cost discipline be enforced by establishing the total program acquisition cost estimate developed for the production milestone as a not-to-exceed threshold. A program in danger of breaching the threshold should be assessed to determine whether it should be restructured, discontinued, or permitted to proceed as planned.
- DOD management make fuller use of independent estimates. The independent estimates should not be arbitrarily accepted, but the recommendations of the independent estimators should be considered and decisions not to accept them should be fully explained and documented.

We believe that one way for the Secretary to address these items is to issue a cost estimating handbook. This handbook could be developed by the OSD Cost Analysis Improvement Group along the lines of OMB's A-76 "Cost Comparison Handbook," or as an expansion of DOD's 1971 "Military Equipment Cost Analysis" textbook. The handbook should be provided to the services' cost estimating functions, and would ensure that consistency and uniformity among the services exist regarding the estimating procedures used, the costs to be included, and the structure of the estimates. It should also provide a comprehensive tracking and documenting system.

In developing a handbook, the following elements should be included as part of the required documents for a cost estimate.

- The period of time on which the estimate was based and whether it is an original or an update of an earlier estimate. The original estimate should be prepared at the time approval is given for a new system. Estimates should be updated to reflect significant changes in the program, or when assumptions used to develop the original estimate change. Program costs should be thoroughly reviewed for currency, accuracy, and realism at each of the major milestone decision points.
- The assumptions the cost estimate is based on, particularly the system design, total numbers of units to be procured, production rates, and inflation rates. Changes to these assumptions should be shown in updated estimates with an explanation of the cost impact and the organizational authority responsible for the change.
- Methodology and techniques used to prepare the estimate, ranging from estimates based on parametric techniques in the early stages of a program, to detailed estimates based on actual experience gained to date in the later stages of development. If the estimate was derived from parametric models, the type of model should be fully described along with its relevance to the current system.

- Reasons for uncertainties in estimates should be identified, strategies laid out to deal with them, and the range of cost increases that could occur should be identified. Estimate confidence levels should be stated along with a sensitivity risk analysis of possible changes in requirements, schedule, and quantity.
- The estimate should contain all research and development, investment and procurement, military construction, and operation and support costs. Any excluded costs associated with the weapon system, but included under another estimate, should be fully identified.
- Changes to DOD's reporting documents required by the estimate.

The implementation of the new and existing guidelines should be monitored by the Cost Analysis Improvement Group, as the principal advisor within DOD concerning cost estimating. In addition, the DOD Inspector General could periodically review the services' efforts to implement the cost estimating guidelines.

#### DOD COMMENTS AND OUR RESPONSE

The following summarizes the major points in DOD's comments regarding this chapter and provides our responses:

##### DOD comment

DOD did not agree with the findings contained in our draft report that overall DOD guidance and service guidance did not, in some cases, meet the cost estimating criteria which we articulated in our July 1972 report. It said that DOD and service directives provide more comprehensive guidance than is needed to meet the nine criteria cited in our report. (See app. IV.) DOD went on to cite specific DOD and service directives, regulations, and so forth, which contained this guidance.

DOD further stated that Army Regulation 11-18 shows that the Army's policy is to include all relevant costs and to validate cost estimates.

##### Our reponse

Our 1972 report listed nine criteria which we felt were essential for effective cost estimating, with which DOD agreed.

In analyzing DOD's response to our draft, we revised the report to recognize the volumes of guidance DOD has published on cost estimating. We do not make a point of DOD's guidance not meeting the criteria. We continue to believe, that the examples provided in the report show that some of the criteria are not

always met and revisions are needed in DOD's cost estimating procedures.

#### DOD comment

DOD did not agree with our findings that there is no overall DOD guidance on cost estimating and that the services have been allowed to develop their own guidance, thus compounding the problem further. DOD provided us with a long list of over 30 OSD and service directives which they said were adequate guidance.

#### Our response

Although our draft report referred to the lack of overall DOD guidance, we revised the report to show that there is a need to improve its guidance.

DOD provided an impressive list of service regulations. Appendix II identifies the regulations we examined during this review.

DOD stated that a major function of the Cost Analysis Improvement Group and its counterparts in the services is to ensure that all cost elements are included in the cost estimates they review. Our example on page 11 regarding the Bradley illustrates that all costs are not included in the cost estimates the Cost Analysis Improvement Group reviews. Our example on page 24 regarding the B-1B shows that the costs included in the estimate the Cost Analysis Improvement Group reviewed were not included in the estimate reported to the Congress.

The services are updating their cost estimating guidance. The Navy has replaced Naval Material Command Instruction (NAVMATINST) 7000.19A with NAVMATINST 7000.19B. NAVMATINST 7000.19B still requires cost estimate documentation to be sufficiently detailed to permit the reconstruction of the cost estimate by external reviewers and refers to the elements of information specified in Chief of Naval Operations Instruction (OPNAVINST) 7000.17A. OPNAVINST 7000.17A describes the Cost Estimate Documentation Summary discussed on page 12 of this report. Navy cost estimators told us the Navy is in the process of updating 7000.17A to eliminate the Navy requirement to include in one document most of the information a reviewer needs to adequately evaluate a cost estimate.

The Army is in the process of initiating some major changes to its cost estimating process; but these changes have not been incorporated into their new guidance. The Army Materiel Development and Readiness Command Regulation 37-4 (dated 10/4/82) includes nothing on total risk assessing cost estimates (implemented by letters of instruction dated 3/6/75 and 10/6/82),

annual updates for estimates (letter dated 9/21/81), and joint independent cost estimating teams (Memorandum of Understanding dated 5/27/82). The Army should include the new initiatives in their updated guidance.

The Air Force's cost estimating handbook--AFSCM 173-1 dated April 17, 1972--was described to us as the Air Force's primary cost estimating guidance. It is no longer in print. The Air Force is studying how to update it and will not print more until the new manual is available.

DOD stated that each weapon system is unique, and there is no single approach for the development of cost estimates that could be routinely applied to all systems. We agree each weapon system is unique and there must be some flexibility in cost estimating guidance. However, DOD's current guidance is too general. The services' guidance is much more specific even though each service's guidance pertains to a wide variety of weapon systems. The Army, for example, develops cost estimates for rotary aircraft, tracked vehicles, and missiles. The Navy develops estimates for fixed-wing aircraft, rotary aircraft, ships, and missiles. The Air Force develops estimates for fixed-wing aircraft and missiles. The result is two sets of guidance applied to estimating costs for rotary aircraft, two sets for fixed-wing aircraft, and three sets for missiles. It is possible for OSD to develop overall guidance and it should do so. DOD said its policy is to permit the services to tailor guidance to their individual needs.

DOD believes the current guidance provides the necessary framework for high quality estimates. Our examples illustrate that DOD is not developing high quality estimates and reporting them to the Congress. We believe improved guidance and increased monitoring of its implementation are necessary if the problems illustrated by our examples are to be minimized in the future.

#### DOD comment

DOD partially agreed with our finding that it did not document data sources, assumptions, methods, and decisions basic to the estimate for virtually every system we reviewed. It did not agree with our statement that documentation is lacking on all weapon systems.

#### Our response

This section of the report has been rewritten to recognize DOD's comments and to more clearly present what we found. In 1972 we found inadequate documentation on virtually all systems reviewed. On the current assignment, we found similar problems on three of the systems reviewed.



DOD said that Cost Analysis Improvement Group reviews have found that program cost estimate documentation has generally been adequate. The illustrations drawn from the seven selected weapon systems show, that for these systems, documentation is not adequate for determining how the estimates were developed (see pp. 11 to 13) or the reasons for cost growth from one estimate to the next. (See p. 13.) We believe cost estimates cannot be used to establish cost discipline if costs cannot be traced from one estimate to the next and the reasons for cost growth cannot be identified.

DOD stated that we did not ask for the 1978 LAMPS estimate on which the successive iterative estimates were based. Our auditors did ask repeatedly for the 1978 estimate, but were told that it was not available. DOD provided a copy of the computer printouts available for the 1978 estimate on November 28, 1983, after the completion of our review.

#### DOD comment

DOD did not agree with our finding that, because of the competitive nature of weapon system contracts, contractors may underbid to sell a program to DOD and that cost estimates are often based on this overly optimistic contractor data. DOD stated that its cost estimators use a variety of data sources in preparing estimates and that contractor data may be one of the sources if the estimator believes the data should be used.

#### Our response

The examples drawn from the selected weapon systems illustrate that some cost estimates are based on optimistic and inaccurate contractor data. (See pp. 19 and 20.) Our examples also show that the independent estimators have been ineffective in preventing this problem. (See p. 24.) In its comment, DOD describes how its estimating process should prevent understated estimates. Our examples show the system did not work.

#### DOD comment

DOD partially agreed in our finding that several weaknesses in DOD cost estimates should be corrected: (1) recognizing the confidence levels associated with early cost estimates, (2) ensuring consistency of estimating methodologies, (3) identifying program risks, and (4) ensuring consistency of inflation recognition.

DOD stated that the corrections we suggest are not required because guidance is already in place on the first three and DOD requires the use of uniform inflation rates. With regard to risk, DOD stated that funds provided for risk in the budget are

the first to be cut by the Congress and that programs cannot expand beyond their yearly budget allocation which acts as a cost constraint.

### Our response

DOD's comments indicate that DOD already has policies in place to address the problems we found. We acknowledge the existence of the documents setting forth policy. However, the problems we found occurred despite these policies--more needs to be done to ensure implementation. DOD actions to improve cost estimating guidance and ensure its implementation would help prevent the cost estimating deficiencies illustrated by the examples in this report from occurring in the future.

DOD strongly disagreed with our observation that the annual budget allocation represents the only cost constraint placed on weapon system programs. DOD states that DOD Directive 5000.1 and DOD Instruction 5000.2 require that thresholds be established for performance, schedule, and costs. Breaching these thresholds requires a complete new DOD review of the program before determining whether to continue with its acquisition.

DOD Directive 5000.1 and DOD Instruction 5000.2 do not establish firm, not-to-exceed thresholds over the life of a weapon systems acquisition program, and do not require a decision on program continuation when a cost threshold is breached. Examples drawn from our seven selected weapon systems illustrate that the cost estimates presented at the milestone decision points are not effective cost constraints. On the Bradley, the estimate used for the production milestone decision, scheduled for January 1980, showed a total program cost of \$7,742 million. Eleven months later the December 1980 SAR showed a total program cost of \$12,686.7 million. On the Apache the full-scale development milestone estimate (Milestone II) showed a total cost of \$3,758.1 million for 536 aircraft. The Apache production milestone decision showed a total cost of \$7,380.8 million for 446 aircraft. The Hellfire's estimate for the full-scale development decision in March 1976 was \$735 million. In March 1982 the production milestone estimate was \$2,047.6 million. For the Navy's LAMPS MK III program, the cost estimate in March 1978 (full-scale development) was \$3,907.6 million; in June 1982 (production milestone) the estimate was \$6,745.6 million; and in December 1982 the estimate was \$8,261.6 million.

In addition, cost estimators and program office officials told us that the most important portion of the program's cost estimate is the budget year. The remainder of the estimate is of value for planning but the budget year is the portion of the estimate that demands their attention.

DOD Directive 5000.1 (March 29, 1982) requires the establishment of a dollar threshold at Milestone I (concept selection) that cannot be exceeded to carry the program through Milestone II (entry into full-scale development). DOD Directive 5000.1 does not require a similar threshold for the Milestone II program go ahead decision which initiates full-scale development and allows the program to proceed to production and deployment. DOD Directive 5000.1 states that approval to proceed into full-scale development or into production shall depend on the DOD Component demonstration that resources are available or can be programmed to complete development, to produce efficiently, and to operate and support the deployed system effectively. Funding availability shall be reaffirmed by the DOD Component before proceeding into production and deployment. DOD Directive 5000.1 refers to DOD Instruction 5000.2 for the specific facets of affordability to be reviewed at milestone decision points.

DOD Instruction 5000.2 does not require a DSARC review be held if milestone thresholds are breached. It requires the Defense Acquisition Executive be notified of threshold breaches to decide whether or not a program review or another DSARC will be required.

DOD Instruction 5000.2 also states that a cost-effectiveness analysis for all major acquisitions shall be performed by the DOD Components to support Milestone I and Milestone II. This instruction points out that a Secretary of Defense Decision Memorandum documents the Secretary of Defense's milestone decision, including approval of goals, thresholds, and threshold ranges for cost, schedule, and performance. A Secretary of Defense Decision Memorandum is prepared to reflect revised thresholds and updated program direction resulting from threshold breaches or projected breaches reported by the DOD Component. DOD Instruction 5000.2 also states that programming and budgeting decisions that may invalidate a milestone decision or other Secretary of Defense Decision Memorandum direction shall be recommended to the Defense Resources Board for explicit consideration of the effect on military capability and total resource requirements. In addition, the DOD Component head shall explain and justify to the Defense Resources Board differences between program baselines established at Milestone II (entry into full-scale development) and quantity and funding in the program or budget under review.

#### DOD comment

DOD did not agree with our finding that assumptions mandated by DOD management in preparing cost estimates are often optimistic and management has tended to pressure estimators through control of the assumptions.

DOD also did not agree that physical and performance characteristics provided to cost estimators produced unrealistically low estimates. It stated that cost analysts are not told how to do their analyses and are not forced to use only the most optimistic assumptions. DOD also did not agree with our example of unrealistic assumptions presented in a Navy memorandum.

DOD partially agreed with our findings that decisions made at development milestones and during the budget process reinforces the over optimism, and agreed with our findings that although the DOD Acquisition Improvement Program initiatives promise long needed improvements, they still face resistance.

### Our response

The relevant portions of this report have been revised after considering DOD's response that the use of OMB inflation rates is required and that the work of the Naval Sea Systems Command after the release of the March 1982 memorandum from the Assistant Secretary of the Navy for Shipbuilding and Logistics resulted in the April 9, 1982, estimating guidelines. (See pp. 17 to 19.)

DOD states that its estimates are based on formal requirements documents (such as the Army's Materiel System Requirements Specification) which do not provide guidance that will require the cost analyst to produce an unrealistically low cost estimate. We found cases where the DOD estimates did not include all the elements specified in the Materiel System Requirements Specification--the Hellfire's fire-and-forget seeker with an estimated cost in excess of \$1 billion and the Bradley product improvements costing \$982.1 million are examples.

The March 1982 memorandum from the Assistant Secretary of the Navy for Shipbuilding and Logistics and the subsequent repricing using the April 1982 Naval Sea Systems Command Controller cost estimating guidelines resulted in a \$2.7 billion reduction in the Navy's Five-Year Shipbuilding Plan. When asked why the new costing concepts embodied in the April 1982 guidelines were not used earlier, a senior Navy cost estimator stated that in times when ship costs are declining it is much easier to use more optimistic assumptions. The estimator added it was very difficult to "sell" the use of what might be considered more realistic assumptions in such situations. When asked how much of the \$2.7 billion savings would be realized, the Navy estimator could only comment on the \$432.9 million pertaining to fiscal year 1984. The Navy estimator felt that of the \$432.9 million, only \$115 million relating to earlier award of ship contracts would definitely be realized. The estimator could offer no opinion on the remainder, and said we would have to wait and see if what was predicted actually became reality.

The examples in this section of the report show that DOD cost estimates are understated as a result of the direction provided by management to the cost estimators or by decisions made by management. DOD states that when budget constraints render given programs unaffordable, these programs are reexamined and usually restructured. Our point is that the cost estimates on which the budgets are based are sometimes overly optimistic.

#### DOD comment

DOD agreed with our finding that independent cost estimator's estimates and recommendations are not always accepted, but that its concurrence should not be interpreted to mean that independent estimates should always be accepted.

#### Our response

This section of our report has been rewritten to indicate that independent estimates should not be arbitrarily adopted as the official program estimates. It is important, however, that recommendations of DOD's independent estimators be given more consideration by DOD management.

#### DOD comment on our recommendation

DOD did not agree with our proposal to establish the total program acquisition cost estimate developed for the production milestone as a not-to-exceed threshold saying that this requirement is already established under DOD Instruction 5000.2 (Mar. 8, 1983).

#### Our response

DOD Instruction 5000.2 (Mar. 8, 1983) does not establish a not-to-exceed threshold at any milestone. DOD Directive 5000.1 (Mar. 29, 1982) requires the establishment of a dollar threshold at Milestone I (concept selection) that cannot be exceeded to carry the program through Milestone II (entry into full scale development), but has no similar requirement beyond Milestone II.

We believe a not-to-exceed threshold should be established for the total cost of weapon systems and that DOD and the Congress should conduct a rigorous review of any weapon system in danger of breaching the threshold.

#### DOD comments on our recommendation

DOD did not agree with our recommendation regarding the issuance of standardized criteria for cost estimates. DOD contends that current guidance is adequate to ensure proper service cost estimates and to allow the services to tailor their estimating procedures to fit their needs.

### Our response

As pointed out in our report (see pp. 9 and 10) and in our response to DOD's previous comments (see DOD comment on pp. 28 to 30), we believe that DOD should improve its guidance as recommended in this report. A "cost estimating handbook" provided by OSD to the services would clarify what is expected from the cost estimating process and would help resolve the problems of vagueness and conflicting guidance discussed in our report.

### CHAPTER 3

#### DOD REPORTS TO THE CONGRESS

##### NEED MORE REALISM

DOD cost estimates are reported to the Congress through SARs, unit cost exception reports, and the budget process. Major concerns have been expressed by the Congress and its oversight committees for some time over the accuracy, timeliness, and completeness of DOD's reporting, particularly in the area of cost estimating.

In its review of weapon systems acquisition procedures and policies of the DOD, the Special Panel on Defense Procurement Procedures of the House Armed Services Committee found that the SARs do not identify potential problems that might lead to cost growth. Its report states that the absence of timely and complete cost information that more clearly identifies potential cost growth hinders the efforts of the Armed Services Committees in exercising legislative and oversight responsibilities. The Special Panel also found that the SARs do not disclose substantive changes that may occur in a program during the calendar year. The Panel noted these changes then appear in the December SAR<sup>1</sup>. (See app. VI item 4.)

In our review we found

- SARs do not reflect the latest anticipated program acquisition costs
- SARs do not show total acquisition objectives under consideration,
- important cost categories are not reported in SARs,
- costs are not reported consistently in SARs, and
- unit cost exception reports have not solved the problem of a lack of current data reported to the Congress.

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<sup>1</sup>U.S. Congress, House Committee on Armed Services, Special Panel on Defense Procurement Procedures Report, Weapons Acquisition Policy and Procedures: Curbing Cost Growth, 97th Congress, 1st Session, Committee Print No. 13, February 12, 1982.

SARS DO NOT REFLECT THE LATEST ANTICIPATED  
PROGRAM ACQUISITION COSTS

We found major differences between the officially approved program acquisition cost reported in SARs and the currently anticipated program acquisition cost projected by the program office. These differences are the result of the considerable time lag between preparing a SAR and submitting it to the Congress, and the requirement that SARs reflect the President's approved budget.

DOD states that it is not required to report program costs that are not part of the officially approved program. The weapon systems we reviewed provided examples showing that costs considered necessary to the weapon system were not included in the official program and therefore not reported to the Congress. These costs were sometimes reported after a period of several years. Reporting delays of this kind were addressed by the Special Panel on Defense Procurement Procedures (see app. VI item 4) and led to a permanent requirement for the unit cost reports.

Although it is reasonable that DOD should have the opportunity to evaluate program alternatives, our examples illustrate that in some cases known requirements have been excluded from program cost estimates. In some of these cases, these items have been excluded by not defining them as part of the approved program. Specifics from the programs we reviewed are:

- The March/July 1982 program office estimate for the Bradley System projected a \$429.4 million cost for tube launched, optically tracked, wire guided (TOW) missile improvements. The TOW requirement was also included in the Bradley's June 1979 Materiel System Requirement Specification--which defines the scope of the program. These improvements were not formally approved or funded and did not appear in the SAR estimates until December 1983 when they were shown at a cost of \$307.7 million.
- The December 1981 SAR for the Apache helicopter reported a cost estimate of \$72.6 million lower than the estimate resulting from the November 1981 ASARC production review. The March 1982 production DSARC lowered the ASARC's approved program by the \$72.6 million to agree with the fiscal year 1983 budget. The March and June 1982 SARs reflected this lower estimate. Reporting the fiscal year 1983 budget or production milestone estimate as the approved program did not result in timely and informative reporting to the Congress.



--February and July 1980 revisions of the Hellfire missile program office estimate projected procurement costs of \$522.8 million and \$553.9 million, respectively. The reporting of these cost increases was delayed until the December 1980 SAR. This caused the March, June, and September 1980 SARs for the Hellfire, which were reporting program costs of \$332.9 million, to be understated by as much as \$221 million.

--Current Hellfire estimates, including the December 1982 SAR, do not include costs for a new missile seeker needed to meet Army requirements to increase the survivability of the Apache/Hellfire system. The Army canceled an earlier seeker development program, estimated at over \$1 billion, and is evaluating three lower cost options for the seeker requirement. If approved, a new seeker would further increase Hellfire acquisition costs. Seeker development costs were not included because they are not part of the officially approved program.

The Congressional Budget Office found similar problems which are discussed in its study entitled A Review of the Department of Defense, December 31, 1982 SARs. (See app. VI item 10.) The study found over \$40 billion in costs were not included in 13 DOD weapon systems cost estimates.

The Congress has addressed this problem of faulty cost estimates by requiring, in one case, DOD to certify to the validity of its cost estimate. This occurred on the B-1B Bomber program. Although this report discusses some weakness in the B-1B estimate, the concept of certification appears sound. Expansion of this practice to require DOD certification on all estimates reported to the Congress may be of value in encouraging DOD to include all costs in its estimates.

#### SARS DO NOT SHOW TOTAL ACQUISITION OBJECTIVES UNDER CONSIDERATION

As discussed in chapter 2 (see p. 22), DOD sometimes does not report the total number of units it is considering for its weapon system programs. For example, the LSD-41 Navy decision coordinating paper, then under revision, showed 16 ships. The paper directed the program office "to continue the acquisition of 10 ships while planning for 16."

As pointed out on page 37, the Congress is concerned about the lack of complete information that would identify potential cost growth. Footnoting the SARs to point out unit increases being considered may resolve some of these concerns.

IMPORTANT COST CATEGORIES ARE  
NOT REPORTED IN SARs

DOD Instruction 7000.3 requires SAR reports to include only program acquisition costs<sup>2</sup>--they do not include costs such as operation and support. By not reporting other costs, such as operation and support, a significant portion of program life-cycle costs are omitted from congressional reporting. These operation and support costs can often be 1/3 to 3/4 of the total life-cycle costs and may exceed the program's production cost. Because these costs are not reported in SARs, the Congress is not aware of significant cost fluctuations. For example, the 1982 program cost estimate for the Bradley System was found by the Army Audit Agency to be understated by \$6.4 billion in operation and support costs.

COSTS ARE NOT REPORTED  
CONSISTENTLY IN SARs

Some costs are reported in one SAR only to be dropped from succeeding SARs. The Bradley System's December 1980 SAR, included a \$740.9 million provision for product improvements. These product improvements were never formally approved and were dropped in the December 1982 SAR. The 25MM ammunition procurement program for the Bradley System was also included in the SAR from December 1980 through September 1982. Program costs were reduced by \$1.1 billion when ammunition costs were deleted from the December 1982 SAR. DOD states that this practice is allowable under their current regulations.

UNIT COST EXCEPTION REPORTS HAVE NOT  
SOLVED THE PROBLEM OF A LACK OF CURRENT  
DATA REPORTED TO THE CONGRESS

The 1982 Defense Authorization Act (Public Law 97-86, section 917) required program managers of major defense systems to issue unit cost reports to their military service secretaries in fiscal year 1982. The law provides for two types of unit cost reports--a quarterly unit cost report and an exception unit cost report. The exception report is issued following a significant increase in estimated program acquisition unit cost or estimated fiscal year procurement unit cost. Public Law 97-252 extended this requirement indefinitely.

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<sup>2</sup>Acquisition costs are the costs of developing and producing the system; and life-cycle costs are these costs plus the costs of operating and supporting the system over its service life.

The unit cost reports were intended to bring attention to unit cost increases and to address the problem of reporting current data regarding DOD program cost increases to the Congress. The Congress was concerned that information reported in the SARs was primarily historical and did not provide timely indications of potential cost problems. (See app. IV item 4.) The unit cost report legislation places a requirement on the weapon systems program manager to file a report when there is reason to believe the program unit costs would breach thresholds specified in the legislation. The Congress expected the unit cost reports to be a prospective reporting document that would report more current data than the SARs.

However, DOD has interpreted this requirement in a manner that does not allow more current data to be reported. The unit cost report regulation--DOD Instruction 7220.31--states that unit cost reports will be based on the latest estimate of the cost of the current DOD-approved program. This is the same information that is reported in the SARs. DOD calculates the difference between the current SAR and the baseline SAR and reports that difference in the unit cost report. Therefore, the unit cost reports do not provide a more prospective view of weapon system costs than SARs. They report changes in the official DOD program only--not cost growth that is anticipated but defined as outside the approved program.

#### CONCLUSIONS

The reports DOD provided to the Congress need more realism. We found that:

- Some of the weapon systems cost data reported to the Congress is not accurate, complete, or timely. SARs do not always report the most currently anticipated program costs, sometimes report certain costs inconsistently, and do not report operation and support costs.
- Cost known to be part of a system's requirements are not always included in the officially approved program for the system.
- One of the primary reasons the unit cost exception reports were introduced in 1982 was the Congress' concern that the cost data in SARs was not current. However, since DOD has based the unit cost exception reports on SARs, the data they contain suffers from the same timeliness problems as the data reported in SARs.
- An expanded requirement for DOD certification of the validity of its estimates may result in more complete cost reporting to the Congress.

## RECOMMENDATIONS

To provide more realistic cost reports to the Congress, we recommend that the Secretary ensure that:

- SARs report all relevant program costs (such as operation and support), use the most current data, and report costs in a consistent manner. In an exceptional situation where costs are excluded from the estimate, those costs should be clearly identified and the rationale for their exclusion explained.
- Clear criteria are established regarding the costs to be included in the officially approved program for a weapon system.
- DOD disclose the total number of units it is considering for a program by providing a SAR footnote when that number is different from the approved program reported in the body of the SAR.
- Unit cost exception reports disclose any anticipated cost growth that has not been included in the latest officially approved estimate.

## MATTERS FOR CONGRESSIONAL CONSIDERATION

Although the Congress has deliberated at great length over the credibility of cost estimates it receives from DOD, a solution to the problem still is not at hand. The Congress, or its oversight committees, have required DOD to certify as to the validity of cost estimates on particular systems. The B-1B bomber program is a recent example. Also, as a result of legislation, unit cost exception reports are required to be submitted by DOD to the oversight committees when certain cost thresholds are breached. We suggest that the Congress may want to require DOD to certify that the cost estimates it reports are prepared according to sound cost estimating guidelines, and represent the total cost for the weapon systems program. Programs in danger of breaching these estimates should undergo a rigorous evaluation by DOD and the Congress. (See pp. 24 and 25.)

## DOD COMMENTS

The following summarizes DOD's comments on this chapter and provides our responses:

### DOD comment

DOD did not agree with any of our findings regarding DOD reports to the Congress. DOD stated that the improvements we suggested are not possible, and addressed each one individually as follows:

(1) DOD said the SARS can only report the latest approved DOD program, and that this is necessary if DOD is to be allowed to do proper planning and evaluation of program alternatives.

Our response

It is reasonable that DOD should have the opportunity to plan and evaluate alternatives to their programs; however, this should not permit DOD to exclude from its estimates costs that are recognized to be necessary to complete the weapon system acquisitions. Our examples illustrate that DOD has excluded costs from its estimates or delayed the reporting of costs that would give the Congress the information it seems to want and needs to be better informed. (See pp. 38 and 39.)

(2) DOD states that the congressional data sheets and the SARS reflect the Secretary of Defense approved program contained in the Five-Year Defense Program.

Our response

DOD Instruction 7000.3 requires DOD to report all costs--not just the Five-Year Defense Program. The instruction requires DOD to report all program costs, including current and prior year costs; budget year costs; balance to complete the Five-Year Defense Program; and the balance to complete the program acquisition. Our report example illustrates this problem. (See p. 39.)

(3) DOD's comment indicates that DOD is reluctant to include operation and support costs in SAR because of the lack of precision inherent in the estimating of operation and support costs.

Our response

We feel that estimates, including operation and support costs, would be of value to the Congress. No operation and support costs are reported now. Using the operation and support estimates DOD currently develops would fill this gap. (See p. 40.)

(4) DOD states that generally, SARS report costs consistently and that SAR policy permits the exclusion of costs under certain circumstances.

### Our response

The examples in our report illustrate that DOD's SARs do not always report costs consistently. DOD's comment indicates that this practice is allowable under current SAR policy--this policy should be changed. (See p. 40.)

(5) DOD states its policy on unit cost reporting is the same as SARs--the latest cost estimate of the approved program will be reported.

### Our response

The Congress passed the Unit Cost Report legislation because the data the Congress received through the SARs was not timely. If the Congress believes the SAR data is not timely and DOD confirms that its policy toward the unit cost reporting is the same as its policy toward SAR reporting, then the logical conclusion is that Unit Cost Reports have not solved the problem of timeliness of the data DOD reports to the Congress as stated in our report. (See pp. 40 and 41.)

### Our overall response to this comment

DOD's interpretation of rules and regulations allows it to state the improvements suggested by us are not possible. The improvements are possible--the rules and regulations that govern DOD cost reporting to the Congress can be changed--and should be. Congressional actions clearly indicate that it wants change.

### DOD comment

DOD did not concur with the analyses contained in our draft report which showed, by restating DOD's estimates for five of the seven weapon systems we reviewed, that the current weapon systems cost estimates could be substantially understated and could cost over \$65.8 billion--a potential understatement of \$21 billion.

DOD stated that it is not correct to say that DOD intentionally and substantially understates cost estimates. DOD further stated that the estimates were not comparable and that different year dollars were used in the estimates for each system.

### Our response

We agree that the estimates are different and also have different year dollars. Our intent was to show that for each

system there were numerous estimates and historically weapon systems costs tend to grow. However, it is subjective as to what will eventually be in the programs we reviewed and we have therefore deleted this section from our report.

## CHAPTER 4

### RECENT DOD ACTIONS SHOULD

#### HELP IF IMPLEMENTED

OSD and the services recognize the need to improve their cost estimating process, and as a result, they are continually taking some steps to improve this capability. Currently, OSD, the Air Force, Navy, and Army each have efforts underway to improve their cost estimating practices. OSD efforts are part of the DOD Acquisition Improvement Program. The current efforts underway by the Air Force and the Navy, for the most part, appear to be a reemphasis and reinstatement of past measures. On the other hand, in 1982 the Army started what appears to be an extensive effort to improve its cost estimating with several new initiatives.

#### OSD EFFORTS UNDERWAY TO IMPROVE COST ESTIMATING

In April 1981 the Deputy Secretary of Defense set out 32 initiatives to be pursued to improve the DOD acquisition process. A Task Force on Acquisition Improvement was established to do a comprehensive review of the initiatives. As of June 1983, 13 of the initiatives were considered completed and 9 required some further action. The others were merged into six major areas: (1) program stability, (2) multiyear procurement, (3) economic (stable) production rates, (4) realistic budgeting, (5) improved readiness and support, and (6) encouraging competition. The realistic budgeting initiative will consider budgeting to most likely cost, technological risk funding, and budgeting for inflation. Improvements in all of these areas should also have an effect on better cost estimating and reporting.

#### EFFORTS UNDERWAY BY THE AIR FORCE AND THE NAVY TO IMPROVE COST ESTIMATING

Some of the ways the Air Force and the Navy are trying to improve their cost estimating capabilities are through additional (1) cost estimating research, (2) use of computers, and (3) recruiting and training of cost estimators. In addition, the Navy is considering additional cost estimating guidance. The Air Force appears to be reemphasizing its baseline program management system with some modifications. This system is designed to be a contract between the program manager or project office and the Air Force Systems Command or field organization commander. The contract should reflect the program director/manager's best estimate of the cost to accomplish the program objectives. The system was to establish and maintain cost discipline and track costs. The objective of the new effort is to



involve more players in the contract process and to establish a mutual understanding among all major organizations participating in the weapon systems acquisition of what the program will consist of before formalizing the agreement or "contract." The contract is to define the scope of the program in terms of schedule, cost, and identification of items not included in the program objectives. The Air Force appears to be making another effort to implement this system under "Project Cost."

Project Cost, initiated in early 1983, is a program which has pulled together all Air Force Systems Command cost control measures and added some new ones. Over 200 actions are being undertaken within Project Cost concentrating on three areas: (1) weapon system affordability, (2) program stability, and (3) program management. The Air Force has selected 10 of these actions to receive special merit.

- Stringent review of contractor wages.
- A new baselining effort.
- Reduction of data/documentation required from contractors.
- Increase program emphasis up front.
- Stabilizing programs.
- Designing and managing with available funding.
- Increased effective competition.
- Increased use of "should" costs.
- Program manager accountability.
- Improvement in cost estimating.

#### EFFORTS TO IMPROVE THE ARMY'S COST ESTIMATING

The Army has approximately 45 initiatives planned or in process to improve cost discipline on its major weapon systems. Many of the initiatives are in the early stages of implementation or in the pilot implementation stages. In some cases, only interim instructions have been established with the intention of establishing formal regulations after determining if the concept is feasible and what improvements or changes are needed. The initiatives that relate to cost estimating include:

- Total Risk Assessing Cost Estimate for Production,
- Program Management Control System,
- Joint Independent Cost Estimating teams,
- use of major cost drivers to validate cost estimates,
- annual updating of program manager's cost estimates,
- Risk Review teams,
- reducing the size of the Materiel Systems Requirements Specifications which serves as the basis for cost estimates,
- single best cost estimate from the Army Materiel Development and Readiness Command, and

--displaying uncertainty ranges in cost estimates.

The Total Risk Assessing Cost Estimate for Production, Program Management Control System, and Joint Independent Cost Estimating team are three of the major initiatives.

#### Total Risk Assessing Cost Estimate for Production

By an October 6, 1982, Letter of Instruction, the Army initiated the concept of funding for technological risk for the early years of production, known as Total Risk Assessing Cost Estimate for Production. It is to provide consistency in procurement planning, programming, and budgeting under conditions of risk and uncertainty. The concept involves identifying and quantifying risks when a weapon system transitions from development to production, submitting the risk cost with the baseline estimate, and reserving funds to cover the expected cost of the uncertainty.

Although the Army is the only service at this time with Total Risk Assessing Cost Estimate for Production, each of the services have implemented similar techniques for budgeting for technological risk in the research and development phase of weapon system acquisition.

In developing the Total Risk Assessing Cost Estimate for Production, specific categories of risk have been identified such as threat uncertainty and design changes. However, specifically excluded from Total Risk Assessing Cost Estimates for Production's expected risk costs are factors such as unknown unknowns, inadequate funding in early years, and quantity changes.

#### Program Management Control System

The objectives of this system are to define program objectives, provide increased discipline in the materiel acquisition process, track program execution against general elements of approved acquisition strategy, provide increased visibility of program trends, and earlier identification of decision alternatives. In addition, it is to define cost baselines with an auditable track to the budget, formalize a program change process, and require monthly status against a formal program baseline.

#### Joint Independent Cost Estimating team

Independent cost estimates and cost analysis briefs are now being prepared by a team consisting of representatives from the Comptroller of the Army, Army Materiel Development and Readiness Command, and major subordinate commands. The team is directed

to concentrate on significant costs in each life-cycle phase, undertaking sensitivity analyses for those cost drivers critical to the cost estimate.

#### PROBLEMS THAT WILL AFFECT THE SUCCESSFUL IMPLEMENTATION OF RECENT ARMY INITIATIVES

Although the Army initiatives are in the early stages of implementation, problems have already been observed. Some command and program office officials are not receptive to some aspects of the new cost estimating and reporting system. We found resistance and delays to implementing the Total Risk Assessing Cost Estimate for Production, the Program Management Control System, and Joint Independent Cost Estimating team initiatives. For example, we found that Apache program office officials are reluctant to implement the Total Risk Assessing Cost Estimate for Production concept because they are concerned that reserves for risk contingencies will be viewed as budget "fat" and will be cut from their funding quickly. The Program Management Control System implementation was delayed because of disagreements between the program office and Army Headquarters about which cost estimate to use as the basis for future analysis of cost growth. The Joint Independent Cost Estimating concept is opposed by some Army Aviation Research and Development Command officials who believe that cost estimators outside the command will not have the time, resources, or expertise to adequately evaluate the costs of the weapon system.

In addition, the Total Risk Assessing Cost Estimate for Production excludes risk categories that are characteristic of all major weapon system programs, and if they are not considered, then weapon system costs will continue to be understated.

#### CONCLUSIONS

In the past 2 years, DOD and the services have initiated efforts to improve cost estimating and reporting. DOD's Acquisition Improvement Program includes several initiatives which, if implemented, should improve cost estimating. These initiatives address program budgeting, inflation indexes, and program restructuring. The services, especially the Army, have also begun to update guidance and improve estimating procedures. We believe that the OSD and service initiatives are needed to help ensure effective cost estimating and should be implemented in conjunction with our recommendations presented in chapters 2 and 3.

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## United States Senate

COMMITTEE ON  
 GOVERNMENTAL AFFAIRS  
 WASHINGTON, D.C. 20540

May 21, 1982

The Honorable Charles A. Bowsher  
 Comptroller General  
 General Accounting Office  
 441 G Street, N.W.  
 Washington, D.C. 20548

Dear Chuck:

As you know, my Committee has had a strong interest in how effectively and efficiently the Defense Department manages its acquisition process. We have held several days of hearings concerning Defense Department acquisition procedures and have been working to authorize an Inspector General in the Department as well.

The recent controversy surrounding the Defense Department's cost estimate for the B-1B bomber raises very clearly one of the central problems affecting the Department of Defense acquisition process: the effectiveness of cost estimating procedures in the Defense Department for major weapons systems. The Defense Department, in the B-1B case, apparently had developed several cost estimates for the bomber which reached different conclusions than the estimates supplied to Congress. As you know, I supported the GAO's efforts to obtain cost analyses and supporting data used by the Defense Department to develop the cost estimates sent to Congress on the plane and, with several of my Committee colleagues, sent a letter to the Secretary of Defense urging their cooperation.

One of the reasons this case became so contentious is the fact that no one knows exactly how the Defense Department develops its cost estimates, how the cost data submitted to the Defense Department by the contractors is used in assessing projected costs nor how the Department decides on which of the many cost estimates, developed internally and by contractors, it will select as the official estimate and submit to Congress.

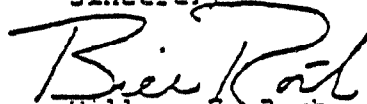
I believe this issue deserves a thorough review. I am requesting that the General Accounting Office conduct a study to assess the cost estimating process in the Defense Department for major acquisitions. I would expect the study to review the process in its entirety from initial development of cost estimates to the submission of a final estimate to Congress. Perhaps the best approach to use for such a study is to examine several actual examples of how the cost estimating process worked for specific major acquisitions. The study should not exclude an examination

Charles A. Bowsher  
Page 2

of contractor data and cost analyses and how they are utilized by the Defense Department in the development of cost estimates.

I look forward to hearing from you on this matter. Your staff may contact Link Hoewing of my Committee staff at 224-4751, if there are any questions.

Sincerely

  
William V. Roth, Jr.  
Chairman

WVR:sb

DOD COST ESTIMATING GUIDANCE

DOD Directive 5000.1, Major System Acquisitions, March 29, 1982--This directive states DOD's acquisition policy for major systems or major modifications to existing systems. It directs DOD components to estimate and budget realistically, and adequately fund procurement (research, development and production), logistics, and manpower for major systems.

DOD Instruction 5000.2, Major System Acquisition Procedures, March 8, 1983--This instruction replaced DOD Instruction 5000.2 dated March 19, 1980 (see below), and revises procedures for DOD's implementation of DOD Directive 5000.1.

DOD Instruction 5000.2, Major System Acquisition Procedures, March 19, 1980--This instruction provides the supplementary procedures for DOD use in implementing DOD Directive 5000.1 (see above). Regarding estimates, the instruction states:

"The validity of decisions reached at each milestone depends upon the quality of cost, schedule, performance, and supportability estimates presented at the milestone reviews. Although there is considerable uncertainty early in the acquisition process, every effort must be made to use the best available data and techniques in developing estimates. Bands of uncertainty shall be identified for point estimates. Broad bands of uncertainty shall be expected early in the acquisition process, with smaller bands developed as the program matures and uncertainty decreases. Traceability of successive cost estimates, to include adjustments for inflation and to segregate estimating error from program changes, shall be maintained starting with program cost estimates approved at Milestone I."<sup>1</sup>

DOD Directive 5000.28, Design to Cost, May 23, 1975--This directive establishes policy, guidance, and responsibilities of Design to Cost principles to the acquisition of defense systems, subsystems, and components.

DOD Instruction 5000.33, Uniform Budget/Cost Terms and Definitions, August 15, 1977--This instruction has a threefold purpose:

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<sup>1</sup>Concept selection and entry into the demonstration and validation phase of the acquisition of a new system.

- establishes uniform budget/cost terms for use in the management of DOD weapon/support systems;
- presents the framework of cost terms and definitions which include the basic components of cost associated with DOD weapon/support systems; and
- identifies cost categories, work breakdown structure elements, and the appropriations associated with each cost term, as the means of improving the completeness, consistency, use, and understanding of these terms in the DOD decision process.

DOD Directive 5000.4, OSD Cost Analysis Improvement Group, October 30, 1980--This directive provides the permanent charter for the OSD Cost Analysis Improvement Group. It specifies the organization, responsibilities, and administration of the Group and includes the criteria and procedures for the preparation and presentation of cost analyses to the OSD Cost Analysis Improvement Group.

DOD Directive 5010.20, Work Breakdown Structures for Defense Materiel Items, July 31, 1968--This directive establishes DOD policy governing the preparation and application of work breakdown structures for use during the acquisition of systems, equipment, or other materiel items.

DOD Instruction 7000.2, Performance Measurement for Selected Acquisitions, June 10, 1977--This instruction sets forth objectives and criteria for the application of uniform DOD requirements to selected defense contracts. The provisions of this instruction specifically require the use of Cost/Schedule Control Systems Criteria in selected acquisitions.

DOD Instruction 7000.3, SARs, March 2, 1983--This instruction provides standardized format and instructions to be followed by DOD components in responding to Secretary of Defense requirements for summary reporting of technical, schedule, quantity, and cost information concerning major defense programs. The SAR is established as the standard, comprehensive summary status report on major defense systems.

DOD Instruction 7000.11, Contractor Cost Data Reporting, September 5, 1973--This instruction provides guidance for collecting projected and actual cost data on acquisition programs from contractors and in-house government plants through a single integrated system for DOD cost analysis and procurement management purposes.

DOD Instruction 7041.3, Economic Analysis and Program Evaluation for Resource Management, October 18, 1972--This instruction outlines policy guidance and establishes a framework for consistent application of

- economic analysis of proposed programs, projects, and activities and
- program evaluation of on-going activities.

DOD Instruction 7045.7, The Planning, Programming, and Budgeting System, October 29, 1969--This instruction establishes procedural guidance for

- processing changes to the approved resources of the Five-Year Defense Program;
- submission, analysis, review, and approval of new and revised DOD programs and budgets; and
- maintenance and updating of the Five-Year Defense Program structures.

OSD Cost Analysis Improvement Group Aircraft Operating and Support Cost Development Guide (Draft)--This guide provides guidelines for preparing and presenting estimates of operating and support cost to the OSD Cost Analysis Improvement Group and DSARC. It also provides definitions for operating and support cost elements used in the cost oriented resource estimation model.

Sample Operating and Support Analysis, Operating and Support Cost Estimates for Air Force FX Aircraft, DSARC III, prepared for the Secretary of Defense, Cost Analysis Improvement Group, January 1, 1980--This sample is designed to complement the Cost Analysis Improvement Group's Cost Development Guide. It is intended to show an example for how operating and supporting costs can be developed for the Cost Analysis Improvement Group review with available data bases and one example of an appropriate format for presentation of cost estimates.

Military Standard 881A, Work Breakdown Structures for Defense Materiel Items, April 25, 1975--This standard establishes criteria governing the preparation and employment of work breakdown structures for use during the acquisition of designated defense materiel items. The standard specifies that the DOD component project management will use the work breakdown structure as a coordinating medium in cost estimates.



ARMY COST ESTIMATING GUIDANCE

Army Regulation No. 1-1, Planning, Programming, and Budgeting within the Department of the Army, May 25, 1976--The purpose of this regulation is to prescribe the Army's Planning, Programming, and Budgeting System and its relationship to the DOD Planning, Programming, and Budgeting System and Joint Strategic Planning System.

Department of the Army Pamphlet No. 11-1, Guide for Improved Use of Defense Documentation Center by Cost Analysts, January 1976--The purpose of this guide is to facilitate better interchange of data among cost analysts and organizations through improved use of Defense Document Center programs, products, and services.

Department of the Army Pamphlet No. 11-2, Research and Development Cost Guide for Army Materiel Systems, May 1976--The purpose of this guide is to provide a framework for the presenting, documenting, and reporting of cost estimates of the Research and Development phase of a materiel system's life cycle. It establishes minimum standards for presenting and documenting these cost estimates.

Department of the Army Pamphlet No. 11-3, Investment Cost Guide for Army Materiel Systems, April 1976--The purpose of this guide is to provide a framework for preparing, documenting, and reporting cost estimates of the investment phase of a materiel system's life cycle. It establishes minimum standards for presenting and documenting these cost estimates.

Department of the Army Pamphlet No. 11-4, Operating and Support Cost Guide for Army Materiel Systems, April 1976--The purpose of this guide is to provide a framework for presenting, documenting, and reporting cost estimates of the operating and support phase of a materiel system's life cycle. It establishes minimum standards for presenting and documenting these cost estimates.

Army Pamphlet No. 11-5, Standards for Preparation and Documentation of Life-Cycle Cost Estimates for Army Materiel Systems, May 1976--This guide provides a framework for the presentation and life-cycle cost estimates of major Army materiel systems. It states that it was prepared for use by Army cost analysts in standardizing the presentation and documentation of life-cycle cost estimates.

Army Regulation No. 11-18, The Cost Analysis Program, October 10, 1975--This regulation establishes Department of the Army policy and procedures governing Army-wide cost analysis. It assigns responsibilities and outlines command and staff relationships for the cost analysis program.

Army Regulation No. 15-14, Systems Acquisition Review Council Procedures, April 1, 1978--This regulation provides guidance and establishes procedures governing ASARC.

Army Regulation No. 1000-1, Basic Policies for Systems Acquisition, April 1, 1978--This regulation establishes the basic Army policy for acquisition of materiel systems, and together with Army Regulation 15-14, implements DOD Directives 5000.1 and 5000.2.

U.S. Army Materiel Development and Readiness Command Regulation 37-4, Cost Estimate Control Data Center Activities, October 4, 1982--This regulation prescribes the policies, responsibilities, and procedures for the operation of Cost Estimate Control Data Centers within Army Materiel Development and Readiness Command. These centers are to review and validate cost estimates and data before being released for official use.

Letter of Instruction for Implementation of the Total Risk Assessing Cost Estimate for Production, October 6, 1982--This letter of instruction establishes interim policy, procedures, and responsibilities for implementing Total Risk Assessing Cost Estimate for Production.

DARCOM Circular No. 11-1, Army Materiel Development and Readiness Command Program Management Control System, September 20, 1982--This circular directs the implementation of the Program Management Control System with its effectiveness to be evaluated and once proven to be integrated into appropriate regulation. It specifies the policy, procedures, and responsibilities for Program Management Control System implementation.

Memorandum of Understanding between the Comptroller of the Army and the Army Materiel Development & Readiness Command, May 27, 1982, on Joint Independent Cost Estimating teams--This memorandum outlines procedures for establishing and operating a joint team to prepare independent cost estimates for major weapon systems.

Letter on Annual Update of Baseline Cost Estimates from the Adjutant General, September 21, 1981--This letter establishes Army policy for baseline cost estimates to be updated at least annually by the program manager to reflect changes as the systems progress through the acquisition phases.

Army Development and Readiness Command Pamphlet P700-6, Naval Material Command Pamphlet NAVMAT P5242, Air Force Logistics Command Pamphlet AFLCP/AFSCP 800-19, October 15, 1977, Joint Design-to-Cost Guide, Life-Cycle Cost as a Design Parameter--This guide provides information and guidance for application of the design-to-cost concepts.

NAVY COST ESTIMATING GUIDANCE

SECNAV Instruction 4000.31, Life-Cycle Costing, December 7, 1970--This instruction establishes policy and responsibilities for the development and implementation of Navy life-cycle costing policy and procedures for less than major acquisitions.

SECNAV Instruction 5000.1A, System Acquisition in the Department of the Navy, November 17, 1978--This instruction promulgates the policies for weapon system acquisition established by DOD Directives 5000.1 and 5000.2, and provides supplemental acquisition policy guidance within the Department of the Navy.

SECNAV Instruction 5420.172B, Establishment of the Department of the Navy Systems Acquisition Review Council, May 18, 1976--This instruction defines the organization, mission, functions, and procedures of the Navy Systems Acquisition Review Council.

SECNAV Instruction 7000.14B, Economic Analysis and Program Evaluation for Navy Resource Management, June 18, 1975--This instruction provides policy guidance and responsibilities for economic analysis and program evaluations within the Navy.

SECNAV Instruction 7000.17B, Contractor Cost Performance Measurement for Selected Acquisitions, April 14, 1978--This instruction prescribes policy, objectives, and responsibilities for the application of the Cost/Schedule Control Systems Criteria for selected Navy acquisitions.

SECNAV Instruction 7000.19B, Department of the Navy Cost Analysis Program, March 12, 1975--This instruction establishes policy on cost estimating throughout the Department of the Navy and assigns responsibilities for estimating, validating, and reviewing in the cost analysis program.

SECNAV Instruction 7700.5D, Selected Acquisition Reports, December 19, 1979--This instruction implements DOD's SAR requirements and provides additional guidance for the staffing and submission of these reports.

NAVAIR Instruction 4265.1A, Pricing Information Associated with Planning, Programming, and Budgeting of Aircraft and Missile Programs, February 1, 1971--This instruction establishes the responsibilities and procedures for requesting, preparing, and disseminating pricing information associated with Naval Air Systems Command Headquarters aircraft and missile programs.

NAVMAT Instruction 7000.17D, Contractor Cost and Schedule Performance Measurement and Reporting for Major Acquisition Projects, March 4, 1981--This instruction establishes the

contractor cost and schedule performance measurement and reporting requirements for Naval Material Command major defense acquisitions.

NAVMAT Instruction 7000.19A, Naval Material Command Cost Analysis/Estimating Program, July 30, 1976--This instruction implements the Department of the Navy's cost analysis program within the Naval Material Command. It emphasizes the importance of providing realistic cost estimates in support of the Navy's acquisition process and planning, programming, and budgeting efforts. It states that each systems command is to have a cost analysis/estimating group responsible for cost estimating policy and guidance.

NAVMAT Instruction 4330.37, Should Cost, March 25, 1974--This instruction provides guidance and procedures on the use of should-cost studies in determining pricing of Navy contracts.

NAVSEA Instruction 7000.9, Financial Management Manual Volume 5: Cost Estimating and Analysis, July 14, 1980--This instruction provides guidance, document requirements, and responsibilities of NAVSEA cost estimating process.

NAVSEA Instruction 7300.10, Classification of Cost Estimates, January 27, 1977--This instruction provides policy and guidance for a classification system involving cost estimates.

NAVELEX Instruction 7720.4A, Policy and Responsibilities for NAVELEX Cost Estimating and Analysis, September 9, 1975--This instruction establishes a Central Cost Estimating and Analysis Group in NAVELEX which will set forth policy, procedures, and assign responsibilities for the development of system/equipment cost estimates and for performance of technical cost analyses. The objective of the instruction is to improve the credibility and validity of cost estimating and analysis within the Naval Electronic Systems Command.

OPNAV Instruction 7000.17A, Cost Analysis, September 15, 1976--This instruction provides supplemental policy guidance for further implementation of the Department of the Navy Cost Analysis Program.

OPNAV Instruction 7000.18, Economic Analysis and Program Evaluation for Navy Resource Management, July 27, 1973--This instruction provides policy guidance and responsibilities for economic analysis and program evaluation under the command of the Chief of Naval Operations.

OPNAV Instruction 7000.19A, Review of Comptroller Organizations, January 24, 1978--This instruction provides guidance, responsibilities, and objectives for the review and approval of Navy comptroller organizations.

OPNAV Instruction 7710.1B, Ship Cost Adjustment Report, June 19, 1973--This instruction provides guidance, procedures, and responsibilities for preparing and approving the Ship Cost Adjustment report within the Department of the Navy.

#### AIR FORCE COST ESTIMATING GUIDANCE

Air Force Regulation 173-1, The Air Force Cost Analysis Program, October 10, 1975--This regulation establishes the Air Force Cost Analysis Program, specifies its objectives and functions, and assigns responsibilities for the conduct of the program within the Department of the Air Force.

Air Force Regulation 173-11, Independent Cost Analysis Program, December 12, 1980--This regulation establishes the Independent Cost Analysis Program, prescribes policies, assigns responsibilities, and defines procedures for preparing, reviewing, documenting, and presenting studies done as part of the Independent Cost Analysis Program. It outlines Air Force Cost Analysis Improvement Group support provided to the Air Force Systems Acquisition Review Council and the DSARC.

Air Force Regulation 800-5, Selected Acquisition Reports, June 6, 1980--This regulation establishes responsibilities for the preparation and submission of SARs.

Air Force Regulation 800-6, Program Control-Financial, September 7, 1976--This regulation provides policy, establishes reporting requirements, assigns responsibilities, and establishes procedures for applying financial management control techniques to Air Force acquisition and modification programs. This regulation is being revised.

Air Force Systems Command Manual 173-1, Cost Estimating Procedures, April 17, 1972--This manual serves as a comprehensive reference for Air Force Systems Command cost estimating in support of system acquisition activities. Cost estimating methods, documentation, and review are described. The techniques apply to all persons who must prepare or use cost estimates.

Air Force Systems Command Regulation 173-2, Confidence Levels of Cost Estimates, October 2, 1978--This regulation prescribes policy, responsibilities, and procedures for rating cost estimates prepared according to Air Force Systems Command Manual 173-1 and Air Force Regulations 173-1 and 173-11. This regulation provides a system to rate the confidence levels of cost estimates considering the methods used in preparing the estimates and the availability of data.

Air Force Systems Command Regulation 550-18<sup>2</sup> Program Baseline Management, October 20, 1980--This regulation describes the policy and procedures for Program Baseline Management within the Air Force Systems Command. It states that

"The Program Baseline is a "contract" between the program or project office (PO) and the AFSC Commander or field organization Commander which reflects the Program Director/Manager's best estimate of the cost to accomplish the effort described in current direction. This contract accomplishes two main objectives: (1) to establish and maintain program cost discipline and (2) to provide an unequivocal program cost track. The Baseline is independent of program funding."

Air Force Systems Command Regulation 800-6, Program Baseline Management, December 3, 1981--This regulation describes the policy and procedures for program baseline management within the Air Force Systems Command. It applies to all acquisition programs at Air Force Systems Command product divisions and centers and to selected Headquarters Air Force System Command managed programs at the laboratories. The program baseline is a "contract" between the program or project manager and the designated baseline approval authority that reflects the program manager's best estimate of the cost to accomplish the effort described in current direction. The baseline will not necessarily equate to current approved funding. The contract has two main objectives:

- (1) Sets and keeps program cost discipline.
- (2) Provides an unequivocal program cost track that is documented in a standardized format.

Air Force Systems Command Pamphlet 173-3, Cost/Schedule Management of Nonmajor Contracts (Joint Guide), November 1, 1978--This pamphlet provides procedures for the cost/schedule management of nonmajor contracts and in particular, the implementation and use of the Cost/Schedule Status Report.

Air Force Systems Command Pamphlet 173-5, Cost/Schedule Control Systems Criteria Joint Implementation Guide, October 1, 1980--This pamphlet provides procedures for use during planning and implementation of Cost/Schedule Control Systems and for surveillance of contractor compliance.

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<sup>2</sup>This regulation has been incorporated into Air Force Systems Command Regulation 800-6.

Air Force Logistics Command and Air Force Systems Command Pamphlet 173-6, Cost/Schedule Control Systems Criteria Joint Surveillance Guide, July 1, 1974--This pamphlet provides uniform guidance for the Military Departments and other Defense agencies responsible for surveillance of Cost/Schedule Control Systems Criteria consistent with the provisions of DOD Instructions 7000.2.

Air Force Systems Command Pamphlet 800-15, Contractor Cost Data Reporting, November 5, 1973--This pamphlet provides uniform procedures which have been approved for use in implementing and administering the Contractor Cost Data Reporting System.

Air Force Logistics Command Pamphlet 173-3, A Guide for Estimating Aircraft Logistics Support Costs, March 12, 1974--This pamphlet provides guidance for estimating logistics costs for new systems and addresses the Air Force Aircraft Procurement Appropriation (3010) and the depot maintenance portion of the Operations and Maintenance Appropriation (3400).

Aeronautical Systems Division Regulation 173-1, Aeronautical Systems Division Cost Analysis Program, October 21, 1981--This regulation establishes policy, operation procedures, fundamental concepts, and responsibilities of the Comptroller Staff, Program Offices, Comptroller Senior Collocates, and other organizations within Aeronautical Systems Division that perform cost analysis, develop cost estimates, and conduct cost studies. The Aeronautical Systems Division Cost Analysis Program has been established to support the purpose and objectives of Air Force Regulation 173-1, the Air Force Cost Analysis Program.

Air Force Test & Evaluation Center Regulation 55-1, Air Force Test and Evaluation Center Operations Regulation, August 15, 1982--This regulation defines how the Air Force Test and Evaluation Center will implement the operational test and evaluation of weapon systems. It includes direction regarding the initial funding estimate.

Air Force Flight Test Center Regulation 170-2, Product/Service Unit, July 18, 1980--This regulation describes methodology, responsibilities, establishment and validation procedures, and the use and control of product/service units. It applies to all Air Force Flight Test Center organizations that use product/service units for estimating and tracking costs and resource use.

DESCRIPTIONS OF THE ARMY, AIR FORCE, AND  
NAVY COST ESTIMATING PROCESSES

ARMY COST ESTIMATING PROCESS

The Army's cost estimating process is described in various Army and OSD regulations. (See app. II.) According to these regulations--particularly Army Regulations 11-18 and 15-4 and Army Materiel Development and Readiness Command Regulation 37-4--cost estimates of major systems at milestone decisions take the following track and involve the following organizations.

- The materiel developer (usually the program manager) is responsible for preparing the program cost estimate.
- The cost estimate control data center, within the cost analysis activity of the applicable major subordinate command, performs a validation of the program office cost estimate. (Army Materiel Development and Readiness Command Regulation 37-4 describes validations, which is a test to confirm the cost estimate.)
- The Comptroller of the Army Cost Analysis Division is responsible for establishing a joint team of the Comptroller of the Army, Development and Readiness Command, and major subordinate command representatives to prepare an independent cost estimate and a cost analysis brief. The cost analysis brief compares the program office and independent estimates and recommends the preferred Army estimate.
- ASARC recommends an Army cost position for the Secretary of the Army's decision and subsequent recommendation to the Secretary of Defense.
- The OSD Cost Analysis Improvement Group reviews and evaluates the program office and independent cost estimates and advises DSARC on cost estimates.
- DSARC recommends a cost position for the Secretary of Defense's decision.

These regulations also describe the following estimating track for annual cost estimates of major systems:

- The materiel developer is responsible for preparing the program cost estimate.
- If the annual cost estimate has only minor changes, the cost estimate control data center performs a validation of the estimate.



--If the annual cost estimate has significant changes, the cost estimate control data center performs a level I validation. Also, a joint team of the Comptroller of the Army, Army Materiel and Readiness Command, and major subordinate command representatives prepare an independent cost estimate, a cost analysis brief, and arrive at an Army cost position.

#### Documentation of Army Cost estimates

Army Pamphlets 11-2 through 11-5 specify that "completeness" (communicating results in a format that encompasses the whole system) and "reproducibility" (recording what was done so others may understand the ground rules, assumptions, analysis, and results) are the principles driving cost estimate documentation. According to the Army pamphlets, each estimate will be a self-contained documented record and a building block for future estimates.

The pamphlets also indicate that documentation is organized on a module basis so that each cost element stands as a self-contained unit. The basic building block for documenting the estimate is called the documentation module, consisting of a cost data sheet and variable explanation sheets for each cost expression.

#### Review of Army cost estimates

According to the Army Materiel Development and Readiness Command Regulation 37-4, Army Regulation 11-18, and DOD Directive 5000.4, the following reviews are required of cost estimates for each milestone decision,

- independent cost estimate,
- cost analysis brief, and
- OSD Cost Analysis Improvement Group review.

Army Regulation 11-18 states that an independent estimate is developed to test the reasonableness of the program office cost estimate and to provide an unbiased second opinion of a system's cost. The regulation describes the cost analysis brief as a comparative analysis between the program office and independent estimates to surface and explain major cost differences and recommend the preferred Army estimate. DOD Directive 5000.4 describes the OSD Cost Analysis Improvement Group's review as providing DSARC with a review and evaluation of the program office and independent estimates with the purpose of advising DSARC on cost matters.

AIR FORCE COST ESTIMATING PROCESS

According to Air Force Regulation 173-11 and Aeronautical Systems Division Regulation 173-1, for a major program milestone, such as initiation of full-scale development, the Systems Program Office prepares a cost estimate and an independent cost analysis that is performed by the systems division Directorate of Cost Analysis. Both the Systems Program Office estimate and the related independent cost analysis are reviewed by the systems division Comptroller and Commander. The two estimates are then presented in a series of joint briefings by the two teams through the chain of command. The estimate briefings are given to Air Force Logistics Command (Comptroller), Air Force Systems Command (Program Evaluation Group, Comptroller, and Commander), Headquarters, U.S. Air Force (Air Force Council, Comptroller, Financial Management, Cost Analysis Improvement Group, and Air Force Systems Command Acquisition Review Council<sup>1</sup>), and OSD (Cost Analysis Improvement Group<sup>1</sup>). Also, briefings may be made to the using commands for the system. The briefings at each level are frequently on a joint basis, that is the Air Force Systems Command briefing may be given to all the organizations at the same time. For the new Defense Resource Board directed budget independent cost analyses, the process is the same except the chain stops at the OSD Cost Analysis Improvement Group.

The System Program Office's budget estimate follows essentially the same track, except no Air Force Systems Acquisition Review Council or DSARC, up to the Secretary of the Air Force. The Secretary of Defense reviews the Air Force budget submittal as part of the budget process, then provides the DOD budget to the President through OMB.

Documentation of Air Force cost estimates

As stated in Air Force Systems Command Manual 173-1:

"Cost estimate documentation is a detailed record of the procedures, data, environment, and events resulting in a cost estimate. These records describe configuration, development, and production schedules, defined quantities, conditions related to technological requirements, deployment concepts, and operating plans. All known or anticipated influences on the cost to the government for acquiring and operating a system over a prescribed span of time are considered in estimating; therefore, they should be considered in documenting or recording the cost estimating effort. Completeness of the cost estimate is an important objective that requires documenting excluded as well as included costs. A detailed record is required for follow-on cost estimates, cost tracking, formal submissions

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<sup>1</sup>Air Force Systems Acquisition Review Council or DSARC depending on which approval level is required.

of abstracts of cost estimates, periodic reviews, and other requirements."

The manual further states that due to the variation in program phases that involve cost estimate preparation, a similar wide variation can be expected in estimate documentation. The manual adds, however, that each estimate should conform to a basic pattern and include the following:

- System data, is a record of descriptive information of the system being estimated, including (1) the purpose of the estimate, (2) background and scope, (3) ground rules, constraints, and assumptions, and (4) system description and areas of cost uncertainty.
- System element data contains the complete record of each work breakdown structure item, including (1) item description, (2) data sources, (3) basic data, and (4) estimate derivation.
- Supporting data covers the items of additional backup; for example, method of evaluation. The types of supporting data and circumstances under which each is used are cost quantity curves and estimating relationship records.
- The system estimate should portray the estimating structure and be time phased as required.
- Estimate confidence, should include a short but comprehensive narrative depicting the degree of confidence in the data, methods, and result.

Further, Aeronautical Systems Division Regulation 173-1-- one of the product/developer divisions under Air Force Systems Command--requires the System Program Office to formally document its annual estimates and sufficiency reviews according to criteria contained in the regulation. Air Force Regulation 173-11 establishes further documentation requirements for both the System Program Office cost estimates and the independent cost analysis. According to Air Force Regulation 173-11, documentation by both should be complete enough to allow reconstruction of the estimate by an independent party and should at least include:

- Summary program description.
- Program ground rules (schedule, quantity, etc.).
- Team membership.
- Estimating assumptions.
- Program technical and physical parameters used in generating the estimate.
- Cost models or cost estimating relationships used and their data bases or sources.

- Cost factors and their derivation and data sources.
- Cost improvement (learning) curves.
- Cost sensitivity and risk analysis.
- Proper detailed and summary level tables of the cost estimates.
- Cost tract (independent cost analysis only).
- Costs by fiscal year.
- Current program funding by fiscal year.
- Program integrated master schedule.

#### Review of Air Force cost estimates

The Systems Program Office milestone estimate and the related independent cost analysis are reviewed through the Air Force chain of command, the Air Force and OSD Cost Analysis Improvement Groups, and the Air Force Systems Acquisition Review Council or DSARC. The System Program Office annual budget estimates are reviewed through the Air Force chain of command and by OSD, and are then provided to the President by the Secretary of Defense through OMB.

#### THE NAVY COST ESTIMATING PROCESS

The process of developing an official Navy cost estimate begins in the project offices within the major systems commands, such as Naval Air Systems Command and the Naval Sea Systems Command. Although the program manager is responsible for developing program cost estimates, the cost estimate is actually prepared by cost estimating groups within each of the commands under the Navy matrix approach to program management. The cost estimating divisions are responsible for preparing timely and accurate cost estimates for DSARC/Defense Naval Systems Acquisition Review Council reviews, budget submittals, support of contract negotiations, and design to cost goals.

According to Secretary of the Navy Instruction 7000.17A and Chief of Naval Operations Instructions 7000.17A and 7000.19B, once the estimate is approved by the appropriate command, it is generally reviewed by the following Navy organizations:

- Naval Material Command--oversees the organization and operation of cost estimating groups within the commands and ensures that they have the capability to produce quality estimates, and has cognizance over all elements of program acquisition. According to Chief of Naval Operations Instruction 7000.17A, cost estimates should include development, investment, and operating and support costs which conform to Military Standard 881 or another approved work breakdown structure. Naval Material Command is responsible for ensuring the maintenance of a cost data base for major systems to establish and implement cost tracking procedures, provide

a basis for continuous review and evaluation of estimating performance, and require that cost estimates be properly documented.

- Navy Comptroller Office--ensures that SARs and other congressional reporting documents are consistent with documented estimates for major systems and fiscal limitations of the budget. It also monitors cost analysis techniques employed by the Department of the Navy.
- Chief of Naval Operations--maintains independent cost estimating groups, ensures that realistic estimates are provided for Navy systems, and develops and maintains documenting and cost tracking procedures in addition to a cost data base for initial and follow-on cost estimating. According to Chief of Naval Operations Instruction 7000.19B, the Chief of Naval Operations is also responsible for providing guidance and developing estimating methodologies that ensures that the total costs of acquisition and ownership are reported to Navy decisionmakers.
- Secretary of the Navy--The Chief of Naval Operations provides program recommendations to the Secretary for approval in a Decision Coordinating Paper which is regularly updated. The Secretary of the Navy receives advisory support from the Navy Systems Acquisition Review Council. The Secretary is the highest decision authority in the Navy and gives the final approval for program estimates designated for review. Other programs may be delegated to the Chief of Naval Operations or the Chief of Naval Material Command for program approval, in which case they would be the final authority for approval of Navy cost estimates.

#### Documentation of Navy estimates

Principal forms of documentation for Navy cost estimates are the Decision Coordinating Papers, Cost Estimate Documentation Summaries (Naval Material Command Form 7000/2), and budget documents specified in the DOD Budget Guidance Manual 7110-1-M. The Navy regulations heavily emphasize the importance of documenting, however, the only specific document format explained in detail is the Cost Estimate Documentation Summary.

According to Chief of Naval Operations Instruction 7000.17A, the Cost Estimate Documentation Summary will include weapon system characteristics, the procurement quantity, the assumed production environment, and the resultant estimated costs (research and development, investment, and operating and

support) to the extent that they have been estimated at that point in time, no matter how tentative. The instructions require the form to be color coded to indicate the quality and the reliability of the estimate.

Chief of Naval Operations Instruction 7000.17A requires the following elements of information to be included in documenting an estimate:

- Date the estimate was prepared or changed.
- Category of the estimate.
- Name of the organization preparing the estimate or change.
- Purpose of the estimate or change.
- Summary of characteristics considered.
- Ground rules, assumptions, and constraints.
- Data sources.
- Estimated cost and method of derivation.
- Changes required to the Resource Annex of the Decision Coordinating Paper.
- "Design to cost" requirements.
- Range of uncertainty.

All estimates will include a statement regarding the confidence the estimator has in the results. Confidence could be expressed in terms of a range of costs. While a detailed statistical treatment is desirable, a subjective estimate of the cost range may be submitted with appropriate rationale if the uncertainty is not easily quantified.

Chief of Naval Operations Instruction 7000.17A also states that every program manager will develop a cost profile track that would trace the history of the costs involved in the program from concept formulation to the present time. This cost profile track will graphically display changes in funding levels with the appropriate rationale for such changes. It will be presented in the form of a variance analysis that reflects all Navy and DOD decisions relative to the program, as well as quantity changes, engineering changes, schedule changes, escalation changes, and so forth. This track, in addition to being available for DSARC/Defense Naval Systems Acquisition Review Council presentations, is updated and submitted as backup information for Navy correspondence from Naval Material Command to Chief of Naval Operations relating to changes in program costs.

#### Review of Navy estimates

An independent review of Navy estimates is primarily the responsibility of OP-96D-Secretary of the Navy/Chief of Naval Operations Advisor for Resource Analysis within the Office of the Chief of Naval Operations. OP-96D provides an independent

estimate of life-cycle costs of major weapon systems during major milestone reviews. This independent estimating group provides a critical review and analysis of cost, schedule, performance, and other pertinent financial management aspects for the Chief of Naval Operations and the Secretary of the Navy before DSARC proceedings. The objective is to test the reasonableness of the program manager's estimate.

The Naval Material Command Cost Analysis Division also has a small staff which reviews estimates sent up by the commands. Its review is also aimed at testing the reasonableness of the program office's estimate.

CRITERIA BASIC TO AN  
EFFECTIVE ESTIMATING PROCESS<sup>1</sup>

CLEAR IDENTIFICATION OF TASK

To prepare a cost estimate, the estimator must be provided with the system description, ground rules and assumptions, and technical and performance characteristics of the system. A well defined system description which specifies conditions and constraints of the estimate is essential in clearly identifying the scope of the estimate and documenting how it was prepared.

BROAD PARTICIPATION IN  
PREPARING ESTIMATES

The acquisition of a major weapon system involves many DOD and contractor organizations in deciding mission need and requirements, and defining performance parameters, force structures, and other system characteristics. The cost estimate should ensure that all organizations which have had an input into the system design have participated in preparing the cost estimate. Each organization should have had its data independently verified for accuracy and completeness and have cost controls in place to ensure the reliability of its data.

AVAILABILITY OF VALID DATA

Numerous sources of data are available to the cost estimator. These data sources vary in reliability. A principal source is the historical data base from which cost estimators project costs of new systems from previously similar or comparable systems. The estimator should use care in determining whether such data is suitable for the purposes intended. The data should reflect current cost trends and be directly related to the systems performance characteristics and specifications.

STANDARDIZED STRUCTURE FOR ESTIMATES

DOD Military Standard 881-A provides a standard method, called a work breakdown structure, for dividing the acquisition effort into specific work packages peculiar to a type of system. The identification of these work packages becomes more detailed as the system progresses through the acquisition cycle.

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<sup>1</sup>These criteria are from GAO's July 24, 1972 report entitled, Theory and Practice of Cost Estimating for Major Acquisitions.



The work breakdown structure ensures that

- estimates can be related to the total program,
- relevant cost categories are not omitted,
- the estimate can be refined as the system design becomes more defined, and
- estimates for similar types of systems can be compared by estimators and decisionmakers.

An estimate derived from the work breakdown structure assists management in monitoring and directing diverse project activities being contracted by the services and the contractors.

#### PROVISION FOR PROGRAM UNCERTAINTIES

One of the most difficult and often criticized aspects of cost estimating concerns identifying uncertainties and developing a realistic allowance for their cost impact. Work objectives should be divided into knowns and unknowns and provisions made for their resolution.

#### RECOGNITION OF INFLATION

Economic changes over the period of a system's development and acquisition can have a significant effect on the cost to develop, produce, and operate the weapon systems. It is important that inflation be recognized and realistically provided for if estimates for total program costs are to be valid.

#### RECOGNITION OF EXCLUDED COSTS

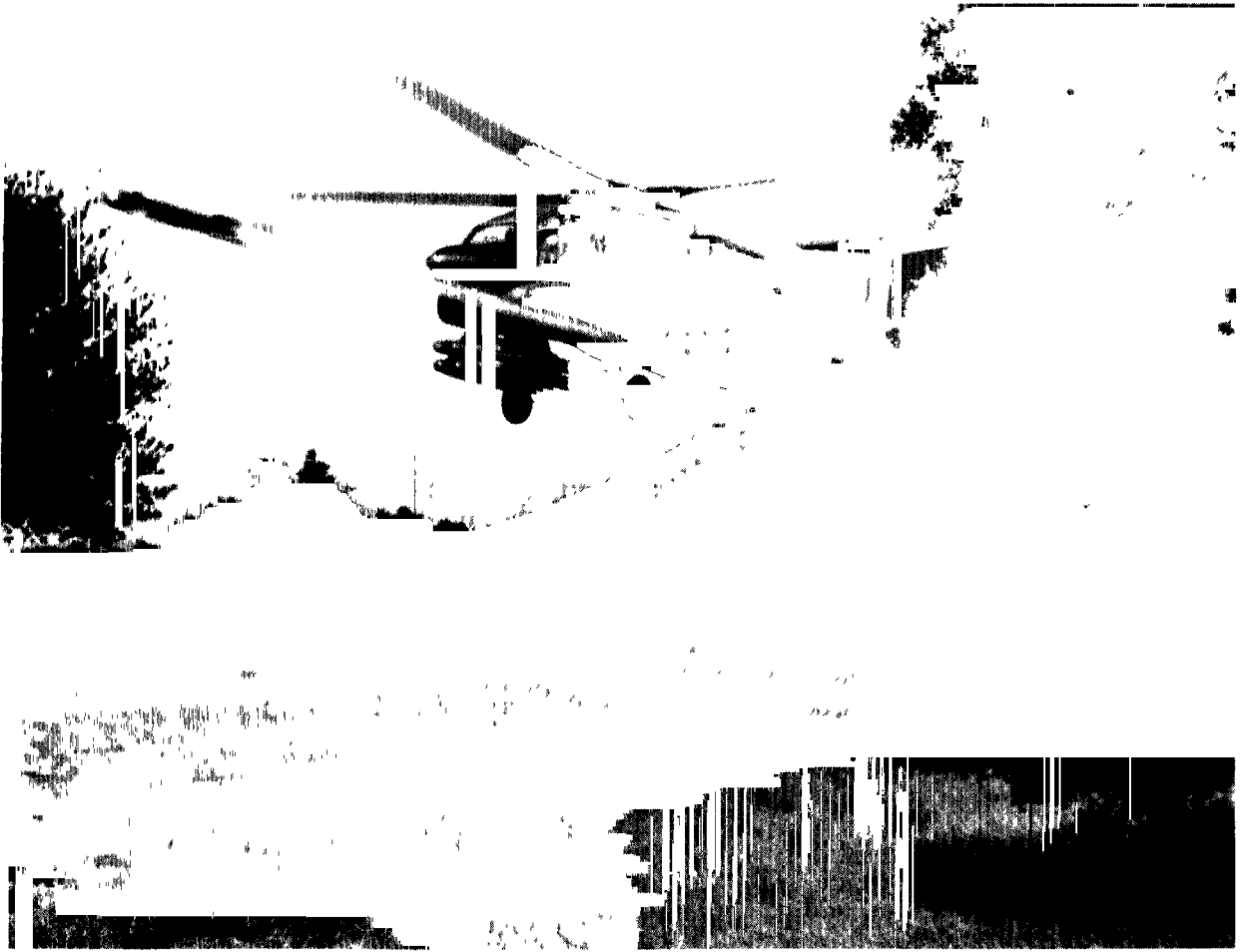
Weapon systems cost estimates should contain provisions for all costs associated with that weapon system. If major costs have been excluded from an estimate or included under another category, it is important that the estimator disclose this information and include its rationale.

#### INDEPENDENT REVIEW OF ESTIMATES

An independent review of a cost estimate is crucial to the establishment of confidence in the estimate. The independent estimator must examine the original estimate and verify, modify, and correct it as necessary to ensure completeness, consistency, and realism of the information contained in the cost estimate.

#### REVISION OF ESTIMATES WHEN SIGNIFICANT PROGRAM CHANGES OCCUR

It is important that cost estimates be updated to reflect changes because changes in the system's design requirements drive the cost. Large changes in the cost of an acquisition significantly influence decisions to continue, modify, or terminate a program.

DESCRIPTIONS OF SYSTEMS REVIEWEDARMYApache attack helicopter (AH-64)

APACHE HELICOPTER

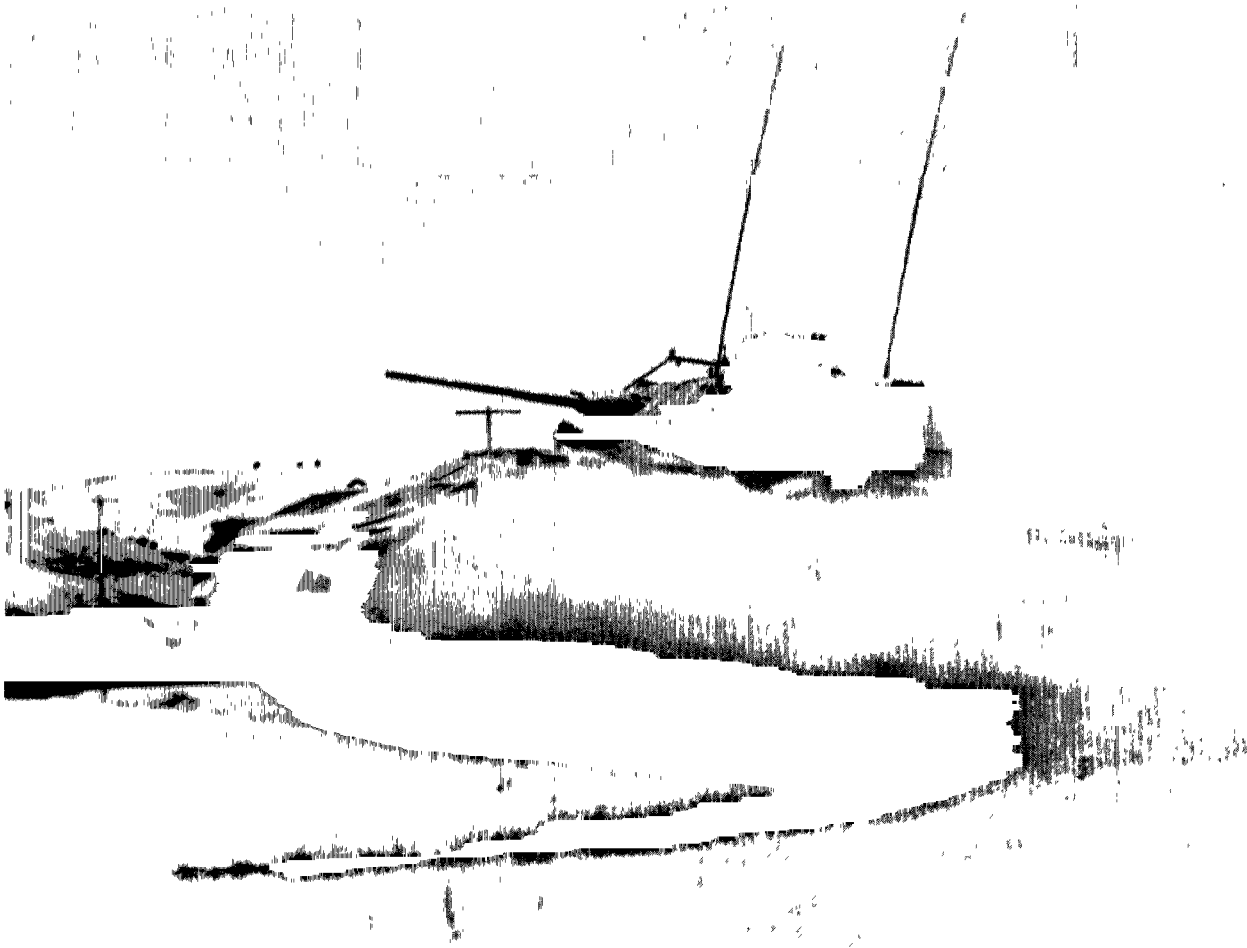
The Apache attack helicopter is a twin-engine, four-bladed helicopter operated by a tandem-seated crew of two. The pilot is located in the rear cockpit, and the copilot/gunner is in the forward position where concentrating on detecting, engaging, and destroying enemy targets with the laser-guided Hellfire missile, 2.75-inch aerial rockets, and 30-mm chain gun can be enhanced. To perform target sighting, the Apache is equipped with a

special target acquisition designation sight which, along with the pilot night vision system, also enhances the crew's ability to navigate and attack targets during darkness and in conditions of limited visibility.

The Army has developed the Apache and its primary armament, the Hellfire, to be its principal aerial antiarmor weapon for the mid-1980s and beyond. Their basic mission is to support ground forces by destroying enemy tanks and other ground targets from the air.

Hellfire Missile System**HELLFIRE MISSILE**

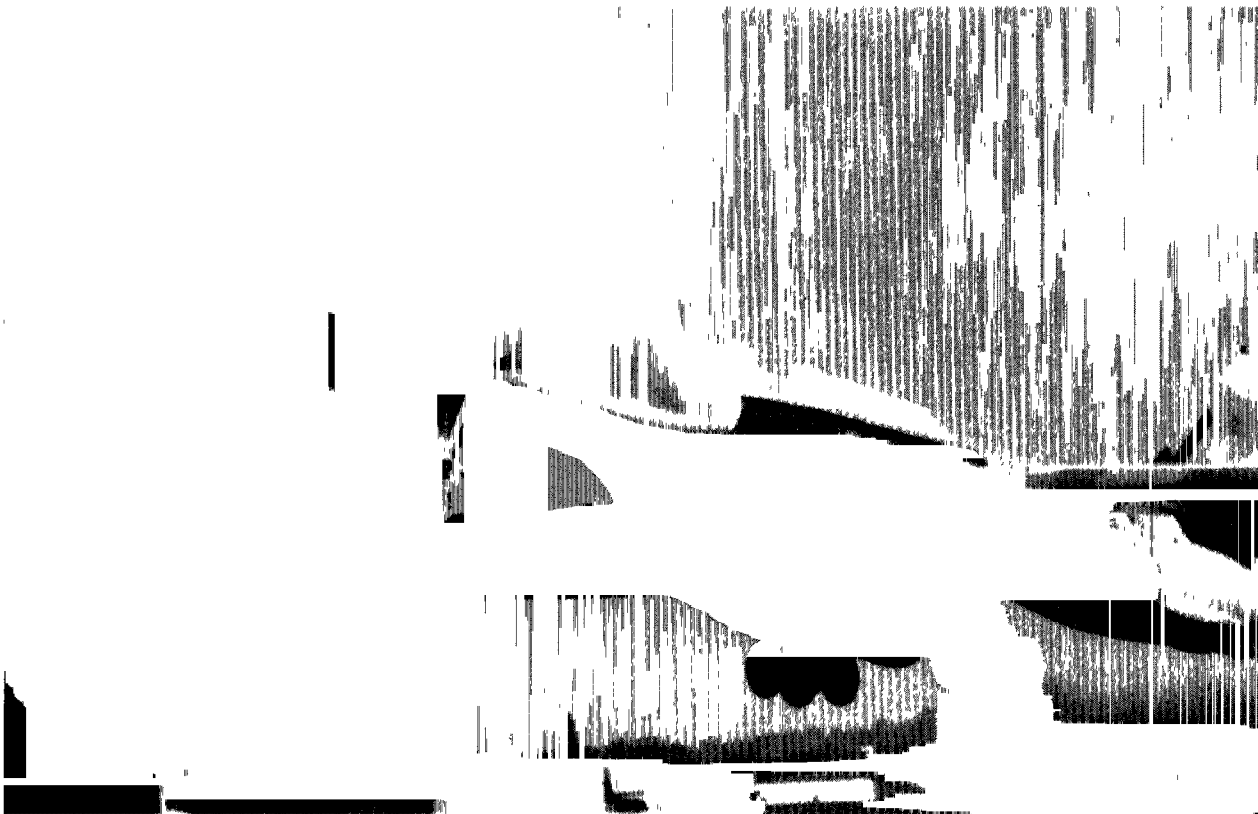
The Hellfire is an antitank missile developed specifically for the AH-64 Apache helicopter. The missile is laser guided; its seeker homes onto laser energy reflected from a designator onboard the Apache or other helicopters accompanying the Apache, or located on the ground. According to the Army, several Hellfires can be launched in rapid succession, enabling simultaneous engagements of more than one target.

Bradley Fighting Vehicle Systems**BRADLEY FIGHTING VEHICLE SYSTEM**

The objective of the Bradley Fighting Vehicle Systems program is to develop and field vehicles that normally, in combat operations, will be employed as part of a combined arms team with the M1 Abram Tank. Included in the Bradley program are the Infantry Fighting Vehicle, formerly the Mechanized Infantry Combat Vehicle, and the Cavalry Fighting Vehicle, formerly the Armored Reconnaissance Scout Vehicle. They are companion vehicles to the M1 tank in close combat offensive and defensive operations. The Infantry Vehicle provides mounted fighting capability for a 9-person (soon to be 10-person) mechanized infantry squad. It is equipped with six firing port weapons, a 25-mm automatic gun, a 7.62 coaxial machinegun, and a

smoke grenade launcher. The Calvary Vehicle, with five crew members, will serve as the scout vehicle in mechanized infantry and armor battalions and in armored cavalry squadrons.

The Infantry Vehicle will replace selected M113A1 armored personnel carriers in designated mechanized infantry battalions. The Calvary Vehicle will replace selected M113A1s and improved tube-launched, optically-tracked, wire-guided TOW missile vehicles.

AIR FORCEB-1B long-range combat aircraft system**B-1B BOMBER**

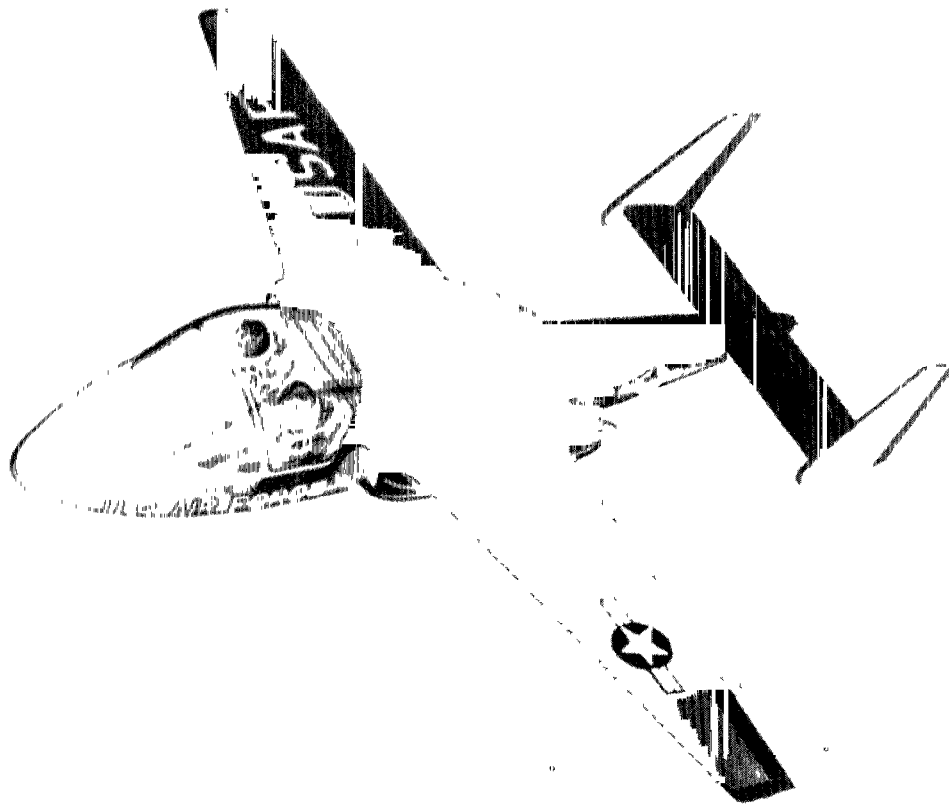
The B-1B is being designed to carry out manned bomber operations throughout the spectrum of conflict. Its primary mission is as a penetrating bomber. Other missions which the B-1B is to perform include the support of tactical land and air warfare, naval warfare, and theater nuclear warfare. Consequently, the B-1B is to provide flexibility with an inherent capability to carry a wide variety of weapons over long distances.

The B-1B uses the B-1A aerodynamic shape and structures as well as many systems designed for the B-1A. To permit higher gross take-off weights, the B-1B will have stronger landing gear than the B-1A.

Communications and traffic control systems on the B-1B are essentially the same as those incorporated on the last B-1A built. The B-1B avionics systems are to be improved to accommodate expanded missions. Offensive avionics systems incorporate improved equipment like that being installed in B-52s. It will also have a multimode radar derived from equipment being installed in F-16 aircraft. The defensive systems include an expanded version of the ALQ-161 electronic countermeasures system originally designed for the B-1A.

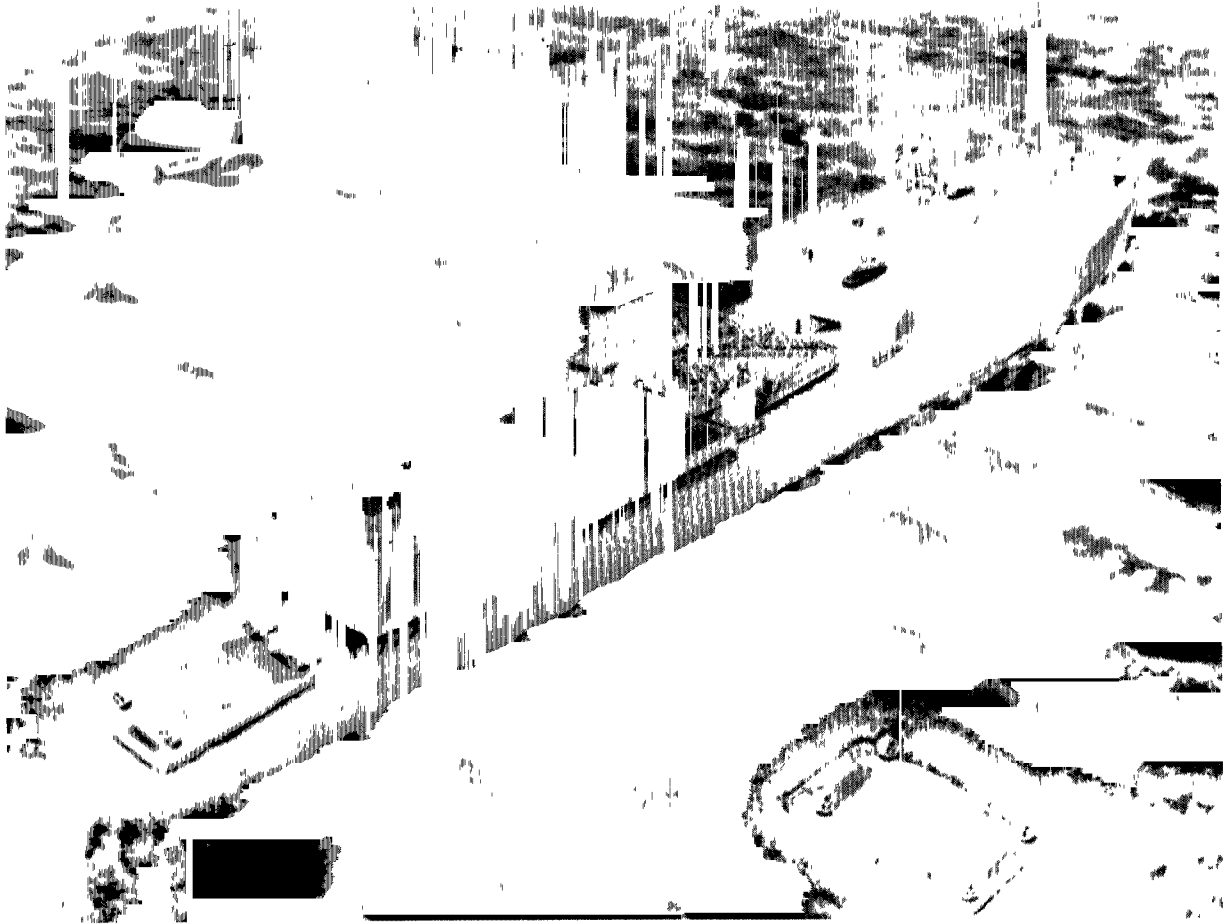
The B-1B weapon bays will have the capability to carry all types of mission required weapons as well as additional fuel. The aircraft is operated by four crew members.



T-46A trainer aircraft system

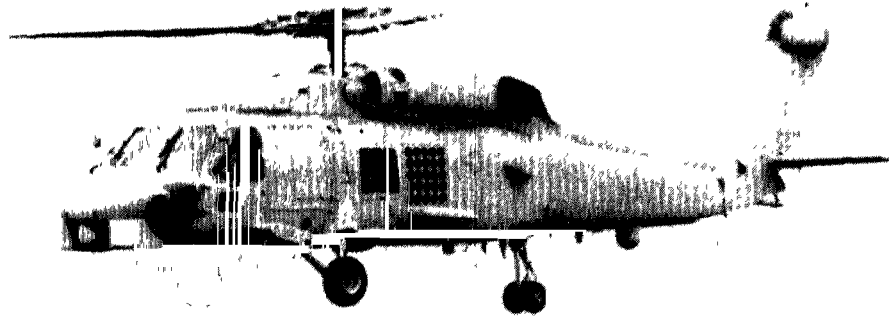
T-46A TRAINER AIRCRAFT

The T-46A is a development and acquisition effort to replace the T-37 aircraft. The T-46A aircraft is to provide the Air Force primary training capability beyond 1986. The T-46A aircraft is to provide significant improvements in performance, maintainability, and noise pollution over the T-37 aircraft. The T-46A aircraft is considered to be within the state of the art with low complexity in its components.

NAVYLSD-41

LANDING SHIP DOCK (LSD)-41

The LSD-41 program is designed to replace the LSD-28 class. The ship design is a modified repeat LSD-36 design which the Navy emphasizes is technically proven, using simple, unsophisticated systems. The ship is to displace about 15,745 tons fully loaded and be diesel powered.

LAMPS MK III**LIGHT AIRBORNE MULTI-PURPOSE SYSTEM (LAMPS) MK III HELICOPTER**

LAMPS MK III is a computer-integrated ship and helicopter system designed principally for antisubmarine warfare with secondary mission capabilities of antiship surveillance and targeting, search and rescue, medical evacuation, and logistics support. LAMPS MK III is to be deployed aboard cruisers, destroyers, and frigates. The helicopter, designated the SH-60B Seahawk, is a derivative of the Army's UH-60A Black Hawk troop assault helicopter.

OTHER REPORTS OR STUDIES RELATING TO DOD'S  
COST ESTIMATING AND REPORTING PROCESS

- (1) Majors Edwin M. Lewis, and Eugene D. Pearson, (Air Force), The Air Force Cost Estimating Process: The Agencies Involved and Estimating Techniques Used (Wright-Patterson Air Force Base), Ohio: Air Force Institute of Technology, June 1977.

Within the Air Force cost estimating process, cost estimates are developed in an atmosphere of optimism. The cost estimator is provided organizational motivation to develop an estimate which can be used to advocate the new weapon system to DOD and the Congress. The individual estimator is hampered in efforts to develop estimates by the lack of an adequate, standardized data base; lack of feedback on the accuracy of the estimates; and little or no feedback on how changes have effected prior estimates.

- (2) Inaccuracy of Department of Defense Weapons Acquisition Cost Estimates, House Committee on Government Operations, 96<sup>th</sup> Congress, 1st Session, Report No. 96-656, November 16, 1979.

On November 15, 1979, the Committee on Government Operations approved and adopted the Legislation and National Security Subcommittee's report entitled Inaccuracy of Department of Defense Acquisition Cost Estimates. Some of the study's findings were as follows:

- Major weapon system cost estimates are not accurate and do not provide the Congress with the information needed to effectively evaluate DOD budget requests.
- The initial planning estimate has been approximately 100 percent below the actual cost of major systems, while the later, more refined development estimate has been approximately 50 percent below procurement costs.
- The major reasons cited by the military for cost variances are: economic inflation changes, 30 percent; quantity changes, 28 percent; and schedule changes, 16 percent. Also, the military acknowledges an "actual estimating error" of 12 percent which amounts to over \$10 billion.
- Because major weapon systems cost estimates have not proven accurate over time, the quantities of weapons procured have had to be reduced, thereby cutting into the national security potential.

- Because of continued underestimating, there has been created a so-called "bow wave" effect, which means that weapons procurement will probably have to be further cut in the future because of insufficient funds.
- The cost estimating process used by the services does not parallel the service and DSARC process, which may contribute to the difficulty in developing more accurate estimates.
- Insufficient staff resources within the three services and within OSD may contribute to the consistently inaccurate cost estimates for major weapon systems.

Discussions during these hearings also revealed that DOD continues to use unrealistic inflation rates. Further, compounding the problem is DOD's practice of attributing to "economic change" some of the cost increases due to delays in the production schedule of a weapon system, in addition to actual increase due to the unanticipated economic rate of inflation.

The Committee report concluded the following:

It is the Committee's intention to demonstrate that the Congress must have available reliable and accurate cost information at critical points in the weapon systems authorization and appropriations process if the American public is to receive maximum benefit from the expenditure of their defense dollars. The record is clear that the Congress has not been getting that information.

- (3) Department of the Army, Office of the Auditor General, Cost Discipline Advisory Committee Special Review, Audit Report No. HQ 82-701, 10/28/81.

Inflation indexes used by Army program managers to estimate program costs are based on different methodologies and should be assessed for impact on programs.

Inflation indexes on the M-1 tank program were overstated when compared to the actual rate of inflation incurred. These overstated rates had the effect of masking real cost increases on the program. The M-1 cost estimates are overly optimistic and were primarily based on contractor estimates.

- (4) U.S. Congress, House Committee on Armed Services, Special Panel on Defense Procurement Procedures Report, Weapons Acquisition Policy and Procedures: Curbing Cost Growth, 97th Congress, 1st Session, Committee Print No. 13, February 12, 1982.

Specifically, the panel found that the factors contributing to cost growth are unrealistic inflation estimates, poor cost estimates, program stretchouts, changes in specifications, inadequate budgeting, high risk system design, poor management, and lack of competition.

The panel found that each year DOD continues to base its budget request on unrealistically low inflation estimates established by OMB. In fact, DOD's own analysis of recent cost growth data indicates that approximately 30 percent of the cost growth experienced by the 47 major weapon systems reported in SARs is due to low inflation estimates. During one of the panel's hearings, Deputy Secretary Carlucci, referring to DOD's recent management initiatives to improve the acquisition process, indicated that, ". . . budgeting for inflation is perhaps the most difficult of all the initiatives." Carlucci continued,

"I can claim some progress in a lot of other initiatives, but at this point I can't claim that we have solved that problem."

Another significant contributor to cost growth is erroneous cost estimating by contractors. The panel found several examples of poor estimating by contractors during its investigation. For example, during the panel's case study of the Black Hawk helicopter program, it was determined that for the period 1977-79 the contractor underestimated the man-hours required to produce the first 163 Black Hawk helicopters by over 54 percent. This means that instead of the 97,200 man-hours initially estimated, the true requirement was approximately 150,077 man-hours, which resulted in a significant, unanticipated cost growth. This is not an isolated example. The panel's record is replete with discussions of poor estimating, and it is clear that such errors are major contributors to cost growth. Incentives are required to force more accuracy and realism into estimates. The panel record clearly documents contractors' propensity for competitive optimism--"buying in."

Among the panel's finding is that SAR is inadequate in its reporting on major weapon systems to the Congress, thus inhibiting proper oversight. The SAR system does not

consistently provide timely and complete information. The present SAR system provides quarterly updates that do not always reflect substantive fact-of-life changes that may have occurred in a program since the December 31 SARs.

Although Secretary Carlucci testified that,

"We do have the CAIG [Cost Analysis Improvement Group], as you know, which works with the DSARC to provide the independent cost analysis,"

the record is not clear on whether Cost Analysis Improvement Group cost analyses actually influence the final cost estimates which appear in defense budget proposals. Mr. Augustine testified that,

"They [CAIG] have some competent people, but I would fault their efforts in two regards: One, their methodology is not sufficiently accurate to give high-cost [highly accurate] cost estimates; and secondly, they are too seldom listened to. If we had listened to them more carefully in the past, we might not be sitting here today."

- (5) Joseph T. Kammerer, Estimating in the '80s--Special Section, Concept. The Journal of Defense System Acquisition Management, spring 1981, Volume 4, Number 2.

Many cost analysts shy away from projecting the impact of the economy on future defense expenditures. The excuse is often given that such projections are too subjective, too uncertain, and would be viewed as guesswork. The current procedure also allows us to conveniently place the blame for cost growth on inflation, an economic force beyond our control.

Whenever a Navy weapon systems program has significant cost-growth problems, the questions from top management are, "What happened? Where did we go wrong in estimating the costs?" The answers are often not readily available and the reason is the lack of good cost estimating documentation. To track cost estimates, good documents are essential. Even when documents are fairly good, the question can often not be answered satisfactorily because cost estimators do not track cost performance very well.

- (6) American Defense Preparedness Association, Cost Discipline Report, Chicago, Illinois, July 21 to 22, 1982.

Cost estimates on weapon systems development programs are not well done, are not updated with sufficient frequency, and are characterized by being overly optimistic,

particularly at the early stages of the program. Many of these problems stem from the competitive nature of the DOD budget, defense industry competition, and the contracting process.

Although on the surface, the Army, OSD, and the Congress want to know the real costs, the competitive environment, both within the budget process and with the defense industry, creates an atmosphere that results in very optimistic and high-risk programs with questionable cost realism.

- (7) Dr. Walter B. LaBerge, Defense Acquisition: A Game of Liar's Dice? Concepts, The Journal of Defense Systems Acquisition Management, winter 1982.

Prior attempts at improving DOD acquisition have centered on improving the process without attacking the strong environmental motivations that make people behave the way they do. The DOD procurement system performs in a nonoptimal way with large overruns and delays because the environment forces that behavior. The DOD acquisition system is very much like the barroom game of "liar's dice." In that game, winning comes from concealing the true facts (e.g., the roll of one's dice) and by asserting not what is, but rather what might be.

At the outset of a program, the DOD bid process encourages substantial contractor overoptimism in technical accomplishment, in schedule, and in cost. The management level above the program manager is itself swept up in its own liar's dice game. The figure of merit by which senior officials are scored is how well they can convince their military and civilian superiors that their own program should be funded instead of someone else's. To do this, they also need programs which can be promised quickly and at low cost. In sum, no one benefits from being conservative. Everyone benefits by being unrealistic. All the incentives are on selling.

- (8) George W. S. Kuhn, A Defense Strategy for the 80s, Washington, DC: Heritage Foundation, January 21, 1983.

No rationale whatever exists for DOD continuing to ignore future program changes, which are the principal cause of acquisition cost growth. More direct control must be exercised over cost estimates and cost escalation. Cost overruns must be penalized by enforcing standards of cost escalation. The original quantity requirement might serve as an upper limit on procurement; the original program cost estimate could be an upper spending limit. Preferably, some range of growth above the original cost estimate should be allowed. The range might differ with different



kinds of equipment--tracked vehicles versus aircraft, for example. The range might specify allowable limits for different kinds of cost increases: a greater margin could be allowed for technical changes to meet original performance goals; the margin for changes to add performances capability could be more limited. Whatever the standard chosen, the limit must be strictly enforced. The Army's Fighting Vehicle System long ago violated any reasonable cost growth margin: it is now more than 2,500 percent over estimate.

Budgeting practices are altogether unrealistic in their attempts to plan for and manage cost escalation. Cost projections are consistently and optimistically understated. During the program's acquisition, no adequate reference is made to the actual cost escalation experience of other similar programs. Even the program's own history of cost change is seldom taken as a guide. Finally, budgets are assumed to increase at steady rates (high or low), which has never proved true even in the best budget times.

The result of unrealistic cost and budget projections is an enormous upward pressure on budgets from within ongoing programs. Put differently, almost every program in the DOD acquisition process needs, at any given time, greatly expanded funds just to accomplish current goals. Moreover, the overall budget is subjected to more such pressure with every addition of a new program. These internal budget pressures are of such proportions that even generously increasing budgets cannot keep up. Any new funds are soaked up with little or no new output.

- (9) Air Force, Affordable Acquisition Approach report, February 9, 1983.

A study of old and new weapon systems acquisitions concludes that it is taking longer and costing more to acquire major Air Force systems. In addition, the report states that some key cost management tools are needed such as developing a more likely cost estimate that includes future growth, unknowns, and so on. The report concludes that once the most likely cost is established, the Air Force must program and fund to that level, and that the Air Force must ensure realistic inflation rates are used in program estimates.

- (10) Congressional Budget Office, Special Study, A Review of the Department of Defense December 31, 1982, SARs, August 1983.

Some of the findings of the Congressional Budget Office study of the December 31, 1982, SARs for 62 weapon systems are presented below. The Congressional Budget Office made an analysis of cost changes reported by DOD for the fourth quarter of 1982, for the 1982 calendar year as a whole, and over the years from 1977 to 1982.

SARs are very useful for monitoring cost changes and other developments in weapons acquisition programs and for providing rough indicators of overall cost growth. In several respects, however, the SARs continue to contain incomplete, inaccurate, and conflicting information.

There are numerous indications that the latest SAR data may not reflect the ultimate acquisition cost.

The cost estimates for 13 systems excluded at least \$40.8 billion in program costs that were footnoted in SARs or reported in other DOD budget documents, such as the congressional data sheets. The Congressional Budget Office believes that these costs should be included in the SAR estimates. Doing so would raise the December 1982 estimated costs for the 13 systems by 13.8 percent. Of the 13 systems, 3 were Air Force programs, 9 were Navy programs, and 1 was an Army program. For the F-15 and F-16 programs, for example, the Air Force did not report almost \$14 billion for procurement of additional aircraft. The Navy did not report over \$4 billion of military construction costs for the Trident submarines. The Navy also did not include nearly \$6 billion of CVN (Nuclear Aircraft Carrier) procurement costs for a carrier in 1988 and advance procurement in 1986-88 for later ships.

The services used different inflation rates in 1982 to estimate the procurement costs of aircraft and missiles. The use of different inflation rates for 1982 could significantly affect estimates of future program costs because the differences would be compounded over the years. Moreover, the use of two different rates for identical systems or similar systems made by the same prime contractor suggests that some programs are overfunded or underfunded.

- (11) Congressional Research Service, Cost Overruns in Major Weapon Systems: Current Dimensions of a Longstanding Problem, Report No. 83-194 F, October 15, 1983.

Among the factors widely considered to be most responsible for cost overruns is the practice of making unrealistically low initial cost estimates. In testimony before the Senate Committee on Governmental Affairs on March 23, 1983, Deputy Secretary of Defense W. Paul Thayer stated that "unrealistic cost estimating is a major cause of cost growth." He went on to explain that:

"In the past we have been overly optimistic about the projected outyear costs of programs. The cost growth that results from this optimism produced increasing instability, stretch-outs, and more cost increases. It is a vicious cycle and a difficult one to reverse."<sup>1</sup>

Indeed, it is widely acknowledged that program costs are often purposely underestimated either because the contractors are lowering their cost estimates to win a contract with hopes of recovering costs on follow-on contracts (a practice known as "buying-in") or because DOD is forcing a program to fit available funding rather than providing the funding it takes to do the job.<sup>1</sup>

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<sup>1</sup>Deputy Secretary of Defense. Internal memorandum to the secretaries of the military departments and others on the subject of improving the acquisition process; with attached recommendation and issues for decision, April 30, 1981.

OUR PAST REPORTS AND TESTIMONY RELEVANT  
TO THE DOD COST ESTIMATING  
AND REPORTING PROCESS

1. Status of Major Acquisitions as of September 30, 1981:  
Better Reporting Essential to Controlling Cost Growth  
(MASAD-82-24, 4/22/82).

Agencies' cost, schedule, and quantity data show that the initial estimates and planning data provided to the Congress vary greatly from current estimates. The cost of 137 defense programs increased a total of \$243.1 billion, or 132 percent over the congressional budget estimates, that is, total estimated cost of projects provided the Congress with initial budget justifications. Major reasons cited for cost growth included

- inflation underestimated and/or not included in the planning estimate;
- inaccurate estimates; and
- changes in scope/quantity, engineering, schedule, and mission.

Over the years, we have reported on the problem of cost growth, the need to improve existing reporting systems, and the need for establishing a reporting system to include all major civil acquisitions and those major defense programs not on DOD's SAR system.

2. Budgetary Pressures Created by the Army's Plans to Procure  
New Major Weapon Systems Are Just Beginning (MASAD-82-5,  
10/20/81).

Procurement costs for 14 major Army weapon systems increased by 30 percent from \$52.2 billion, to \$68.1 billion, over the 1981-85 plan. This was due to a combination of factors: (1) the effects of deliberate production stretchout, which include incurring more fixed cost than planned and higher inflation associated with greater annual spending rates in future years, (2) program cost growth due to underestimating, and (3) the use of higher inflation estimates than had been used previously. Early production contracts were budgeted using cost estimates that have proven to be optimistic.

3. Improving the Weapon Systems Acquisition Process  
(MASAD-81-29, 5/15/81).

A compilation of concerns regarding the weapon systems acquisition process is given. These represent our opinions based on the many reviews we have made over the past several years. The services should be instructed to prepare their cost estimates conservatively. Too much optimism has crept into past estimates. The recent sharp rise in the cost estimates of several acquisition programs shows that sufficient realism was lacking in developing these estimates. A more critical review of the cost estimates prepared for presentation to DSARC should be made.

4. Cost Growth in Major Weapon Systems (B-163058, 3/26/73).

Costs of 45 systems covered by DOD SARs at June 30, 1972, increased by some \$31.5 billion, or 39 percent over planning estimates and 20 percent over development estimates. One reason for this cost growth was inaccuracy in estimating by both competing contractors and military service representatives. Both the competing contractors and service representatives are strongly motivated--the one to propose and the other to accept low cost estimates--to win the contract and to gain approval against competing systems within the same service or similar systems proposed by another service. It is neither wise nor equitable to delegate cost estimates for new development to competing contractors, nor to base the government's funding plans on such estimates. The government must have the capability to develop reliable cost estimates.

5. Theory and Practice of Cost Estimating for Major Acquisitions (B-163058, 7/24/72).

Uniform guidance on cost estimating practices and procedures which would be the basis for formulating valid, consistent, and comparable estimates throughout the services was lacking. Each service issued its own guidance for the estimating function, which ranged from a detailed estimating manual to a few general statements. Guidance was often ignored by the estimators.

Cost estimates for a specific system frequently are a succession of revisions; the current cost estimate is derived by refining and revising the preceding cost estimate. Accurate revision of both the original and updated cost estimates require documents showing data

sources, assumptions, methods, and decisions basic to the estimate. In virtually every system we reviewed, documents supplying such information were inaccurate or werelacking. Among the resulting difficulties were:

- Known costs had been excluded without adequate or valid justification.
- Historical cost data used as a basis for computing estimates were sometimes invalid, unreliable, or unrepresentative.
- Inflation was not always included or uniformly treated when it was included.
- Understanding and proper use of the estimates was hindered.

Readily retrievable cost data which could serve as a base for computing cost estimates for new weapon systems generally were lacking.

We recommended that the Secretary of Defense should develop and implement guidance for consistent and effective cost estimating procedures and practices throughout DOD. In developing this guidance, the Secretary of Defense should consider the criteria for cost estimating set out in this report. Of particular importance is providing for:

- An adequate data base of readily retrievable cost data.
- Treatment of inflation.
- An effective independent review of cost estimates, including judgment by top officials as to the realism of the cost estimates on which decisions are based.
- More complete documents of cost estimates, coupled with a requirement for an adequate feedback of results, to provide a basis for comparing costs achieved with those estimated.

6. Evaluation of Unit Cost Reports Submitted Under Public Law 97-86, Section 917 (MASAD-82-36, 5/10/82)

We reviewed 19 unit cost reports submitted to the Congress by DOD to determine the completeness, currentness, and accuracy of the data presented. Overall, DOD made a

reasonably successful effort to comply with the requirements of submitting unit cost reports. However, some reports were lacking in completeness and accuracy. In some cases, program estimates did not include all costs, were not consistent with independent estimates, and will soon be outdated because of changes and uncertainties in the program.

7. The B-1 Bomber Program--A New Start (GAO/MASAD-83-21, 4/13/83).

The B-1B program still omits known program costs, for example, independent cost estimates prepared by OSD and Air Force analysts agree on \$1.4 billion in additional acquisition costs not included in the estimate provided to the Congress. OSD and Air Force guidance defining program costs permit varying interpretations of what is to be included in major acquisition cost estimates. We believe that the Congress would have better visibility of the acquisition cost if all related costs were reported in one place. We recommended that all acquisition costs related to the B-1B program be provided to the Congress in a single package.

8. Consistent and Uniform Treatment of Inflation Needed in Program Cost Estimates Provided to the Congress (PSAD-78-8, 3/20/78).

OMB and agency procedures do not result in uniform treatment of expected inflation or price changes in the budget and cost estimates provided to the Congress. The Congress should require that OMB develop inflation policy and procedures which agencies would uniformly apply to annual program and budget estimates. Uniform criteria would provide comparable program data.

9. A Range of Cost Measuring Risk and Uncertainty in Major Programs: An Aid to Decisionmaking (PSAD-78-12, 02/02/78).

Although efforts can and should be made to continuously improve the reasonableness of program estimates, over optimism still exist. Problems caused by inflation, cost estimating, and program uncertainty are further complicated by the advocacy or optimistic nature of many estimates. A major program within an agency competes with other agency programs for funds. The agency must compete with other federal agencies for a share of the total federal budget.

Since funds are limited, program proponents tend to state the most favorable estimate which reflects the assumption that no problems will arise or that problems will have only a minimal effect.

10. Cost Information Presented to the Congress on the C-5B Aircraft Program (GAO/MASAD-83-5, 12/30/82).

The C-5B cost estimate of \$8.8 billion supporting the fiscal year 1983 budget was understated by \$700 million due to the omission of certain acquisition costs (ground support equipment, simulators, technical data, etc.) from its estimate.

11. F/A-18 Naval Strike Fighter: Progress Has Been Made but Problems and Concerns Continue (MASAD-81-3, 2/18/81).

Although there has been some cost growth, costs have soared primarily because of the inflation impact. Even though substantial increases have already been reported, the current program cost estimate is based on projected escalation rates which are consistently lower than those projected by industry. If actual escalation rates continue to be higher than rates used by DOD, program cost estimates will continue to be understated.

12. Impediments to Reducing the Costs of Weapon Systems (PSAD-80-6, 11/8/79).

We found that the design-to-cost concept was not closely followed and the departures included (1) failure to establish the cost data base needed to establish cost performance estimating relationships relevant to design-to-cost objectives, goals, and decisions and (2) overemphasis on controlling the more immediate and visible acquisition costs than the more substantial life-cycle costs.

13. Comparative Life-Cycle Cost: A Case Study (PAD-78-21, 8/16/78).

A case study of the costs for two Army tanks, XM-1 and M60A3, demonstrated the importance of life-cycle cost comparisons. Comparing only acquisition costs, the XM-1 is twice as expensive as the M60A3. When life-cycle costs (totals for buying, operating, and maintaining tanks) during a 20-year period are considered, the XM-1 costs are about 20 percent more because of large, nearly equal maintenance and operation costs for the two tanks. Thus,



the XM-1 need be only 20 percent more cost effective, and the consensus of Army studies has been that its cost effectiveness compared to the M60A3 is considerably more than this percentage.

14. Review of Life-Cycle Cost Concept (PSAD-78-74, 3/2/78).

Actions have been initiated encouraging the use of life-cycle cost considerations in decisionsmaking, but progress has been slow. Issuance of guidance and operating and support costs accumulation and reporting has been spotty, and the effect of initiated actions is just being recognized. Issues requiring attention are: accountability for meeting operating and support cost goals is unclear, assumptions for developing operating and support estimates are not updated to show changes in program requirements, operating and support estimates are not reported to the Congress, costs of operating and support data are not compared to benefits, and more life-cycle cost training is needed. To make life-cycle cost a viable factor in controlling operating and support costs, the Secretary of Defense should: accelerate efforts to provide uniform and standard cost definitions and cost estimating guides, hold program managers accountable for operating and support costs, require systematic updating and reporting of life-cycle cost estimates, and provide program managers expert cost analysts to assist in life-cycle cost decisions and trade-offs.

15. Life-Cycle Cost Estimating--Its Status and Potential Use in Major Weapon System Acquisitions (PSAD-75-23, December 30, 1974).

The life-cycle cost of a weapon includes the cost to acquire, operate, and maintain the weapon over its useful life. Decisions on proceeding with a weapon system's development have generally been based on the acquisition cost of the weapon.

DOD must overcome its reluctance to disclose ownership cost estimates. Acquisition costs of major weapon systems are a matter of record--they are published in SARs prepared for the Congress by DOD for most of the larger systems--but service officials are not as open about disclosing estimates of ownership costs.

In an environment where major weapon systems about to be or already being developed, are competing with each

other for funds, the concentration is on securing sufficient funds to "get the program off the ground" rather than directing attention to the operation and maintenance costs which will not require funding for several years.

The Congress may wish to institute procedures by which the Secretary of Defense will periodically inform interested committees of the Congress on the progress being made in improving DOD's ability to estimate ownership costs and furnish such estimates after necessary improvements are achieved.

16. Need for More Accurate Weapon System Test Results to Be Reported to the Congress (PSAD-79-46, 3/9/79).

To overcome the problem of not receiving accurate information it needs in making weapon system procurement decisions, the Congress enacted legislation requiring DOD to submit annual reports to the Congress (congressional data sheets). Among other things, these documents are to include results of operational tests and evaluations on major systems for which procurement funds are requested.

We also found that the results of the tests and evaluations of 10 Navy and 5 Air Force weapon systems contained in the data sheets reviewed were incomplete, misleading, and/or outdated.

We recommend that the Secretary of Defense improve the quality and timeliness of operational test results reported in congressional data sheets.

17. Statement of Walton H. Sheley, Jr., Director, Mission Analysis and Systems Acquisition Division, before the Senate Committee on Governmental Affairs, on DOD Acquisition Issues, March 23, 1983.

"The failure to develop reliable cost estimates results in cost growth that is built-in, that is, cost growth that could have been avoided if more time, attention, and realism was used in developing estimates. All too often optimistic estimates are used to gain approval for acquisitions. Once a decision is made on the basis of faulty estimates, it may take years before the real costs surface."

18. Statement of Walton H. Sheley, Jr., Director, Mission Analysis and Systems Acquisition Division, before the Special Panel on Defense Procurement Procedures, House Armed Services Committee on Weapon System Cost Growth, October 22, 1981.

"As far back as the early 1970s, GAO has reported that both planning and development cost estimates on Federal acquisitions in many cases are quite optimistic on technical development problems, cost, and potential performance. Recognizing the technical complexity of R&D [Research and Development] projects, we believe it is extremely important that adequate project definition be performed to provide as accurate and reliable an estimate of schedule milestones and total project cost as possible.

"The desire of program advocates to sell the program to both agency management and the Congress with low-cost estimates and high expectations for solving technical problems is understandable. After all, the vitality of an agency depends to a large extent on new program starts. But this must be balanced against the need for as realistic appraisals as possible of the potential resources needed. Recent testimony by DOD recognizes that unrealistically low contractor and agency estimates on the front end aggravates cost growth. What is needed is more candor up front in presenting programs to the Congress and not promising more than can be realistically delivered."

19. Statement of Jerome H. Stolarow, Director, Procurement and Systems Acquisition Division, before the House Committee on Government Operations, Subcommittee on Legislation and National Security, on Weapons Systems Costs, June 25, 1979.

"The question that arises is why the early estimates--even given the lack of firm data--are always so much lower than the later estimates. I think it is fair to say that human nature plays a major role.

"Program advocates both in DOD and industry want to get a program started. They tend to be highly optimistic with respect to costs, technical developmental problems and operational characteristics, i.e., the proposed weapon will do wonders at a very low cost. This is expressly intended to "sell" both the decisionmakers in DOD as well as the Congress."

AUDIT WORK LOCATIONS

This review required audit work at the following locations:

Office of the Secretary of Defense--Cost Analysis  
Improvement Group, Washington, D. C.

ARMY

Apache Helicopter Program Office, St. Louis, Missouri.  
Army Audit Agency, Redstone Arsenal, Huntsville, Alabama.  
Army Audit Agency, Warren, Michigan.  
Army Audit Agency, Washington, D.C.  
Bradley Fighting Vehicle System Program Office, Warren,  
Michigan.  
Headquarters, U.S. Army, Washington, D.C.  
Headquarters, U.S. Army Materiel Development and  
Readiness Command, Alexandria, Virginia.  
U.S. Army Aviation Research and Development Command,  
St. Louis, Missouri.  
U.S. Army Missile Command, Redstone Arsenal, Huntsville,  
Alabama.  
U.S. Army Plant Representative Office, Hughes Helicopter  
Incorporated, Culver City, California.  
U.S. Army Tank Automotive Command, Warren, Michigan.

NAVY

Headquarters, Naval Material Command, Washington, D.C.  
LAMPS MK III Program Office, Crystal City, Virginia.  
LSD-41 Program Office, Crystal City, Virginia.  
Naval Air Systems Command, Washington, D.C.  
Naval Sea Systems Command, Washington, D.C.  
Navy Audit Service, Washington, D.C.

Office of the Chief of Naval Operations, Washington, D.C.

AIR FORCE

Air Force Flight Test Center, Edwards Air Force Base,  
California.

Air Force Logistics Command, Wright-Patterson Air Force  
Base, Ohio.

Air Force Test and Evaluation Center, Kirtland Air Force  
Base, New Mexico.

Air Force Plant Representative Office at Airborne  
Instruments Laboratory, Long Island, New York.

Air Force Plant Representative Office at Boeing, Seattle,  
Washington.

Air Force Plant Representative Office at General Electric,  
Evendale, Ohio.

Air Force Plant Representative at Fairchild, Long Island,  
New York.

Air Force Plant Representative at Rockwell, El Segundo,  
California.

Air Force Systems Command, Andrews Air Force Base,  
Maryland.

B-1B System Program Office, Wright-Patterson Air Force  
Base, Ohio.

Headquarters, U.S. Air Force, Washington, D.C.

T-46A System Program Office, Wright-Patterson Air Force  
Base, Ohio.

CONTRACTORS

Airborne Instruments Laboratory, Long Island, New York.

Boeing Military Airplane Company, Seattle, Washington.

Fairchild Republic Company, Long Island, New York.

FMC Corporation, San Jose Ordnance Plant, San Jose,  
California.

Garrett Turbine Engine Company, Phoenix, Arizona.

General Electric's Aircraft Engine Group, Lynn,  
Massachusetts.

General Electric, Evendale, Ohio.

Hughes Aircraft Company, Electro-Optical & Data Systems  
Group, Culver City, California.

Hughes Helicopters Incorporated, Culver City, California.

Lockheed Shipbuilding and Construction Company, Seattle,  
Washington.

Rand Corporation, Santa Monica, California.

Rockwell Corporation, Deluth, Georgia.

Rockwell International, El Segundo, California and  
Palmdale, California.

Sikorsky Aircraft Division, Stratford, Connecticut.

OTHERS

Defense Contract Administration Service Management  
Agency, Phoenix, Arizona.

Defense Contract Audit Agency at Airborne Instruments  
Laboratory, Long Island, New York.

Defense Contract Audit Agency at Boeing, Seattle,  
Washington.

Defense Contract Audit Agency at Fairchild, Long Island,  
New York.

Defense Contract Audit Agency at Garrett, Phoenix, Arizona.

Defense Contract Audit Agency at General Electric,  
Evendale, Ohio.

Defense Contract Audit Agency at Rockwell, El Segundo,  
California.

Defense Contract Audit Agency, Los Angeles, California.

Defense Contract Audit Agency, St. Louis, Missouri.



# AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

DEDICATED TO PEACE WITH SECURITY THROUGH DEFENSE PREPAREDNESS

ROSSLYN CENTER, SUITE 900, 1700 NORTH MOORE STREET, ARLINGTON, VIRGINIA 22209  
703-522-1820

Founded 1919

November 10, 1983

Mr. Frank C. Conahan  
Director  
National Security and International  
Affairs Division  
United States General Accounting Office  
Washington, D. C. 20548

Dear Mr. Conahan:

The American Defense Preparedness Association appreciates the opportunity to review and comment on a draft of your proposed report "DoD Needs to Provide Better Weapon Systems Cost Estimates to the Congress". We have provided in the subsequent paragraphs our comments concerning this draft report.

Your organization has been on this trail for over ten (10) years and has issued a variety of reports on the subject. The basis of your reports in the early years was the SAR data. This data base has now been supplemented by information in the Unit Cost Reports required by Section 917, PL 97-86.

Your current draft report recognizes the considerable on-going efforts of OSD and the Services to improve their weapon systems cost estimates. An examination by a layman of Appendix III to your report would convince him, I believe, that all three Services have developed, over time, intelligently structured systems for producing and validating weapon systems cost estimates. In Chapter 5 of the report you also indicate that OSD and the Services have recently taken steps to improve the cost estimating process. In light of this effort, a substantial part of the report, based on history, appears to be out of date. Would your conclusion, that cost estimating in the Defense Department is still unacceptable; have been appropriate if the new emphasis had been in existence at earlier times?

The ADPA statement on page 3 of the Draft Report is still valid.

Valid cost estimating depends on gathering all pertinent facts and proper analyses by competent people. Cost estimating is an integrated activity, depending for success on availability of several specialities: engineers, production specialist,



Mr. Frank C. Conahan

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marketing expert, price/cost analysts, management, etc. Ad Hoc teams, called together for individual actions, are not as effective as permanent staffs who bring to bear experience garnered from related or similar programs.

Independent cost estimate teams are necessary at all levels:

- a. at the project-program manager's office to challenge adequacy of the statements of the PM Staff and the contractor.
- b. at the command level to challenge presentation of the PM.
- c. at the Department Headquarters level.
- d. at OSD (the CAIG).

Inflation was a principal cause of cost growth when the "official" OMB forecasts had to be used for budgeting and program management. The recent authority to use more realistic "basket of goods" inflation rates will diminish the problem, but still will not dispose of it altogether. Inflation rates should be permanently removed from the political arena, as far as defense is concerned.

The recent DoD actions for improvement of cost estimating should help to reduce the problem. Defense testimony on the Authorization Bill FY 84 (Part 3, pages 279-379, House of Representatives) shows some progress.

ADPA feels the statement at the bottom of page 14 that "the purpose of documentation is to provide the means for tracking program cost estimates and enforcing cost discipline" is misleading. The need for documentation is not, in our view, to provide an audit trail but rather to permit intelligent program management, especially as managers change, so that successive managers can learn what predecessors have accomplished, how and why.

There is, in our view, a need for cross-fertilization among the Services on new ideas and better ways of accomplishing cost estimates. In this regard an effort to cause and maintain surveillance on this cross-fertilization by OSD we feel would be most beneficial.

Mr. Frank C. Conahan  
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The report indicates the Air Force and the Navy are trying to improve cost estimating capabilities through additional "recruiting and training of cost estimators". We feel this should be a universal action by all Defense activities. Cost estimators of one office ought to be able to function anywhere in DoD.

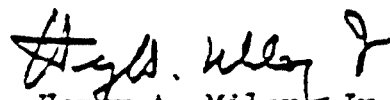
We agree with the nine (9) criteria for effective cost estimating referred to on page 2 of the report and pages 52 to 54 of Appendix I, namely:

- broad participation
- standardized structure
- provide for risks
- recognize inflation
- recognize excluded cost
- independently review estimate
- revise estimate for changes
- identify tasks
- valid data

Cost estimates should follow a uniform structure so that experience in one case can be used for later similar cases. Guidance should not permit optimistic assumptions.

Again, we appreciate the opportunity of providing our comments on your proposed report and stand ready for further discussion if you so choose.

Sincerely,



Henry A. Miley Jr.  
General, U.S. Army (Retired)  
President

ANALYSES OF SAR DATA

The following four pages are the results of analyses of the December 1982 SARs. The 36 weapon systems in these analyses are those for which the effects of the production milestone decision (DSARC III) could be identified in the past SARs.

One set of analyses was done on the cost differences between the system's development estimate (DSARC II) and the SAR current estimate associated with the production decision (DSARC III). A second set of analyses was done on the cost differences between the current estimate associated with the production decision (DSARC III) and the current estimate in the December 1982 SAR.

The six cost variance categories used in the analyses are those that are required to appear in the SAR by DOD Instruction 7000.3. We did not use the seventh required category--economic escalation--because this category involves OMB mandated inflation rates which DOD has no control over.

The dollar figures in the analyses are derived by determining the cost differences between the two estimates for each cost variance category, and dividing by the total number of months between the two estimates for all the weapons of each type. A similar procedure was used for the percentage differences. The overall figures for the 36 systems are derived by dividing the total change by the total number of months between the estimates for all 36 systems. Therefore, the figures in each column do not total to the overall average for the 36 systems.

In addition, because the 36 weapon systems use different base year dollars, the individual systems' costs are not exactly comparable and the totals lack precision. However, this is a weakness inherent in the SAR reporting system and is true of any analysis based on the SARs.

AVERAGE PROGRAM COST PERCENTAGE INCREASE PER MONTH BY SAR COST  
VARIANCE CATEGORY FROM THE CURRENT ESTIMATE ASSOCIATED  
WITH THE PRODUCTION DECISION TO THE DECEMBER 1982 CURRENT ESTIMATE  
(PROGRAM BASE YEAR CONSTANT DOLLARS)

<u>Weapon system</u> <u>category</u>	<u>Cost Estimating Category</u>						<u>Total</u>
	<u>Quantity</u>	<u>Engineering</u>	<u>Support</u>	<u>Schedule</u>	<u>Estimating</u>	<u>Other</u>	
	-----		(Percent)		-----	--	
106 Missiles (11)	<.083>	.049	.101	.023	.136	<.009>	.217
Helicopters (5)	.235	.039	.041	<.011>	.161	.002	.467
Vehicles (4)	.032	.082	.036	.014	.780	<.042>	.902
Aircraft (6)	.129	.183	.123	.025	<.045>	.001	.416
Ships (6)	.339	.047	.015	.026	<.018>	.022	.431
Others (4)	<.196>	.037	.064	<.174>	.138	-	<.131>
Overall average for 36 systems	.237	.117	.077	.024	.048	.009	.512

AVERAGE PROGRAM COST INCREASE PER MONTH BY SAR COST  
VARIANCE CATEGORY FROM THE CURRENT ESTIMATE ASSOCIATED  
WITH THE PRODUCTION DECISION TO THE DECEMBER 1982 CURRENT ESTIMATE  
(PROGRAM BASE YEAR CONSTANT DOLLARS)

<u>Weapon system category</u>	<u>Quantity</u>	<u>Cost Variance Category</u>					<u>Total</u>
		<u>Engineering</u>	<u>Support</u>	<u>Schedule</u>	<u>Estimating</u>	<u>Other</u>	
		----- (millions) -----					
12 Missiles (11)	\$ <1.196>	\$ .705	\$ 1.451	\$ .327	\$ 1.964	\$ <.132>	\$ 3.119
Helicopters (5)	4.600	.756	.796	<.224>	3.152	.040	9.120
Vehicles (4)	.902	2.318	1.004	.403	22.004	<1.188>	25.443
Aircraft (6)	11.191	15.778	10.599	2.171	<3.905>	.125	35.959
Ships (6)	20.808	2.862	.938	1.577	<1.093>	1.352	26.444
Others (4)	<1.351>	.253	.442	<1.201>	.950	0.000	<.907>
Overall average for 36 systems	8.457	4.162	2.749	.855	1.719	.300	18.242

AVERAGE PROGRAM COST PERCENTAGE INCREASE PER MONTH BY SAR COST  
VARIANCE CATEGORY FROM THE DEVELOPMENT ESTIMATE TO  
THE CURRENT ESTIMATE ASSOCIATED WITH THE PRODUCTION DECISION  
(PROGRAM BASE YEAR CONSTANT DOLLARS)

<u>Weapon systems</u> <u>category</u>	<u>Quantity</u>	<u>Cost Variance Category</u>					<u>Total</u>
		<u>Engineering</u>	<u>Support</u>	<u>Schedule</u>	<u>Estimating</u>	<u>Other</u>	
	--	----- (percent) -----					
Missiles (11)	<.059>	.003	.159	.117	.337	.022	.579
Helicopters (5)	<.018>	.028	.061	.056	.331	.002	.460
Vehicles (4)	.729	.117	.045	.028	.224	.003	1.146
Aircraft (6)	.424	.031	.113	.069	.129	.001	.767
Ships (6)	-	.076	.024	.136	.196	-	.432
Others (4)	<.413>	.112	.091	.135	.238	.048	.211
Overall average for 36 systems	.146	.030	.067	.058	.154	.005	.460

AVERAGE PROGRAM COST INCREASE PER MONTH BY SAR COST  
VARIANCE CATEGORY FROM THE DEVELOPMENT ESTIMATE TO  
THE CURRENT ESTIMATE ASSOCIATED WITH THE PRODUCTION DECISION  
(PROGRAM BASE YEAR CONSTANT DOLLARS)

<u>Weapon system</u> <u>category</u>	<u>Cost Variance Category</u>						<u>Total</u>
	<u>Quantity</u>	<u>Engineering</u>	<u>Support</u>	<u>Schedule</u>	<u>Estimating</u>	<u>Other</u>	
	—	—————(millions)					
109 Missiles (11)	\$ <.631>	\$ .036	\$1.699	\$ 1.248	\$ 3.600	\$ .238	\$ 6.190
Helicopters (5)	<.269>	.419	.923	.839	5.013	.028	6.953
Vehicles (4)	13.328	2.139	.825	.505	4.096	.058	20.951
Aircraft (6)	29.057	2.101	7.764	4.767	8.871	.069	52.629
Ships (6)	-	4.481	1.390	7.923	11.446	-	25.240
Others (4)	<2.474>	.671	.545	.809	1.422	.290	1.263
Overall average for 36 systems	4.264	.876	1.974	1.703	4.497	.158	13.472

OUR PREVIOUS RECOMMENDATIONS ON SARs

1. On March 2, 1981, we issued a report entitled Recommendations to Improve Defense Reporting on Weapon Systems (MASAD-81-7), in which we recommended to the Congress that it require the Secretary of Defense change the SAR system to
  - include important systems that are in advanced development;<sup>1</sup>
  - expand the required mission capability assessment statement to describe shortcomings and limitations of systems in their expected operational environments;<sup>1</sup>
  - include planning estimates and a one-time variance analysis for the planning and development estimates in the first report that includes the development estimate;<sup>1</sup>
  - include a brief narrative section on technical and operational risks;
  - include cost estimates for categories of logistic support/additional procurement costs related to the weapon system, such as modification costs, component improvement costs, replenishment spare costs, industrial facilities/production base, simulators, consumables, and modification spares;<sup>1</sup> and
  - include a chart showing the effect on the program cost estimate of different escalation rates.

Synopsis of our other reports relating to SARs follow:

2. "SARs"--Defense Department Reports Should Provide More Information to the Congress (PSAD-80-37, May 9, 1980).

Important information which would be useful to the Congress and to top-level DOD managers is being omitted from DOD's SARs. SARs should give better disclosure as to the status of acquisition, should be shortened to facilitate use by people with little time, and present data that is complete, accurate, and not misleading.

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<sup>1</sup>We also made these recommendations to the Secretary of Defense in our March 1975 report entitled, How to Improve the Selected Acquisition Reporting System (PSAD-75-63, Mar. 27, 1975).



We recommended that DOD include additional data in the SARs such as operational and technical risks, operational capability shortfalls, and logistic support/additional procurement costs and explanations for changes.

3. How to Improve the Selected Acquisition Reporting System  
(PSAD-75-63, Mar. 27, 1975)

Since its inception in 1969, SAR has become the key recurring summary status report to the Congress on the progress of DOD weapon systems acquisitions. It is important that this report provides full disclosure of the status of each system. We identified 10 areas where improvements would result in increased usefulness of SAR to DOD and the Congress. Some of the areas identified were:

- Performance characteristics should be related to mission requirements and an assessment provided as to the extent the system is expected to satisfy the mission requirements.
- All costs which are expected to be expended for the benefit of the development and procurement of a weapon system should be included.
- Considerable improvement could be made in reporting logistic support/additional procurement costs. These type costs should be expanded to include all remaining procurement costs related to a program, but not currently being reported as program acquisition costs. These type costs should be included in the cost section of SAR rather than in a separate section. In addition, the section on logistic support/additional procurement costs should include firm baselines established with footnotes indicating the basis for these baselines, and any changes from these baselines should be provided in the form of a variance analysis.
- Significant pending decisions that may have a major effect on a program should be highlighted.

4. Acquisition of Major Weapon Systems (B-163058, Mar. 18, 1971).

We recommended that the Secretary of Defense ensure that each SAR (a) contain a summary statement regarding the overall acceptability of the weapon for its mission, (b) recognize the relationships of other weapon systems complementary to the subject systems, and (c) reflect the current status of program accomplishments.

5. Status of the Acquisition of Selected Major Weapon Systems (B-163058, Feb. 6, 1970).

In April 1969, the SAR system was chosen by DOD to play an important role in monitoring system acquisitions and also as the mechanism for developing program status information. As with any new reporting system, the SAR system had serious shortcomings, and several areas are in need of improvements.

At the time of our examination, SAR was not sufficiently encompassing, and therefore failed to disclose significant matters concerning the progress of major acquisitions. We also noted inconsistencies in the data reported in the SAR. For example, consistency was lacking in (1) the reporting of early developmental costs and (2) treatment of costs attributed to inflationary trends in the economy.

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