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AN ANALYSIS OF
CONTRACT COST OVERRUNS AND THEIR IMPACTS
THESIS

Brian D. Wilson, Captain, USAF

AFIT/GCA/LSY/92S-8

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AFIT/GCA/LSY/92S-8

AN ANALYSIS OF CONTRACT COST OVERRUNS AND THEIR IMPACTS

THESIS

Presented to the Faculty of the School of Systems and
Logistics of the Air Force Institute of Technology
Air University

In Partial Fulfillment of the
Requirement for the Degree of
Master of Science in Cost Analysis

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September 1992

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Preface

The purpose of this study was to investigate the Office of the Under Secretary of Defense Acquisition (OUSD(A)) claim that out of over 500 contracts studied since 1977, cost overrun at completion was not found to be lower than cost overrun to date from both an absolute and percentage perspective (8). This thesis not only checks the validity of this statement but provides insight as to why this statement is of importance to the DoD.

I would like to thank my thesis advisor, Maj David S. Christensen, for his assistance and understanding not only in the writing of this thesis but for his support throughout my divorce which came at the worst of times. I would also like to thank my parents, my friends the Boyette's, the Kondas's, Tammy Boyd, Robin Grollmus and my classmates for their support during this difficult time in my life. Most of all I would like to thank my children Robbie and Chandler for their patience and understanding. Finally, I would like to thank my ex-wife, Kay, for making me a stronger person and giving me the chance to overcome adversity and graduate from AFIT. I truly hope she finds what she is looking for.

Brian D. Wilson

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Abstract

This study examines the tendency of major program DoD contracts, once in an overrun status, to remain in that status and in many cases, further deteriorate. In these times of budgetary constraints, it is important that government program managers and other key decision makers understand the ramifications of contract overruns especially early in a program's life. The overruns on the A-12 program, for instance, could have possibly been predicted much earlier and the program cancellation avoided if only the program manager had understood the implications of significant cost overruns early in the life of the program (1).

Sixty-five contracts were examined in this study and it was found that, on average, cost overrun at completion was higher than cost overrun incurred between the 15% to 85% completion points. It was also found that cost overruns tend to increase as a program progresses and that this tendency to increase varies among program categories.

AN ANALYSIS OF CONTRACT COST OVERRUNS AND THEIR IMPACTS

I. INTRODUCTION

General Issue

In these times of reduced military budgets and increased public scrutiny of government spending, the Department of Defense (DoD) has become increasingly concerned with the consequences of cost overruns in military acquisition programs. Cost overruns and schedule slips are the most troublesome problems associated with defense acquisition (15:121). The recent A-12 scandal has underscored the need for increased cost control over military contracts.

Currently, within the DoD, there is a high incidence of cost overruns on major weapon-system programs (15:148). Current acquisition management techniques have failed to be totally effective in correcting cost overruns, even when they are discovered early in a program's life. To exemplify this, a program analyst for OUSD(A) claims that out of over 500 major program contracts let by the DoD since 1977, the overrun at completion was not found to be less than the overrun incurred to date (1). From this observation he stated that "given a contract is more than 15 percent complete, the overrun at completion will not be less than

the overrun to date" (8). However, Abba (2) and Jordan (20) both state that before a contract is more than 15 percent complete, the application of immediate and positive management action can reverse the overrun situation in some cases. Cost overrun at completion is defined as the difference between the budgeted cost for the entire program and the actual cost incurred for the entire program. Cost overrun incurred to date is defined as the difference between the planned and actual costs incurred for the program at a particular point of time in the project.

Additionally, it is also claimed by OUSD(A) that "given a contract is more than 15 percent complete, the percentage overrun at completion will be greater than the percent overrun to date" (8). Abba concluded, based upon his observations, that it is impossible to recover from a contract cost overrun once a contract is more than 15 percent complete (2). These assertions have not, until now, been independently verified.

Background

"For a long period of time, the government has been trying to reduce cost growth and increase visibility over defense acquisition programs" (14:5). Various approaches have been made to accomplish this, but prior to the early sixties these attempts have met with minimal success.

However, the current policy used by the DoD has been more effective than any other method (14:5).

In the early sixties a new policy, designated as Cost/Schedule Control Systems Criteria (C/SCSC), was implemented. Under this policy the contractor's own management system is required to meet specific criteria. This new guidance replaced regulations that required contractors to use a pre-defined management system. Cost/Schedule Control Systems Criteria allows contractors the flexibility to create and use management techniques that work best for them as long as the requirements of the government are met.

Under current policy, Department of Defense Instruction (DoDI) 5000.2, "Defense Acquisition Management Policies and Procedures," Part 11B, major program contracts are required to comply with the requirements of the C/SCSC. Currently, major programs, as defined in DoD Instruction (DoDI) 5000.2, include Research, Development, Test and Evaluation contracts in excess of \$60 million and production contracts over \$250 million. Contracts meeting these thresholds are required to use internal control systems which produce data that:

- a. Indicate work in process;

- b. Properly relate cost, schedule, and technical accomplishment;
- c. Are valid, timely, and able to be audited; and
- d. Provide DoD Component managers with information at a practical level of summarization (10:2).

Despite the requirements set forth in DoDI 5000.2, the ability of the government to properly control costs on DoD contracts is still far from adequate. The assertions made by OUSD(A) concerning costs overruns have underscored the need for increased control over military contracts; however, an independent verification of these assertions is required.

Research Problem

The objective of this research is to test the OUSD(A) assertion that DoD acquisition programs cannot recover from a cost overrun condition which occurs in the 15 to 85 percent completion point in a program's life.

Specific Problem Statement. Do data on completed DoD contracts support the OUSD(A) assertion concerning cost overruns? The specific hypotheses to be tested are:

1. Given a sample of completed contracts, the overrun at completion is higher than the overrun incurred between the period of 15 to 85 percent complete.

2. Given a sample of completed contracts, the percent overrun at completion is higher than the percent overrun incurred between the period of 15 to 85 percent complete.

Defense Acquisition Executive Summary Database. The data used to investigate the problem statements were provided by OUSD(A). This database is called the Defense Acquisition Executive Summary (DAES) and is a collection of cost performance data on over 500 completed or near completed contracts from all Services since 1977. The data in the DAES database were extracted from contractor cost management reports.

Investigative Questions. The following investigative questions will be answered:

1. Why are cost overruns of concern to the DoD?
2. What is the significance of the OUSD(A) findings to both the government and contractors?

3. Do cost variances tend to worsen as the program progresses through various stages of completion?
4. Assuming that cost overruns tend to increase as a program progresses, does the rate of cost overrun growth vary among categories (contract types, system types, DoD components and program phase) of programs?

Investigative questions one and two will be answered through a literature review and personal interviews. Questions three and four will be answered after an in-depth evaluation of the DAES database.

Limitations and Assumptions

The database used in this study is the DAES database obtained from OUSD(A) in Washington D.C. Due to time constraints no other data were analyzed. This database does, however, contain cost information on over 500 completed or near-completed contracts from all Services and is considered a representative sample of all DoD contracts.

Additionally, there are no recommendations made in this study as to the methods by which the problem of cost overruns can be resolved. Because of time and resource

constraints only a validation of the OUSD(A) assertion and the significance of it is addressed within this study.

The following chapters address the current literature as it pertains to contract cost overruns in the DoD, the methodology of this study, the results of the analysis, conclusions, and recommendations for further research.

II. Literature Review

General Issue

Since the inception of C/SCSC, there have been many attempts to quantify and predict cost overruns. Although some studies have produced better methods than others, the fact remains that cost overruns are a significant problem to the DoD (8). In fact, programs which experience cost overruns are the norm rather than the exception (15:126). However, it should be noted that most of the literature reviewed concentrated on methods to predict cost overruns and provided little or no guidance on how to avoid them.

For the most part, attempts to predict the magnitude of cost overruns have failed as well as our attempts to stop them in the first place (1). According to Beach, some current methods of estimating contract completion costs, on those contracts which are already experiencing overruns, consistently produce low estimates (3:6). Thus, not only is it claimed that cost overrun conditions cannot be corrected (8), but also there is a lack of ability in the DoD and industry to predict those overruns accurately (3:6). Currently, most predictions of contract completion costs are made by quantitative extrapolation without regard to qualitative factors.

Cost Overruns and the DoD. Cost overruns are of importance to the DoD for several reasons; the most important of which is mission accomplishment. Broad mission objectives are defined annually upon release of the Defense Guidance (DG). The DG is issued by the Joint Chiefs of Staff (JCS) and documents anticipated threats to national security. In order to meet the mission requirements of the DG a Six Year Defense Plan (SYDP) is formulated. The SYDP analyzes the DG and formulates it into a plan to acquire military assets based upon the anticipated threats. If these military assets cannot be developed within the budgetary constraints outlined by the SYDP, mission accomplishment is jeopardized.

Additionally, cost overruns cause schedules to be slipped because some efforts may have to be delayed because of inadequate funding (21:213). According to Gansler, cost growth and schedule extensions are interrelated and reinforce each other (15:120). This is true because Congress often views program schedule extensions as the only way to fit the higher costs into the budget (15:120). Thus when cost overruns are alleviated through schedule extensions, the delay can result in a system not being fielded when needed.

Schedule slips also cause a decrease in the number of systems produced. "As increasing costs confront a fixed or declining budget the only way to fit the high costs into the budget is to stretch out program by increasing development time or by buying fewer production units each year"

(15:121). With fewer units to absorb overhead, the per unit costs rise dramatically resulting in even fewer units being acquired. Thus cost overruns have made a dramatic impact upon America's defense posture in terms of the amount of equipment that can be bought. "If this trend continues we [the USAF] will only be able to buy one aircraft per year by the year 2045" (15:170).

These reduced purchase quantities eventually result in the shrinkage of the defense industrial base and dependance on foreign suppliers. This shrinkage in the industrial base can and will place the United States in a situation where crisis production surge capability is not available in the event of a prolonged conflict while foreign suppliers may not be dependable sources for defense goods during such conditions (15:256).

Another concern of cost overruns to the DoD is public perception. The government's and contractor's reputations are easily tarnished by the occurrence of large cost overruns (21:213). No military power in the world can

function without the support of those people whom it protects because they are the ones who provide the funding. The inability of the DoD to properly manage acquisition programs, like the A-12, can, through the media, have a significant impact on the public's attitude toward the military as a whole.

During 1990 there were many articles and news reports which claimed that the Navy failed to properly manage the A-12 Avenger contract and that the Navy hid the enormous cost overruns from Congress. Although there is no way to quantify the A-12 scandal's impact on public perception of the military, there is no doubt that the Nation as a whole would rather see tax dollars managed much better than was done on the A-12 development contract.

One final effect of cost overruns is the economic impact that they have on the nation. People choose what they want their tax dollars to go for by voting for the public officials that can best represent their desires for public goods (defense, social programs, education, etc.) (29). If the costs of defense goods exceed the budget that was planned, other goods must be given up or that particular defense good must be foregone. The point is that the general public is only willing to sacrifice so much of the national output for national security because it competes

for other public goods (26:702). Therefore, they may not be willing to fund programs which are experiencing cost overruns because defense spending can "crowd out" other public goods (15). Additionally, some low priority defense goods may be "crowded out" by high priority defense programs which are overrunning cost (20). In fact this "guns verses butter" debate has been a dominant issue since the Korean War (15:79). As a result, programs which experience cost overruns are at risk for cancellation. This is reflected in Public Law 97-252, Section 1107 (Nunn - McCurdy amendment), which states that programs which experience cost overruns that exceed certain thresholds will be considered for cancellation.

Although cost overruns have significant impacts on the ability of the DoD to perform its mission, there are methods by which cost overruns can be predicted and planned for. One of the main tools used by the DoD to predict cost overruns and manage contracts is Cost Performance Report (CPR) Analysis.

CPR Analysis

Cost Performance Report analysis is one method by which the Department of Defence (DoD) monitors and controls contractor cost and schedule performance. Cost Performance Report analysis entails a complete quantitative analysis of

all cumulative cost and schedule data in addition to a qualitative analysis of any narrative information provided by the contractor in the CPR.

Cost Performance Report analysis is conducted at all levels of the DoD and is becoming increasingly important as reduced budgets make proper financial decisions a paramount concern. The importance of proper CPR analysis is further emphasized by the fact that OUSD(A) is expending much time and effort educating the DoD acquisition community on the problems associated with current methods of CPR analysis.

CPR Defined. Cost Performance Reports are required to be submitted by contractors on all contracts meeting the C/SCSC dollar thresholds as specified in DoD Instruction 5000.2. Cost Performance Reports provide cumulative cost and schedule information for a particular contract.

On certain smaller contracts, where C/SCSC compliance is not required, Cost/Schedule Status Reports (C/SSR) are submitted by contractors. For the purposes of this and subsequent chapters, a C/SSR contains the same basic information as a CPR. The main difference between CPRs and C/SSRs is that contractors submitting C/SSRs do not have to meet the requirements of a full C/SCSC compliant management system.

Cost Performance Reports and C/SSRs include five data items which are the cornerstone of CPR analysis. These five data items are: ACWP, BCWP, BCWS, BAC and EAC.

Actual Cost of Work Performed (ACWP) - ACWP is the accrued costs of a particular piece of work expressed in dollars. Alternately, ACWP is defined as the cumulative costs actually incurred and recorded for performance measurement purposes within a given time period.

Budgeted Cost of Work Performed (BCWP) - BCWP is the baseline status item in cost reports. It represents what portion of the work has been completed in dollars. In simpler terms, BCWP is the numerical representation (in dollars) of the cumulative cost of all work actually accomplished.

Budgeted Cost of Work Scheduled (BCWS) - BCWS is the amount of money budgeted to do a specific piece of work over a stated period of time. It is specific in that the work is described in detail so that there can be no misunderstandings in regards to the job that was planned. In other words, BCWS is the cost (in dollars) of all work scheduled to be accomplished in a given period of time.

Budget at Completion (BAC) - BAC is the total BCWS for the entire program. It is the 'spend plan' for the contract and should be determined within the first month following contract award.

Estimate at Completion (EAC_c) - For the remainder of this study, EAC_c shall be defined as the contractor's estimate of the total expected costs of a program. Simplistically, EAC is defined as the current ACWP plus the budget of any work that still needs to be completed. This is expressed as:

$$EAC = ACWP + (BAC - BCWP) \quad (1)$$

More inclusively, EAC is the actual direct costs, plus indirect costs allocable to the contract incurred to date, plus an estimate of the costs (direct and indirect) for any authorized work that remains to be completed.

CPR Analysis Defined. CPR analysis begins with a complete examination of all data presented, both quantitative and explanatory, in the CPR. The government analyst approaches CPR analysis with three things in mind.

The first objective is to look for and identify trends, and to highlight areas that are going well and not going well. When negative trends are identified, they form the basis of searches for additional information from additional sources. The second objective is to evaluate the contractor's performance against his plan. The last objective is to use the information provided in the CPR to make projections of

where the contract will ultimately end, or what the likely cost outcome of a contract will be. CPR analysis, then, is the use of various techniques to examine CPR data to look for and identify trends, to measure the contractors progress against his plan, and to make forecasts (25:6-7).

Air Force Systems Command Pamphlet (AFSCP) 173-4, Guide to Analysis of Contractor Cost Data, lists and describes eight indicators for use in analyzing CPRs. These indicators are described in the remainder of this chapter. These eight indicators are as follows:

Cost Variance (CV) - Comparing ACWP and BCWP can provide a measure of cost variance. CV is calculated by subtracting ACWP from BCWP.

$$CV = BCWP - ACWP \quad (2)$$

CV is a measurement of the difference between the budget for a given task and the cost which was actually incurred in performing that task. A negative CV means that a contractor has overrun the budgeted cost for a given quantity of work.

Percent Cost Variance (CV%) - Cost variance can also be presented as a percentage of BCWP to provide the analysts a relative measure of cost performance. Percent Cost Variance is computed as follows:

$$CV\% = CV/BCWP \quad (3)$$

Schedule Variance (SV) - By comparing BCWS and BCWP a measure of schedule deviation in dollars can be attained. Schedule variance is calculated by subtracting BCWS from BCWP.

$$SV = BCWP - BCWS \quad (4)$$

The schedule variance provides a dollar representation of any deviation from the schedule. Schedule variance shows whether or not the work is being accomplished as planned. A negative SV means that less work was accomplished than was planned.

Cost Performance Index (CPI) - The cost performance index measures the cost efficiency with which the work has been accomplished. The formula for CPI is:

$$CPI = BCWP / ACWP \quad (5)$$

A CPI of 1.0 indicates that for every actual dollar spent, a dollar's worth of work has been achieved. An index of greater than one indicates a cost underrun or high efficiency, while an index of less than one indicates a cost overrun or lower level of efficiency.

Schedule Performance Index (SPI) - The schedule performance index provides an indication of the level of schedule efficiency attained by the contractor. The formula for SPI is:

$$SPI = BCWP/BCWS \quad (6)$$

An SPI of 1.0 means that a project is on schedule. An index of larger than one indicates an ahead of schedule situation, while a SPI of less than one indicates that a contract is behind schedule.

Percent Complete (PC) - The percent complete calculation compares the quantity of work accomplished (in dollars) to date with the budget dollar total planned for the entire contractual effort. The formula for PC is:

$$PC = BCWP/BAC \quad (7)$$

Estimate At Completion (EAC_g) - EAC_g is the government's best estimate of the total expected cost of the contracted work. EAC formulas and methods are the primary tool used by government analysts to predict future contract costs. There are many different formulae and methods for calculating EAC, most of which are based on historical data.

Variance at Completion (VAC) -- Variance at completion is defined as the difference between the planned costs for the entire project (BAC) and the EAC. VAC is computed as follows:

$$VAC = BAC - EAC \quad (8)$$

Purpose of CPR Analysis. Analysis of Cost Performance Report and Cost/Schedule Status Report data provide government managers an early indication and quantification of contract cost and schedule problems (12:871). Many times proper analysis and interpretation of the key indicators can give the analyst the ability to identify problem areas in sufficient time for corrective action to be implemented (25:7). Although there is a possibility that a problem might not be uncovered while it is still solvable, proper analysis can allow the prediction of schedule slips and cost overruns in time enough for some corrective action to be taken to at least curb the negative trend (25:7).

Analysis of CPR data can also provide insight into the contractor's internal management control system. "The contractor uses his [government] validated (in accordance with AFSCP 173-5) internal management system to produce the CPR" (25:7). By properly analyzing CPR data, the analyst can verify that the contractor's management system is

working properly. When the internal management control system of the contractor is functioning properly the analyst has a certain level of confidence in the validity of the CPR data and in the validity of his analysis.

Justification

"For a long period of time, the government has been trying to reduce cost growth and increase visibility over defense acquisition programs. Various approaches, including prescribing specific management systems for the contractor, have been made in this effort, but all previous attempts have met with minimal success" (14:7). The current policy, prescribed by the Cost/Schedule Control Systems Criteria (C/SCSC) Joint Implementation Guide (AFSCP/AFLCP 173-5), has improved visibility over program status (14:7), but the assertions of OUSD(A) concerning cost overruns indicate that C/SCSC are not providing a totally adequate means for managing government contracts.

The goals of C/SCSC and CPR analysis, while meritorious, are failing to provide a totally adequate management system for government contracts. The statements made by Christle (8) and Beach (3) indicate that C/SCSC do not provide a method of total control over government contracts. This lack of control over government contracts

has been a concern many years but the ramifications were not fully clear until the A-12 cancellation.

The A-12 Avenger program was a Navy effort to develop and field the next generation, carrier based medium attack aircraft to replace the aging A-6. A land based version, the Advanced Tactical Aircraft (ATA) was also being simultaneously developed for the Air Force to replace the F-111. These aircraft were based upon advanced composite material technology (16). A significant level of risk was assumed at the onset of the contract (16).

From contract start, the A-12 program was a risky venture because of the combination of new composite material technology and the application of a fixed price incentive fee contracting arrangement (16). According to Gansler, when a contract involves high risk the government is better off employing a cost plus contract because it is in a better situation to bear the burden of that risk (15:126). Adding to this condition was the fact that the CPR analyst for the program based her EAC, upon a method, according to Beach, that consistently produced low estimates per program manager direction (3:6). This combination resulted in a situation where the magnitude of projected cost overruns was not accurately estimated early in the program.

By 1990, a cost overrun in excess of \$2 billion dollars had occurred and the schedule had slipped by more than one year (16). Because of the highly classified nature of the program, the Program Director was unable to notify Congress of the status of the project. In mid 1990 cost and schedule information had been declassified and reported to Congress. Upon Congressional notification of the cost and schedule status of the A-12 Program, both the A-12 and the ATA were canceled.

Recent failures in the implementation of proper government contractor monitoring and reporting, as in the A-12 program, have caused significant problems in the DoD. Improper monitoring and failure to analyze CPRs properly can cause hostile inquiries from Congress, embarrassment of the Services involved, and possible program cancellation. The Navy A-12 scandal in 1990 is a prime example of the results of improper contractor monitoring and reporting.

Many studies have been performed in an effort to improve the government's ability to predict the costs of contracts, especially in the early stages of program life. Although, these studies have suggested a wide array of methods to calculate the EAC, the assertions of OUSD(A) indicate that none is totally effective in predicting cost growth.

Scope. Ten EAC studies, collectively termed "estimate at completion research" (7:3) were collected from a wide range of sources, including studies done by the government and government contracted studies. Additionally, several personal and telephone interviews were conducted. The scope of this literature review was constrained by the availability of past research and a time factor.

Method. The 10 studies were reviewed and summarized. Table 1 lists these studies and some attributes of each. Seven of these studies show the recent work done in the area of estimating contract costs at completion while two studies investigate the stable nature of the CPI. The tenth study, the Beach report, while not an EAC study in itself, identified some of the problems with current methods of EAC computation as they related to the A-12 program. The personal interviews were conducted in order to understand the statements and findings of OUSD(A) and to answer investigative questions one and two from chapter one. The methodologies and findings of the studies are presented in the next sections.

TABLE 1

Summary of EAC Research Reviewed

Author (year)	Source	Topic	Type/Number of Contracts	Conclusions
Bright Howard (1981)	Army	EAC Formulas	11 dev	No one EAC formula best in all cases; suggested the SCI
Haydon Reither (1982)	AF	EAC Formulas	15 dev 6 prod	Range to point estimates better than contractor estimates
Blythe (1982)	AF	EAC Formulas	7 dev 19 prod	Adjusted contractor EAC better than index based EAC
Cryer (1984)	AF	EAC Formulas	N/A	Contractor EAC most accurate
Fiedel/Chance (1985)	AF	EAC Formulas	16 dev 40 prod	No optimal EAC method for all types of programs
Price (1985)	AF	EAC Formulas	57 dev	Some EAC methods better than others
Totaro (1987)	AF	EAC Formulas	N/A	Composite index is best
Fayne (1990)	AF	CPI Stability	4 dev 22 prod	CPI stabilizes at 20% complete
Leach (1990)	Navy	A-12 Cancel	1 dev	Some EAC methods produce low estimates
Heise (1991)	AF	CPI Stability	62 dev 93 prod	CPI stabilizes at 20% complete

Previous Research

The research previously conducted is of two types: EAC related research and research related to the inadequacies and consequences of current methods of cost control on DoD contracts. The EAC studies provide a background for understanding the current methods used to compute expected contract completion costs. It is important to understand the concepts behind EAC computations to fully comprehend the inadequacies of current methods of projecting contract completion costs.

Research related to the inadequacies of current methods of cost control are important because they shed light on the importance of the strong assertions made by OUSD(A). Not only do these studies provide insight into the reasons for a lack of ability to predict contract completion costs but they also describe the ramifications of cost overruns on DoD contracts.

EAC Studies. Since the inception of C/SCSC there have been a number of studies which have produced different approaches to the computation of EAC. Out of all these studies there is agreement on only one point, that is, there is no one formula for EAC computation that is always best (7:1). Additionally, many of these studies recommend further research some of which is addressed in this thesis.

According to Christensen et al. (7), EAC studies can be classified into three basic categories: index, regression and other. The index based EAC formulas are expressed in some combination of ACWP, BCWP, BCWS and BAC. The generic index based formula is:

$$EAC = ACWP + (BAC - BCWP) / Index \quad (9)$$

Where the index normally includes CPI, SPI or some combination of both.

The second category of EAC formulas are termed regression based formulas. These formulas are derived from either linear or non-linear regression analysis of historical CPR or C/SSR data. In either case, the dependant variable is usually defined as ACWP and the independent variable(s) is usually BCWP, a performance index, time, or some combination thereof (7:6). All formulas which do not fall in the first two categories, such as formulas based on heuristics, are classified as "other".

The following review of EAC studies is not organized by category but in chronological order. This ordering should provide the reader with a idea of how EAC research has evolved over the past several years. It is important, however, to understand the three categories of EAC formulas

because no one EAC method has been proven best in all circumstances.

Bright and Howard (1981) evaluated nine index-based formulas and two regression based models as to their accuracy at various contract stages. Using data from 11 Army development contracts they found that some EAC formulas are more accurate than others at certain stages in a contract. For instance it was found that formulas using both CPI and SPI were the most accurate and that the SPI should be weighed more heavily in the early stages of a contract. Bright and Howard also found the schedule-cost index (SCI) to be accurate for computing EAC.

$$(SCI = CPI * SPI) \quad (10)$$

Bright and Howard also explained a method by which program re-baselines can be adjusted for in the computation of EAC. A program re-baseline is defined as a change in BAC due to a change in scope or added funding to cover a cost overrun situation. A program re-baseline "causes problems when using C/SCSC reports to measure and predict performance" (5:10). A re-baseline has the summary level effect of degrading visibility and making poor performance appear to be good performance (5:10).

To adjust for baseline changes it was suggested that all forecasts be set equal to the new baseline value until a new performance level is achieved. An alternate method for forecasting EAC on re-baselined data is to adjust all the data to the original budget (5:11). While not specifically stated by Bright and Howard, logic dictates that the method used for adjustment be based upon the situation. For instance, if a baseline is increased due to a scope change then all data should be updated to reflect the new work. Alternately, if the baseline change is conducted in order to bail out an overrun with no change in scope then all data should be adjusted to the original BAC in order to show the actual cost overrun.

Haydon and Riether (1982) combined data from several different types of Navy programs and attempted to test current formulae for calculating EAC. Their study includes a historical database that contains data on twenty-one completed or near completed C/SCSC compliant contracts (17:6). These contracts were an assortment of missile, aircraft, helicopter, black box, and engine programs (17:7).

In their research, five different methods for predicting EAC were attempted. These methods included: EAC based upon manpower loading, regression based EAC formulas, EAC formulas based on lower level work break down structure

(WBS) data, and a range to point translation of various index based formulas. Two of their methods, EAC though manpower loading, and analysis of lower level data produced formulas which provided unreliable estimates (17:32). However, they stated that the conclusion about analysis by lower level data was based on limited examination (17:32).

Three of their techniques did produce reliable point estimates for EAC. These three techniques are: index based EAC formulae, range to point translation techniques, and regression based EAC methods. According to Totaro, the composite performance index method, is the most common form of EAC computation used today (30:111). The composite index (CI) is defined by Christensen (7) as an index that combines both SPI and CPI.

$$CI = .8CPI + .2SPI \quad (11)$$

The range to point method is a probability based method of predicting EAC from a range of EACs computed using different indexed based formulas. The regression based method of EAC formula development is based upon a historical trend defined by the least squares best fit (LSBF) line through that historical data.

Haydon and Riether found that formulae based upon the variables CPI and SPI accurately predicted the cost at completion (CAC) 64% of the time (17:32). The range to point techniques predicted a range within which contract costs should fall (17:10). They found that "in the case where the range was predicting an overrun situation, not acknowledged by the contractor ($\text{Range} > \text{EAC}_c$), the range was the more accurate estimate 79% of the time" (17:32).

Their research showed that range-to-point translation EAC methods were more accurate than methods utilizing only one composite based formula. They found that range estimates, while accurate, could be converted into a more accurate point estimate (17:32). Thus by translating range estimates into point estimates, EAC can be more accurately predicted.

In their conclusion Haydon and Riether recommended that further research be conducted into the effects of categories of contract and weapon system types on EAC computation (17:33).

Two other reports by Blythe (1982) and Cryer (1984), exemplify the problem of using only CPI to compute EAC. The Blythe study and the follow on Cryer study indicate that a weighted composite index is more accurate than any other

index based method (7:20). In both studies this weighted composite index was developed by deriving a regression based model for each index-based formula. It should be noted that the regression based weights usually adjusted the EAC upward.

These studies agree with the Beach report in stating that both schedule and cost performance should be used in computing EAC. Therefore it can be assumed that some of the problems observed by OUSD(A) can possibly be attributed to a lack of consideration of schedule impacts on the accuracy of EAC predictions.

Price (1985) used regression analysis to identify the most accurate EAC formulas. His methodology entailed a scoring and comparison of various index based EAC formulas through regression analysis. His analysis was based on a linear regression between the cost at completion and the estimate at completion (27:2). The results of the thesis "indicate that an estimate at completion based upon weighted cost and schedule indices minimizes the unexplained error and is thought to be the superior forecaster of costs at completion" (27:1).

In the recommendations section, Price states that further research into the effects of different categories

(contract type, branch of service, etc.) of programs on cost performance should be conducted (27:32). Price's thesis further identifies the need to use both cost and schedule performance indicators in the calculation of EAC and is in full agreement with Beach (3:6) on this subject.

Price's recommendations for further research further justify the investigation question in chapter one which relates to cost related trends among various categories of programs.

Totaro (1987) stated that "many formulas are popular with government and contractor performance measurement specialists, but the most popular formula in use today is the composite performance index, which weights CPI and SPI" (30:33). One such formula used is:

$$EAC = ACWP + \frac{BAC - BCWP}{.8(CPI) + .2(SPI)} \quad (12)$$

This formula is recommended in AFSCP 173-4 as highly accurate. However, Christensen, et al. (7) have criticized the research supporting this formula because of its non-empirical nature.

Totaro stated that programs with high technological complexity should weigh the SPI higher than CPI because of a

significant schedule risk. For instance the Space Division System Program Office (SPO) at Los Angeles Air Station weighs SPI at 100 percent at the beginning of a contract due to the high technology that they work with (30:111). Based upon this logic it is not surprising that the A-12 Program Manager's EAC was not accurate early in the program when solely based upon the CPI.

According to Totaro, programs with minimum development and technological risk should weigh CPI much higher than SPI (30:112). However, it was stated that the impact of SPI should always be included in the computation of EAC at the beginning of a contract (30:112). No matter how little risk is assumed in a contract there should be some level of uncertainty taken into account when computing EAC especially in the contract falls behind schedule from the very start (30:112).

Totaro's findings add substance to Beach's assertion that current EAC formulas used by the government consistently produce low estimates of contract completion costs when based solely upon cumulative CPI (3:6). The level of technology assumed in the A-12 program should have dictated the use of a composite index EAC formula, especially in the beginning of the program.

Riedel and Chance (1989) compiled CPR data by program type (aircraft, avionics, and engines), and analyzed it to find out which index based EAC formulae was most accurate for each type of program. They found that certain EAC formulae were more accurate for particular types of programs at a particular range of percent complete. Their study determined that different formulae should be used to estimate contract completion costs in each quartile of percent complete. Their research by no means attempted to pinpoint an ideal EAC method, but instead focused on "identifying a preferred EAC method given a specific stage of contract completion" (28:3).

Riedel and Chance recommended that further research into the area of EAC development should focus on formulas that weigh schedule and cost performance indexes based on various factors (contract type, particular contractor, experience in developing or producing the system, engineering hours required, and technical risk) instead of strictly using a composite formula based solely on SPI and CPI (28:81).

Payne (1990) elaborated on the usefulness of CPI as a predictor of contract completion costs. He stated that a stable CPI is important because it gives a manager confidence in declaring that a contractor is in trouble when

he is overrunning his budget (25:11). Based on a sample of 26 AF contracts, Payne showed that the CPI is stable once a contract is more than half complete (25:30) and will not vary by more than ± 10 percent, after that point. In a sensitivity analysis he also showed that after a contract is twenty percent complete, CPI becomes relatively stable but not necessarily within ± 10 percent (25:30).

Payne's thesis provided some validation to the OUSD(A) observations concerning contract cost overruns. If contracts have stable CPIs at the 20 percent complete point then it follows that if a contract is in a cost overrun situation at the 20 percent completion point it should be expected to have a cost overrun at the end of the contract. Therefore, an unfavorable CPI indicates that a program will not be completed within budget.

In his conclusion, Payne made the following recommendation:

Since the conclusions reached in this research were based on a database that only included USAF aircraft, it is appropriate to question their applicability to US Army and US Navy aircraft and other types of programs such as avionics, engines, missiles and etcetera. Further research into these other types of programs is recommended. (25:31)

Based on Payne's recommendations, Heise (1991), investigated the stability of the CPI and its sensitivity to

program type, contract type and percent complete. The CPI is used in many EAC formulae to project past earned value trends into the future. He analyzed the stability of the index between different categories (contract type and phase of program) of contracts. His analysis, included 155 contracts from DAES database, and showed that CPI stability is a function of percent complete, contract type and program phase.

Heise used a "range" method to determine at what point CPI becomes stable (19:24). Heise defined CPI stability as the percent completion point at which the CPI no longer varies by more than ± 10 percent. He found that the CPI for all categories of contracts becomes stable at the 50 percent contract completion point (19:52). He also discovered that when the contracts were broken down into categories the CPI became stable at the 20 percent contract completion point (19:52). However, the most significant finding of Heise's research was that cumulative CPI tends only to decrease as a project progresses. This particular finding suggests that VAC will be worse than cumulative CV thus affirming Payne's research using a larger sample.

According to Heise's research there are definite differences in CPIs between different categories of programs. This provides strong justification to pursue the

research question in chapter one that deals with trends among various contract categories and types. Additionally, EAC based solely upon CPI can provide a reasonable floor because of the stability of the CPI and the fact that it does not tend to increase.

OUSD(A) has recently expounded on a method of predicting EAC based upon percent of contract cost incurred and percent completion of the contract. This method of calculating EAC was developed by Weida (31) in 1977.

According to Weida's method, Christle, OUSD(A)AP&PI/CM, collected data on several hundred completed or near completed contracts and plotted the percent of cost incurred ($ACWP/BAC$) against the corresponding percent of contract completion. He found that the data points clustered around an "S" shaped curve that represented the normal "ramp up" and "ramp down" of a typical program (1).

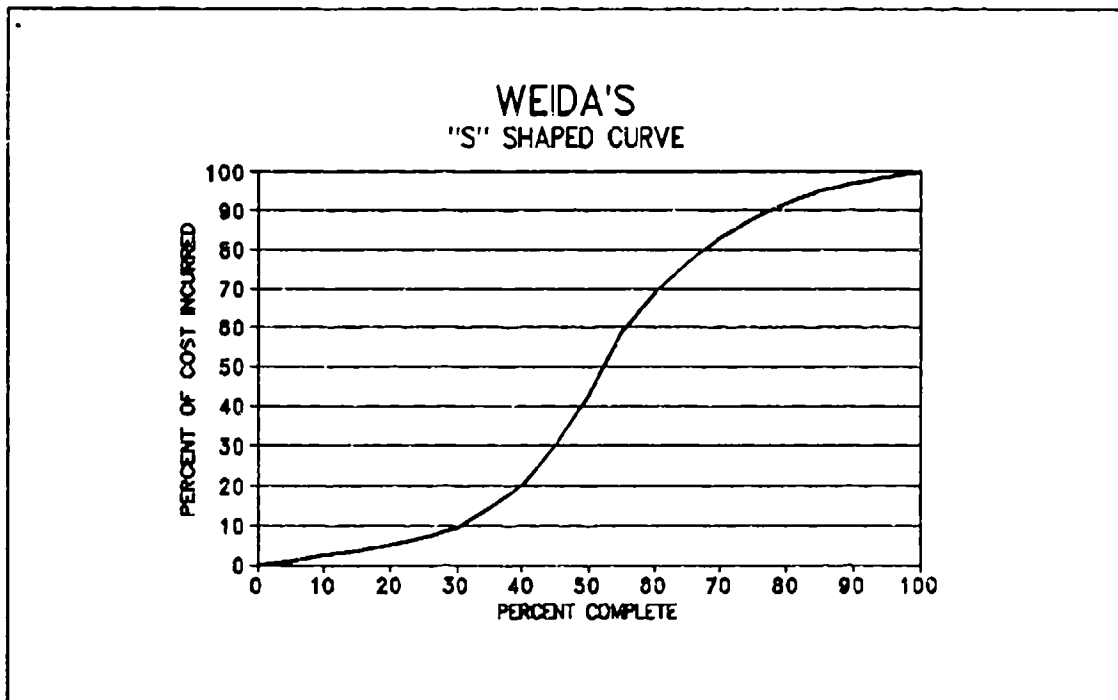


Figure 1. Weida's "S" Shaped Curve

According to this methodology, Abba, OUSD(A)AP&PI/CM, states that EAC can be predicted by comparing ACWP/BAC and the percent complete of a contract to its expected position on the "S" shaped curve. The vertical deviation of the new contract data point from its expected point on the "S" shaped curve gives the expected cost overrun or underrun in percent of BAC.

According to this method, if an observation of ACWP/BAC shows to be a significant positive outlier in respect to the "S" shaped curve then the contract will not be completed within budget. Out of five hundred contracts studied this

has been the case in all of them (1). These observations, while not independently verified, add much validity to the OUSD(A) assertion that contracts cannot recover from cost overrun situations.

Other Research. In a landmark observational finding by Gary Christle, OUSD(A)AP&PI/CM, it was discovered that out of 500 programs since 1977 cumulative CPI does not significantly improve during the period between 15% and 85% complete; in fact, it tends to decline (3:6). From these findings it was hypothesized that given a contract is more than 15% complete, the "overrun at completion will not be less than overrun incurred to date" (8). Additionally, the statement was also made that "percent overrun at completion will be greater than percent overrun incurred to date" (8). Payne (1990) and Heise (1991) have verified the OUSD(A) assertion regarding CPI stability; there has yet to be an independent verification of the cost overruns assertions.

At best, the OUSD(A) observations are based on "casual empiricism". While the observations of Christle/Abba are not being challenged, a more rigorous empirical verification of these observations is needed.

Significance of OUSD(A) Observations. The observations are of great importance to both the government and

contractors. The significance of these observations to the government is that, currently, the DoD does not have the ability to plan and execute military acquisition programs according to a pre-determined plan. Many times, as asserted by Christle, the government has planned and budgeted for the acquisition of a new system but has failed to stick to that plan from a monetary standpoint. If more effective methods for managing defense acquisition programs are not employed soon, the United States runs the risk of losing its stature as a major military power in the future.

The findings are also significant to government contractors. Because of the lean military budgets of today, government contractors can no longer afford the luxury of delivering a product behind schedule and over cost. In light of the current military budget cuts, those contractors unable to find reliable methods of cost control may soon find themselves out of business.

Conclusion

Some of the studies reviewed converged on several ideas; the most common of which was the view that current methods of calculating EAC should consider both cost and schedule performance. However, no one way of computing EAC has been determined to be the best in all cases. Most of the studies did agree in the recommendation for research

that implements the categorization of contracts based upon contract type, branch of service, and system type.

The observations of OUSD(A) and Beach departed from the traditional methods of research and found that not only are the methods for computing estimating contract completion costs unacceptably inaccurate in some instances but the methods for correcting overruns, once they occur, are not as effective as they could or should be.

The discussion above has answered the first two investigative questions set forth in chapter one. The questions answered are: why are cost overruns of concern to the DoD, and what is the significance of OUSD(A)'s observation? The next chapter will present the methodology used to answer the specific problem statement as well as the third and fourth investigative questions.

III. Methodology

Explanation of Method

This chapter describes the procedures used to test the validity of the OUSD(A) assertion that contract cost overruns cannot be corrected. The two hypotheses presented in the specific problem statement were tested through the use of descriptive statistical techniques. The statistical method used to answer the problem statement was a comparison of means. The third and fourth investigative questions involved a hypothesis concerning trends in the data. The answer to this question was approached through regression analysis and an analysis of variances (ANOVA). No attempt was made in this research to ascertain any causal factors associated with contract cost overruns because of the time constraints involved.

The Database. The data used in this study were extracted from the DAES database. This data base came from OUSD(A) and contains cost performance data covering the period from June 1977 to February 1991 (19:21). The DAES database is an accumulation of cost performance data from all services and is used as management tool as outlined in DoDI 5000.2. Each record in the DAES database includes important data items from contract CPRs.

The actual data used were that selected from the DAES database by Capt Scott Heise (19) in his thesis "A Review of Cost Performance Index Stability". Capt Heise used only those contracts from the DAES database that had a full set of CPR data from the period from 15% to 85% complete. This requirement was necessary in order to test the OUSD(A) assertion at a full range of contract completion points. There were 155 out of 400 contracts in the data base that met this criterion. These 155 contracts

represent a [wide] variety of programs (airplanes, ammunition, avionics, engines, ground electronics, helicopters, missiles, rockets, satellites, software, submarines, support equipment, surface ships, tanks, test equipment, and torpedoes) from the Army, Navy and the Air Force. A wide variety of phases are also represented: Demonstration/Validation (DEM/VAL), Full Scale Development (FSD), Follow On Development (FOD), Low Rate Initial Production (LRIP), Full Rate Production (FRP) and Construction (Constr) (for Navy ships). The variety of contract types represented include: Fixed Price Incentive Fee (FPIF), Cost Plus (CP), Cost Plus Fixed Fee (CPFF), Cost Plus Incentive Fee (CPIF), and Cost Plus Award Fee (CPAF). (19:22)

For the analysis two other criteria were required. First, because the causes of baseline changes in the data could not be determined, contracts that did not have a stable baseline (defined as BAC) were also eliminated from the data set. Without knowledge of the reasons for a re-baseline, it is impossible to know which adjustment method, from the Bright and Howard study, should be used.

The contract baseline was determined to be unstable when "the percent complete decreases between any two consecutive periods" (19:24). Percent complete is calculated by the formula:

$$PC = BCWP / BAC \quad (13)$$

A stable baseline is important for the analysis because changes in the BAC for the program can bias the results (5:10). For example if BAC is increased on a contract by an amount equal to the cost overrun to date, it gives the appearance that the cost overrun has been eliminated. Heise indicated that 46 out of the 155 contracts he examined had an unstable baseline based upon the criterion stated above. Therefore those 46 contracts were eliminated from the data set leaving 109 contracts for the analysis. These 109 contracts are listed in Appendix A.

One other constraint was also placed upon the data. Since the hypotheses to be tested are only concerned with programs which have experienced cost overruns, those contracts which did not experience a cost overrun were also eliminated from the data set. Because all programs are expected to have some amount of random fluctuation in cost performance, a contract which has experienced a cost overrun was defined as any contract which experienced a negative CV

less than five percent. Out of the 109 remaining contracts only 65 met this criterion for experiencing a cost overrun. The data for these 65 contracts are listed in Appendix E.

Sample/Population Defined. The 65 contracts used in this study are a sample from the entire population of DoD contracts that meet the criteria for CPR reporting as mandated in DoDI 5000.2. The sample, as described above, is assumed to be representative of population of contracts that are let by the three Services. Because of the unbiased nature of the sample, it is can be assumed that any behaviors found in the sample will be representative of the behavior of the population as a whole at some level of confidence.

There is one limitation inherent in the DAES database that was brought to light by Heise in his thesis. This limitation is the fact that the data are not reported on a consistent basis. Sometimes the data are reported on one, two, four or even five month intervals (19:23). Therefore, some linear interpolation of the data was required in the analysis. Cost growth in military contracts was not arbitrarily assumed to be linear but the closeness, in PC, of the observations allowed for a linear interpolation with a negligible amount of error. For instance, a contractor

may have difficulty in one month but not another leading to a situation where cost growth is not constant. However, this linear interpolation actually normalized the data for such fluctuations and actually provided more accurate insight into overall cost growth trends. A statistical description of the sample data is shown in Table 2.

TABLE 2

Description of Sample by Categories Tested (\$'s in Millions)

Category	n	High	Low	Average	Std Dev	$\overline{VAC}$	$\overline{CV}_{ss}$
FP	42	1798.3	19.8	201.3	201.3	-36.7	-14.3
CP	23	5372.1	16.2	468.7	468.7	-41.5	-18.9
Ground	13	638.5	19.8	205.2	205.2	-23.1	-4.5
Air	43	5372.1	16.2	323.9	323.9	-45.2	-20.9
Sea	9	1798.3	24.9	297.8	297.8	-28.1	-9.2
Army	28	436.2	16.2	134.8	134.8	-20.9	-8.9
Navy	19	5372.1	24.9	591.9	591.9	-54.1	-24.1
AF	18	747.9	38.9	230.8	230.8	-49.2	-18.4
Dev	26	1490.3	16.2	201.1	201.1	-39.7	-16.8
Prod	39	5372.1	19.8	354.7	354.7	-37.5	-15.3
All	65	5372.1	16.2	294.2	294.2	-38.5	-16.0

FP = Fixed Price
 CP = Cost Plus
 Dev = Development
 Prod = Production

Method of Analysis

The analysis of the DAES database includes both a descriptive statistical analysis based on differences between means and a regression based analysis of variances. The data was assumed to be normally distributed because of

the central limit theorem which states that "even if the distribution is not normal but the sample size n is moderately large, the distribution of the X will still be very close to normal" (24:247). This assumption is required to perform the statistical analysis. The following tests will be performed on the 65 contracts as an aggregate and as broken down into the following categories: contract type, system type, DoD component, and program phase. These categories are displayed in Table 3.

TABLE 3

Program Categories and Number in Sample		
Contract Type	Contracts in Sample	Percentage
Fixed Price (FP)	42	65%
Cost Plus (CP)	23	45%
System Type		
Ground Based	13	20%
Air Based	43	66%
Sea Based	9	14%
Service		
Air Force	18	28%
Navy	19	29%
Army	28	43%
Program Phase		
Development	26	40%
Production	39	60%

The contract types in the sample were of two types; fixed price and cost plus. While there are variations in these types of contracts they were not deemed to be

significant enough to have an impact upon the data. System types were broken down into three types; ground based, air based and sea based. Obviously there could be many more categories for system types; but in order to keep the number of categories to a minimum these three were selected based upon required reliability for each. For example, a failure of a jeep could possibly result in nothing more than a long walk, while a failure of an aircraft could result in a fatal fall from a high altitude; thus there is a difference among these systems in required reliability.

The Services were broken down into Air Force, Army and Navy. This selection should be self explanatory. Finally, program phase was broken down into development and production. These two categories capture the totality of system acquisition programs under this category. In DoD programs systems are either in development or production with little or discrepancy between them.

Hypotheses. The hypotheses to be tested are as follows in null form:

1. The CV at completion is greater or equal to the CV incurred between the period of 15 to 85 percent complete.

$$H_0: CV_{100} \geq CV_{pc}$$

$$H_a: CV_{100} < CV_{pc}$$

2. The CV% at completion is greater than or equal to the CV% incurred between the period of 15 to 85 percent complete.

$$H_0: CV\%_{100} \geq CV\%_{pc}$$

$$H_a: CV\%_{100} < CV\%_{pc}$$

3. There is a trend in the data that would indicate that cost overruns, once they occur, tend to recover as the contract progresses toward completion.
4. The trend (from hypothesis #3) in the data does not differ between categories of programs.

Overrun Calculations. For the purposes of this study cost variance (CV) and percentage cost variance (CV%) will be calculated as follows:

$$CV = BCWP - ACWP \quad (14)$$

$$CV\% = ((BCWP - ACWP) / BCWP) \times 100 \quad (15)$$

Budgeted cost of work performed (BCWP) and ACWP, as discussed in chapter two, are cumulative. For the remainder of this study a subscript PC is used to denote data (i.e. $ACWP_{pc}$ and $BCWP_{pc}$) at a specific percent complete. For

example the term $ACWP_{50}$ is defined as the cumulative actual cost incurred at the 50% point of contract completion. Additionally, the final ACWP for each contract was assumed to be the contract cost at completion (CAC).

Hypothesis Testing

The statistical treatment of the data will be the same for hypotheses one and two; however, the variables will be different. The first set of hypothesis tests were based upon a comparison between the means of CV_{PC} and CV_{100} for values of PC between 15% and 85% in increments of 10%. For a complete explanation of this hypothesis testing method see Newbold (24).

Hypothesis Test #1. Is the cost variance at completion greater than the cost variance incurred between the period of 15 to 85 percent complete? Testing was done at the 85% level of confidence.

$$H_0: \overline{CV}_{100} - \overline{CV}_{PC} \geq 0$$

$$H_a: \overline{CV}_{100} - \overline{CV}_{PC} < 0$$

$$\text{test statistic } (t_{calc}) = \frac{\overline{CV}_{100} - \overline{CV}_{PC}}{(s^2_d/n)^{.5}}$$

Where:

$\overline{CV}_{100}$ = the mean cost overrun at 100 percent complete

$\overline{CV}_{pc}$ = the mean cost overrun at pc percent complete with pc = 15, 25, 35, 45, 55, 65, 75 and 85%.

s_d^2 = the variance of $\overline{CV}_{100} - \overline{CV}_{pc}$

n = number of contracts in sample

critical value (t_{crit}) = value from table of cumulative probabilities of the student's t distribution (one tailed test)

When the absolute value of t_{calc} was greater than t_{crit} then H_0 was rejected and H_a was accepted indicating the acceptance of the OUSD(A) assertion at the 85% level of confidence for each stage of completion tested. When the absolute value of t_{calc} was less than t_{crit} then H_0 was accepted indicating the rejection of the OUSD(A) assertion at the 85% level of confidence. This confidence level was selected based upon the actual statistical test performed. Eighty-five percent was the highest level of statistical confidence at which the data supported the OUSD(A) assertions. This confidence level was not chosen in order support the assertions but was used to show the highest confidence level that which the assertions hold true. The actual analysis was performed on a personal computer based statistical package called Microstat (22).

Hypothesis Test #2. Is the percent cost overrun at completion less than the percent overrun incurred between the period of 15 to 85 percent complete? This set of hypothesis tests were based upon a comparison between the means of $\overline{CV\%_{pc}}$ and $\overline{CV\%_{100}}$ for values of PC between 15% and 85% in increments of 10%. Testing was done at the 85% level of confidence.

$$H_0: \overline{CV\%_{100}} - \overline{CV\%_{pc}} \geq 0$$

$$H_a: \overline{CV\%_{100}} - \overline{CV\%_{pc}} < 0$$

$$\text{test statistic } (t_{calc}) = \frac{\overline{CV\%_{100}} - \overline{CV\%_{pc}}}{(s_d^2/n)^{.5}}$$

Where:

$\overline{CV\%_{100}}$ = the mean percent cost overrun at 100 percent complete

$\overline{CV\%_{pc}}$ = the mean percent cost overrun at pc percent complete with pc = 15, 25, 35, 45, 55, 65, 75 and 85%.

s_d^2 = the variance of $\overline{CV\%_{100}} - \overline{CV\%_{pc}}$

n = number of contracts in sample

critical value (t_{crit}) = value from table of cumulative probabilities of the student's t distribution (one tailed test)

When the absolute value of t_{calc} was greater than t_{crit} , then H_0 was rejected and H_a was accepted indicating the acceptance of the OUSD(A) assertion at the 85% level of

confidence. When the absolute value of t_{calc} was less than t_{crit} then H_0 was accepted indicating the rejection of the OUSD(A) assertion at the 85% level of confidence. This test was also performed on Microstat (22).

Hypothesis tests one and two were conducted on the 65 contracts included in this study. The tests were also conducted separately on the program categories presented in Table 3 as a sensitivity analysis. These tests were conducted to answer the specific problem statement as described in chapter one. The results of hypothesis tests one and two are described in chapter four. For a complete explanation of these statistical tests see Newbold (24).

Hypothesis Tests #3 and #4. The treatment of hypotheses three and four were significantly different than that for one and two. Since these hypotheses were related to a trend in the data, regression analysis and an ANOVA were used. $CV\%_{pc}$ (dependant variable) was regressed against percent complete (PC) (independent variable) and a series of indicator variables (which assigned each contract to one of each of the categories defined in Table 2) interacting with PC. For an explanation of the use of indicator variables and interaction effect see Neter (23).

An ANOVA was then conducted in order to determine whether a significant trend was present in the data and whether this trend differed between different categories of contracts. The hypothesis tests were done using the same regression analysis. The hypotheses tested are as follows:

Is there a trend in the data that would indicate that cost overruns, once they occur, continually get worse as the contract progresses toward completion?

Assuming that there is a trend in the data, does this trend vary between program categories?

These hypothesis were tested through an ANOVA created by regressing PC and six indicator variables interacting with PC against $CV\%_{pc}$. The indicator variables and associated interactions with PC were used to differentiate between regression line slopes for different categories of programs. An F and a t-test were then conducted on the results.

The F-test was performed to test hypothesis number three. The purpose of the F-test was to test the hypothesis that there is a trend in the data. An F-test tests the aggregate regression line through the data without regard to

individual variables in the equation. For further explanation of the F-test see Neter (23).

The t-test was used to test hypothesis number four. The purpose of the t-test was to test the significance of the individual variables in the regression equation. The t-test shows whether or not each individual independent variable has a significant impact upon the behavior of the dependent variable.

The regression analysis used was of the linear type. Although Bright and Howard (5) suggested that a curvilinear relationship was most appropriate for this type of analysis, the data from the DAES database did not seem to fit a curvilinear line any better than a linear one. Exponential, log, and log-log transformations were attempted on the data but none provided any better fit than a linear regression did; therefore, linear regression was used. A graphical representation of the regression line in two dimensions is depicted in Figure 2.

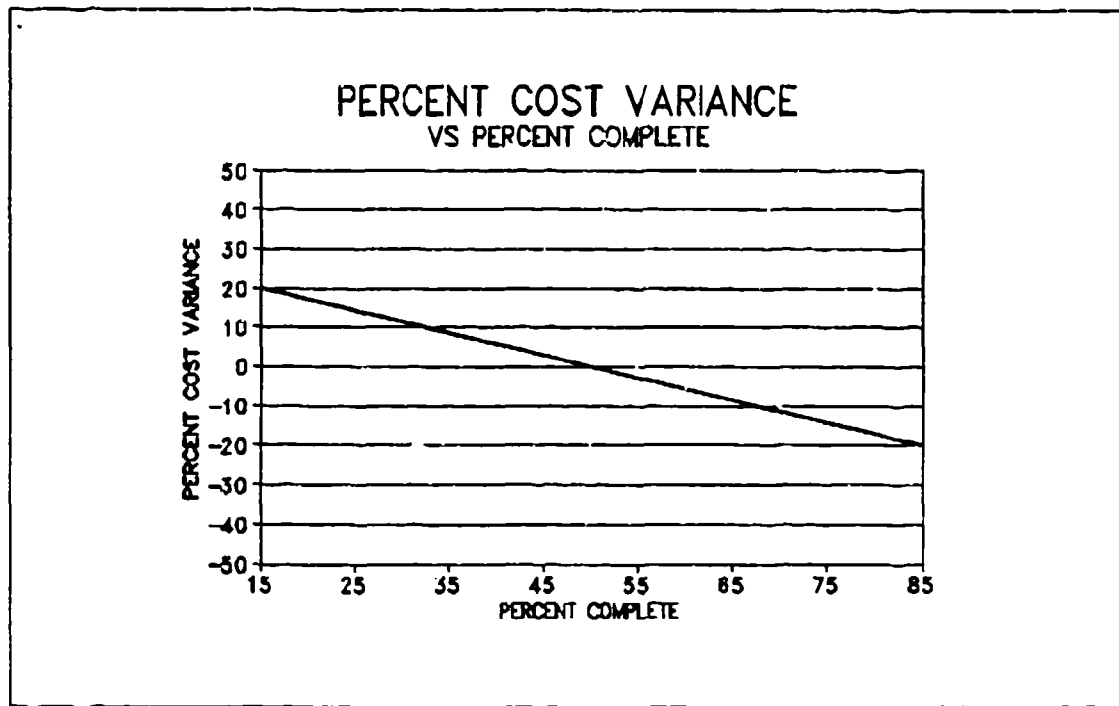


Figure 2. Percent Cost Variance vs Percent Complete

The regression analysis and ANOVA were actually performed on Microstat (22). However, for simplification, the analysis is described below in matrix notation. For an in-depth explanation of matrix based regression analysis see Neter (23).

$Y = bX$ is the basic linear regression formula in matrix notation.

Y is a column vector ($n \times 1$) matrix of all observed values of $CV\%_{pc}$ where n is the number of observations.

b is a column vector (px1) of calculated regression coefficients (slopes) where p is the number of parameters

X is the (nx8) matrix consisting of a column of ones in the first column and a second column which contains all (3955) the observed values of PC. Columns three through eight consist of indicator variable values multiplied by PC where n is also the number of observations. The indicator variable designations for each category are presented in Table 4.

TABLE 4

Indicator Variable Values for Each Category of Program

Category	Indicator Variable Values					
	S1	S2	C1	T1	T2	P1
Air Force	0	0	NA	NA	NA	NA
Army	1	0	NA	NA	NA	NA
Navy	0	1	NA	NA	NA	NA
Cost Plus	NA	NA	0	NA	NA	NA
Fixed Price	NA	NA	1	NA	NA	NA
Air Based	NA	NA	NA	0	0	NA
Sea Based	NA	NA	NA	1	0	NA
Land Based	NA	NA	NA	0	1	NA
Development	NA	NA	NA	NA	NA	0
Production	NA	NA	NA	NA	NA	1

The solution to the matrix provided the least squares best fit (LSBF) line, denoted as $\mathbf{Y} = \mathbf{Bx}$ in matrix notation,

through the data and provided a matrix designated as $\mathbf{b}$ which gave the intercept (b_0) and slopes ($b_{1..}$) for the equation. The matrix $\mathbf{b}$ was calculated through matrix algebra in the following manner:

$$\mathbf{b} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y} \quad (14)$$

The matrix operation described above resulted in the following equation in algebraic terms when performed on the data:

$$\begin{aligned} \text{CV}\%_{pc} = & b_0 + b_1(\text{PC}) + b_2(\text{PC}*\text{S1}) + b_3(\text{PC}*\text{S2}) + \\ & b_4(\text{PC}*\text{C1}) + b_5(\text{PC}*\text{T1}) + b_6(\text{PC}*\text{T2}) + \\ & b_7(\text{PC}*\text{P1}) + \text{error term} \end{aligned} \quad (15)$$

The term b_1 provided an estimate of the relationship between percent complete and percent of cost overrun for the baseline type of program which was an Air Force, air based, cost plus, development program. The terms $b_{1..}$ provide an estimate of the change in slope (trend) from the baseline for each category. Thus, the hypotheses for both tests took the form of:

$$H_0: \beta_{1..} \geq 0$$

$$H_a: \beta_{1..} < 0$$

Where β_i are the true population regression coefficients
 PC when regressed against $CV\%_{pc}$.

An ANOVA was then conducted to determine the
 significance of any trends in the data. The ANOVA was
 accomplished as follows in matrix format:

$$SSR = \mathbf{b}'\mathbf{X}'\mathbf{Y} - (1-n)\mathbf{Y}'\mathbf{J}\mathbf{Y} \quad (16)$$

Where SSR is the sums of square regression which provides a
 summation of the squared deviations of the regression line
 from the mean of $CV\%$. $\mathbf{J}$ is a (8×8) matrix consisting of
 1's.

$$SSE = (\mathbf{Y} - \mathbf{Xb})'(\mathbf{Y} - \mathbf{Xb}) \quad (17)$$

Where SSE is the sums of square error which provides a
 summation of the squared deviations of the regression line
 from the actual values observed for $CV\%$. For a complete
 explanation of ANOVA see Neter (23).

In order to obtain calculated F and t-values, SSR and
 SSE were reduced to mean squared regression (MSR) and mean
 squared error (MSE) as follows:

$$MSR = SSR/(p-1) = SSR/1 = SSR \quad (18)$$

$$MSE = SSE/(n-p) = SSE/(n-2) \quad (19)$$

Where p is the number of parameters (b_0 through b_1) in the regression equation and n is the number of observations.

Once the regression analysis and ANOVA were completed the hypotheses were tested using an F test and a student's t test. For a complete explanation of the F and t -tests see Neter (22). From the matrix procedure and ANOVA above, a calculated F and calculated t -value (t_{calc}) were then computed as follows:

$$F_{calc} = (MSR/MSE) \quad (20)$$

$$t_{calc} = b_{(1-7)} / s_{b(1-7)} \quad (21)$$

or

$$F_{calc} = F_p^{.5} \quad (22)$$

Where $s_{b(1-7)}$ is the standard deviation for each of the regression coefficients in the regression equation and $F_p^{.5}$ equals the partial F for each regression coefficient.

When F_{calc} was larger than the table value for F , then H_0 was rejected and H_a was accepted indicating a significant inverse relationship between PC and CV $\bar{x}_{pc}$ for the entire

regression formula. A inverse relationship between percent complete and cost variance percentage would indicate that the percentage cost overrun becomes greater (negatively) as the contract progresses toward completion.

A t_{calc} was computed for each of the regression coefficients. When t_{calc} was larger than the table value for t , then H_0 was rejected and H_a was accepted indicating a significant but different inverse relationship between PC and $CV\%_{pc}$ for each category of program. Table values for t were obtained from a table of percentiles of the t distribution. Each coefficient, for which H_a was accepted, indicated that there is a significant difference in the cost performance trend for that category (designated by an indicator variable in Table 3) when compared to other categories.

Justification of Approach

The test for differences between means was the most direct method for testing the first two hypotheses. This type of test not only provides information concerning the historical aspects of contract cost overruns but also provides a method by which predictions can be made at some level of confidence. For example, if it was found that cost overruns at 15 to 85 percent complete are always lesser than the overrun at completion, we could say that any

contract currently experiencing a cost overrun would probably have an overrun at the completion of the contract.

The LSBF/ANOVA approach was determined to be the most direct method for determining if there was any trend in the level of cost overruns as contracts progressed toward completion. There is also both historical and predictive value in this approach as with the differences among means approach. The LSBF/ANOVA approach can allow an analyst to make predictions concerning the behavior of cost growth in future contracts. For example if the regression coefficients were negative in a regression of CV% against PC then it could be stated that on average cost overruns tend to get worse, not better. Additionally, this regression line could also be used to predict the expected cost growth over the remaining life of the program.

The next chapter presents the results of both the differences between means and the LSBF/ANOVA methods.

IV. RESULTS

Statistical Results of the Hypothesis Tests

Differences Between Means. The results of the first hypothesis test indicate that the cost overrun at completion is greater than the cost overrun between 15 and 85 percent complete. The results of Hypothesis 1 are summarized in Table 5.

TABLE 5
Summary of Hypothesis Test #1 Results
\$ (MIL)

PC	Mean $\overline{CV}_{pc}$	Mean $\overline{CV}_{100}$	Std Dev	t_{calc}	p
15%	\$-4.64	\$-38.45	\$23.75	3.48	.00045
25%	0.05	-38.45	33.80	3.57	.00034
35%	-8.82	-38.45	23.83	3.45	.00050
45%	-12.62	-38.45	34.42	3.72	.00021
55%	-15.97	-38.45	36.59	3.32	.00074
65%	-19.68	-38.45	42.15	3.24	.00094
75%	-25.15	-38.45	52.08	2.88	.00267
85%	-31.98	-38.45	62.07	2.10	.01960
100%	-38.45	-38.45	81.49	NA	

With a t_{crit} of 1.04, then $t_{calc} > t_{crit}$ for the full range of PC at the 85% level of confidence, thus the OUSD(A) assertion holds true at the 85% level of confidence. In other words, the cost overrun at completion is greater than the cost overrun between 15 and 85 percent complete at the

85% level of confidence. Additionally, the p-value in Table 5 gives the exact level of confidence in the OUSD(A) assertion at a specific percent complete. The p-value gives the probability of accepting the null hypothesis when in fact it is false. Thus, $1-p$ gives the probability of rejecting the null hypothesis when in fact it is false. As an example, at 15% complete the OUSD(A) assertion holds true at the 99.955% ($1-.00045$) level of confidence.

It was noted that at the 25 percent complete point the mean CV was greater than the mean CV at 15% complete. This anomaly was due to the incremental funding on some large (billion dollar) Navy contracts. These contracts were funded at a low level initially and their values were increased after the 15 percent completion point. This was not indicative of the majority of the contracts in the sample.

Hypothesis test one was also conducted on the data when broken down into the categories described in Table 3. The results of these tests are provided in Tables 6 through 13.

TABLE 6

Results of Testing Hypothesis 1 at 15% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{15}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-5.052	-36.783	3.052	.0020
CP	23	-2.714	-41.510	1.892	.0358
Ground	13	-1.038	-23.092	7.471	<.0001
Air	43	-2.056	-45.250	2.994	.0023
Sea	9	-22.225	-28.189	1.057	.1608
Army	28	-0.932	-20.954	7.199	<.0001
Navy	19	-12.538	-54.097	1.663	.0568
Air Force	18	-2.092	-49.172	2.040	.0286
Development	28	-2.079	-39.675	2.496	.0095
Production	37	-6.590	-37.534	2.409	.0106

TABLE 7

Results of Testing Hypothesis 1 at 25% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{25}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	3.260	-36.783	2.985	.0023
CP	23	-5.803	-41.510	1.925	.0336
Ground	13	-0.555	-23.092	7.878	<.0001
Air	43	-5.434	-45.250	2.945	.0026
Sea	9	27.144	-28.189	1.225	.1277
Army	28	-2.054	-20.954	7.083	<.0001
Navy	19	7.343	-54.097	2.065	.0268
Air Force	18	-4.366	-49.172	1.992	.0313
Development	28	-4.229	-39.675	2.410	.0115
Production	37	3.293	-37.534	2.634	.0062

TABLE 8

Results of Testing Hypothesis 1 at 35% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{35}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-9.098	-36.783	3.000	.0029
CP	23	-8.591	-41.510	1.861	.0381
Ground	13	-0.423	-23.092	8.188	<.0001
Air	43	-9.621	-45.250	2.775	.0041
Sea	9	-17.834	-28.189	2.788	.0118
Army	28	-3.699	-20.954	7.083	<.0001
Navy	19	-17.027	-54.097	1.739	.0496
Air Force	18	-8.481	-49.177	1.917	.0361
Development	28	-8.434	-39.675	2.261	.0160
Production	37	-9.286	-37.534	2.570	.0062

TABLE 9

Results of Testing Hypothesis 1 at 45% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{45}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-10.042	-36.783	2.980	.0024
CP	23	-17.324	-41.510	2.185	.0199
Ground	13	-1.750	-23.092	8.122	<.0001
Air	43	-17.171	-45.250	2.766	.0042
Sea	9	-6.572	-28.189	1.608	.0732
Army	28	-5.910	-20.954	6.910	<.0001
Navy	19	-21.689	-54.097	2.273	.0178
Air Force	18	-13.481	-49.172	1.789	.0458
Development	28	-12.600	-39.675	2.094	.0229
Production	37	-12.633	-37.534	3.335	.0010

TABLE 10

Results of Testing Hypothesis 1 at 55% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{55}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-14.345	-36.783	2.655	.0056
CP	23	-18.927	-41.504	1.955	.0317
Ground	13	-4.495	-23.092	8.071	<.0001
Air	43	-20.857	-45.250	2.455	.0092
Sea	9	-9.170	-28.189	1.546	.0804
Army	28	-8.883	-20.954	4.998	<.0001
Navy	19	-24.096	-54.097	2.045	.0279
Air Force	18	-18.404	-49.172	1.633	.0605
Development	28	-16.863	-39.675	1.871	.0361
Production	37	-15.288	-37.534	2.905	.0031

TABLE 11

Results of Testing Hypothesis 1 at 65% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{65}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-18.302	-36.783	2.457	.0092
CP	23	-11.197	-41.510	2.117	.0229
Ground	13	-7.229	-23.092	7.834	<.0001
Air	43	-24.942	-45.250	2.379	.0110
Sea	9	-12.522	-28.189	1.597	.0744
Army	28	-11.585	-20.954	4.998	<.0001
Navy	19	-37.388	-54.097	2.153	.0225
Air Force	18	-22.267	-49.172	1.599	.0641
Development	28	-20.091	-39.675	1.756	.0419
Production	37	-19.369	-37.534	2.976	.0026

TABLE 12

Results of Testing Hypothesis 1 at 75% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{75}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-23.488	-36.783	2.108	.0201
CP	23	-28.200	-41.510	2.116	.0229
Ground	13	-11.230	-23.092	5.605	<.0001
Air	43	-30.946	-45.250	2.081	.0218
Sea	9	-17.601	-28.189	1.840	.0744
Army	28	-14.549	-20.954	4.166	.0001
Navy	19	-37.388	-54.097	2.139	.0232
Air Force	18	-28.741	-49.172	1.419	.0869
Development	28	-24.953	-39.675	1.591	.0617
Production	37	-25.308	-37.534	2.902	.0031

TABLE 13

Results of Testing Hypothesis 1 at 85% Complete
\$ (MIL)

Categories	n	$\overline{CV}_{85}$	$\overline{CV}_{100}$	t_{calc}	p
FP	42	-30.602	-36.783	1.507	.0697
CP	23	-34.497	-41.510	1.550	.0677
Ground	13	-16.451	-23.092	4.556	.0003
Air	43	-38.588	-45.250	1.445	.0780
Sea	9	-22.844	-28.189	1.840	.0515
Army	28	-2.811	-20.954	2.811	.0045
Navy	19	-54.097	-54.238	1.601	.0634
Air Force	18	-39.954	-49.172	1.663	.0568
Development	28	-33.724	-39.675	0.978	.1683
Production	37	-30.661	-37.534	2.357	.0120

Overall, the results of the sensitivity analysis of hypothesis 1 are the same as the results for the data in aggregate with the exception of sea based systems. At 15 percent complete sea based programs have a p-value of .16 which relates to an 84 percent level of confidence. Thus

based upon the sensitivity analysis for hypothesis 1 it can be said that cost overrun at completion will be greater than cost overrun to data at an 84 percent level of confidence.

The results of the second hypothesis test indicate that the percent cost overrun at completion is greater than the percent cost overrun between 15 and 85 percent complete. The results of hypothesis number two are summarized in Table 14.

TABLE 14
Summary of Hypothesis Test #2 Results

PC	Mean CV% _{pc}	Mean CV% ₁₀₀	Std Dev	t _{calc}	p
15%	-5.78%	17.85%	24.28	3.18	.00115
25 %	-9.42	17.85%	23.75	2.34	.01110
35%	-10.17	17.85%	16.88	2.96	.00210
45%	-10.87	17.85%	13.73	3.56	.00035
55%	-12.25	17.85%	13.81	3.16	.00119
65%	-13.20	17.85%	13.76	3.05	.00169
75%	-14.97	17.85%	15.12	2.24	.01420
85%	-16.63	17.85%	17.13	1.14	.12920
100%	-17.85	17.85%	17.73	NA	

With a t_{crit} of 1.04, then t_{calc} > t_{crit} for the full range of CV% at the 85% level of confidence, then the OUSD(A) assertion holds true at the 85% level of confidence. In other words, the percentage cost overrun at completion is greater than the percentage cost overrun between 15 and 85

percent complete at the 85% level of confidence. The use of the p-value is the same as for hypothesis test number one.

Hypothesis test two was also conducted on the data when broken down into the categories described in Table 3. The results of these tests are provided in Tables 15 through 22.

TABLE 15

Results of Testing Hypothesis 2 at 15% Complete

Categories	n	$\overline{CV}_{.15}$	$\overline{CV}_{.100}$	t_{calc}	p
FP	42	-5.585	-20.258	2.615	.0062
CP	23	-6.139	-13.454	4.313	.0152
Ground	13	-.591	-20.755	3.467	.0023
Air	43	-2.901	-18.077	4.981	<.0001
Sea	9	-27.039	-12.569	-.704	.2507
Army	28	-3.563	-20.454	4.930	<.0001
Navy	19	-13.977	-13.287	-.068	.4734
Air Force	18	-.581	-18.617	2.980	.0042
Development	28	-2.230	-20.486	4.504	<.0001
Production	37	-8.469	-15.855	1.260	.1079

TABLE 16

Results of Testing Hypothesis 2 at 25% Complete

Categories	n	$\overline{CV\%}_{.25}$	$\overline{CV\%}_{.100}$	t_{calc}	p
FP	42	-9.117	-20.258	2.121	.0200
CP	23	-9.967	-13.454	1.060	.1504
Ground	13	-.367	-20.755	4.594	.0003
Air	43	-8.222	-18.077	3.318	.0009
Sea	9	-28.203	-12.569	-.797	.2242
Army	28	-7.796	-20.454	4.064	.0011
Navy	19	-17.620	-13.287	-.453	.3280
Air Force	18	-3.283	-18.617	2.580	.0094
Development	28	-7.221	-20.486	3.411	.0010
Production	37	-11.080	-15.855	0.858	.1984

TABLE 17

Results of Testing Hypothesis 2 at 35% Complete

Categories	n	$\overline{CV\%}_{.25}$	$\overline{CV\%}_{.100}$	t_{calc}	p
FP	42	-10.220	-20.258	2.617	.0062
CP	23	-10.066	-13.454	1.763	.0459
Ground	13	-2.074	-20.755	5.396	<.0001
Air	43	-11.147	-18.077	2.441	.0095
Sea	9	-17.167	-12.569	-.424	.3414
Army	28	-9.991	-20.454	3.376	.0011
Navy	19	-14.060	-13.287	-.146	.4428
Air Force	18	-6.327	-18.617	2.259	.0187
Development	28	-11.390	-20.486	2.484	.0098
Production	37	-9.239	-15.855	1.819	.0386

TABLE 18

Results of Testing Hypothesis 2 at 45% Complete

Categories	n	$\overline{CV}\%_{45}$	$\overline{CV}\%_{100}$	t_{calc}	p
FP	42	-10.748	-20.258	3.424	.0007
CP	23	-11.091	-13.454	1.222	.1174
Ground	13	-4.524	-20.755	5.241	.0001
Air	43	-12.969	-18.077	2.041	.0238
Sea	9	-10.004	-12.569	0.531	.3049
Army	28	-11.975	-20.454	3.316	.0013
Navy	19	-11.284	-13.287	.7491	.2317
Air Force	18	-8.713	-18.617	1.953	.0337
Development	28	-13.247	-20.486	2.079	.0236
Production	37	-9.071	-15.855	3.011	.0024

TABLE 19

Results of Testing Hypothesis 2 at 55% Complete

Categories	n	$\overline{CV}\%_{55}$	$\overline{CV}\%_{100}$	t_{calc}	p
FP	42	-12.789	-20.258	2.500	.0026
CP	23	-11.276	-13.454	1.244	.1133
Ground	13	-7.340	-20.755	4.843	.0002
Air	43	-14.479	-18.077	1.566	.0624
Sea	9	-8.721	-12.569	0.913	.1940
Army	28	-14.588	-20.454	2.582	.0078
Navy	19	-10.904	-13.287	1.013	.1612
Air Force	18	-10.047	-18.617	1.809	.0441
Development	28	-14.704	-20.486	1.767	.0443
Production	37	-10.400	-15.855	2.843	.0036

TABLE 20

Results of Testing Hypothesis 2 at 65% Complete

Categories	n	$\overline{CV\%}_{65}$	$\overline{CV\%}_{100}$	t_{calc}	p
FP	42	-14.311	-20.258	2.711	.0049
CP	23	-11.167	-13.454	1.474	.0773
Ground	13	-10.242	-20.755	4.492	.0004
Air	43	-15.198	-18.077	1.417	.0820
Sea	9	-7.920	-12.569	1.393	.1006
Army	28	-16.116	-20.454	2.067	.0242
Navy	19	-10.883	-13.287	1.190	.1247
Air Force	18	-11.106	-18.617	1.910	.0366
Development	28	-15.730	-20.486	1.691	.0512
Production	37	-11.284	-15.855	2.737	.0048

TABLE 21

Results of Testing Hypothesis 2 at 75% Complete

Categories	n	$\overline{CV\%}_{75}$	$\overline{CV\%}_{100}$	t_{calc}	p
FP	42	-16.172	-20.258	2.257	.0147
CP	23	-12.784	-13.454	0.470	.3215
Ground	13	-14.075	-20.755	3.586	.0019
Air	43	-16.411	-18.077	0.940	.1762
Sea	9	-9.400	-12.569	1.380	.1025
Army	28	-17.375	-20.454	1.560	.0652
Navy	19	-12.312	-13.287	0.523	.3038
Air Force	18	-13.236	-18.617	1.597	.0643
Development	28	-17.367	-20.486	1.291	.1039
Production	37	-13.161	-15.855	1.996	.0268

TABLE 22

Results of Testing Hypothesis 2 at 85° Complete

Categories	n	$\overline{CV}\%_{85}$	$\overline{CV}\%_{100}$	t_{calc}	p
FP	42	-17.782	-20.258	1.982	.0271
CP	23	-14.526	-13.454	-.555	.2922
Ground	13	-16.282	-20.755	2.658	.0104
Air	43	-17.877	-18.077	0.704	.2507
Sea	9	-11.177	-12.569	0.889	.1999
Army	28	-19.055	-20.454	1.061	.1491
Navy	19	-14.131	-13.287	-.350	.3652
Air Force	18	-15.497	-18.617	1.505	.0754
Development	28	-19.651	-20.486	0.404	.3447
Production	37	-14.344	-15.855	1.414	.0830

When broken down into categories, the DAES data base does not support the OUSD(A) assertion that percent cost overrun at completion will be less than cost overrun incurred to date. The highest level of confidence in the OUSD(A) assertion concerning percent cost overrun is 47 percent. It should be noted that when the t_{calc} is negative the p-value becomes the confidence in the OUSD(A) assertion concerning percent cost overrun. This is true because of the nature of the one-tailed statistical distribution.

Regression and ANOVA. The results of the regression analysis and ANOVA are listed in Appendix D. The results of the third hypothesis test indicate that there is a definite trend in cost performance. The negative regression coefficients indicate that cost overruns tend to worsen as a

program progresses. The results of Hypothesis 3 are summarized in Table 23 below.

TABLE 23
ANOVA Table For Hypothesis #3

Source	Sum of Squares	Degrees of Freedom	Mean Square
Regression	1.5223	6	.2537
Error	17.4763	578	.0302
Total	18.9985	584	

From the ANOVA table the F_{calc} is 8.391 (MSR/MSE) and the F_{crit} from a F-distribution table is 1.70. Since $F_{calc} > F_{crit}$ for the fitted regression line it can be stated that there is a trend in the CV% at the 85% level of confidence. The findings of testing this hypothesis differ from those of testing Hypothesis 2 because in Hypothesis 2 there was no test for a trend in the data as the contract progressed towards completion.

The results of testing Hypothesis 4 indicate that the trend identified in Hypothesis 3 varies depending on the program category. The results of Hypothesis 4 are summarized in Table 24 below.

TABLE 24

Summary of Hypothesis Test #4 Results

Coefficient	Value	t_{calc}	p
b_0	-.0511	NA	NA
PC	-.1046	2.64	.0861
S1	-.1116	3.57	.0064
S2	-.0493	1.39	.1163
C1	-.0629	2.16	.0310
T1	NA	.78	.4370
T2	.0738	2.26	.0239
P1	.1034	3.87	.0001

Since $t_{calc} > t_{crit}$ for six of the seven regression coefficients it can be said that trends in percentage cost variance differ between these six categories of programs at the 85% level of confidence. The only category of contracts that did not show a significantly different cost growth trend from the baseline type of program (Air Force, cost plus, air based, development program) were Navy programs. Therefore, cost growth trends vary among the following categories of contracts at the 85% level of confidence:

Service:	Air Force Army
Contract Type:	Cost Plus Fixed Price
System Type:	Air Based Sea Based Land based
Program Phase:	Development Production

More specifically, the p-value provides the probability of accepting the null hypothesis when in fact it is false. Thus, $1-p$ provides the probability of rejecting the null hypothesis when in fact it is false. For example, it can be said that the trend in percentage cost variance is different between cost plus and fixed price contracts at the 97.9% ($1-.0310$) level of confidence.

Further interpretation of Table 24 provides insight into the behavior of CV% growth for various categories of programs. Because of the negative coefficients, the CV% of Army, Navy and fixed price contracts degrades at a greater rate than the baseline (Air Force, cost plus, air based, development) type of contract at the $1-p$ level of confidence. Because of the positive coefficients, the CV% of land based and production contracts degrades at a lesser rate than the baseline type of contract at the $1-p$ level of confidence.

Out of all categories, Army contracts have the greatest increase in CV% growth than all other categories because it has the smallest coefficient. On the other hand, production contracts have the least amount of CV% growth because they display the highest coefficient.

This concludes the presentation of the results of the hypothesis tests proposed in chapter three. The next and final chapter draws conclusions from these statistical tests and further discusses the significance of the findings to the DoD. Additionally, recommendations for further research are made.

V. Discussion

Review of the Hypotheses

Hypothesis Restated. The hypotheses proposed in Chapter 1 are restated below:

1. Given a sample of completed contracts (the DAES database), the overrun at completion is higher than the overrun incurred between the period of 15 to 85 percent complete.

2. Given a sample of completed contracts (the DAES database), the percent overrun at completion is higher than the percent overrun incurred between the period of 15 to 85 percent complete.

3. Cost variances tend to worsen as the program progresses through various stages of completion.

4. Given that cost overruns tend to worsen as a program progresses, this tendency varies among categories (contract type, system type, DoD component and program phase) of programs.

These hypotheses were tested using a sample of 65 contracts from the DAES database in order to test the OUSD(A) assertions that the overrun at completion will not be less than the overrun to date and that the percent overrun at completion will be greater than the percent overrun to date. It was assumed that these contracts were a representative sample from the population of all contracts let by all three DoD components. However, since only contracts with stable baselines were included in the analysis, the results of the hypothesis tests can only be extended to those future contracts with stable baselines. The first two hypotheses were tested through a differences between means test at an 85 percent level of confidence. Hypotheses three and four were tested using regression analysis and an ANOVA and were also tested at the 85 percent level of confidence.

Conclusions

The first two hypotheses were found to be true at the 85% confidence level when the aggregate data was tested. This confirms the OUSD(A) assertions that cost overruns and percentage cost overruns at completion are greater than cost overruns and percentage cost overruns between 15 and 85 percent complete at the 85 percent level of confidence. However, when the data were broken into categories the

assertion were not found to hold true at that level of confidence.

The third hypothesis was found to be true at the 85% level of confidence. The hypothesis test revealed a trend in the data that cost overruns tend to worsen as a contract progresses toward completion. The fourth hypothesis was also found to be true. The testing of this hypothesis revealed a tendency for the trend found in hypothesis three to vary across program categories. Thus, the assertions of OUSD(A) have been statistically verified in this study.

Discussion of Findings

The validation of the OUSD(A) observations provides statistical evidence that the current methods of managing DoD contracts are not totally effective. However, some categories of contracts seem to be better than others. The impacts of cost overruns as discussed in Chapter 2 highlight the importance of having an effective method of monitoring and controlling DoD contracts.

In light of these findings it is imperative that the sources of cost overruns be identified and proper management techniques be employed to identify and correct cost overruns early in a program's life.

Recommendations for Further Research

This study verified the OUSD(A) assertion that cost overruns cannot be corrected, given the current methods of management. This was found to be true from both an absolute and a percentage perspective. It was also found that cost overruns tend to worsen as a contract progresses toward completion and that this trend varies among categories of programs.

It is recommended that future research include investigation into the causes of contract overruns and new methods to avoid them. It is also recommended that further research investigate the reasons for the variation in cost performance trends among categories of contracts.

Appendix A: Contracts Included in Study

TABLE 25

Contracts Listed by Name, Phase, Type, and
Cost Overrun (Yes or No)

Program/Contract	Phase	Type	CO
AH-64, Apache Helicopter (Army)			
Avionics, Lot III	FRP	FPIF	Y
Airframe, Lot II	FRP	FPIF	Y
Support Equipment, Lot II	FRP	FPIF	Y
Avionics, Lot II	FRP	FPIF	Y
Support Equipment, Lot I	FRP	FPIF	Y
AMRAAM Missile (Air Force)			
Missile (Leader)	FSD	FPIF	Y
AN/SQQ-89, Anti-Submarine Warfare			
Combat System (Navy)			
Submarine Electronics	FSD	CP	Y
Submarine Electronics	FSD	CP	Y

Airborne Self Protection Jammer

(Navy)

Avionics	FSD	CPAF	Y
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Army Tactical Missile System (Army)

Missile	FSD	FPIF	Y
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Ground Electronics	FSD	FPIF	Y
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B-1B, Strategic Bomber (Air Force)

Offensive Avionics, Lot V	FRP	FPIF	N
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Defensive Avionics, Lot V	FRP	FPIF	N
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Defensive Avionics, Lot II	FRP	FPIF	N
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Engine, Lot I	FRP	FPIF	N
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Offensive Avionics, Lot I	FRP	FPIF	N
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Bradley Fighting Vehicle (Army)

Ammunition	FRP	FPIF	N
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Vehicle	FRP	FPIF	Y
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C/MH-53E, Stallion Helicopter

(Navy)

Aircraft Buy, FY79	FRP	FPIF	Y
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Aircraft Buy, FY78	FRP	FPIF	Y
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CG-47, AEGIS Cruiser (Navy)

Cruiser 62-65	Const	FPIF	N
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Cruiser 48, Yorktown	Const	CP	N
CH-47D, Chinook Helicopter (Army)			
Aircraft Buy, FY82	FRP	CP	N
Aircraft Buy, FY81	FRP	FPIF	N
DDG-51, Destroyer (Navy)			
Electronics	FSD	CPAF	N
Electronics	FRP	FPIF	N
Defense Satellite Communications System (Air Force)			
Booster	FSD	FPIF	Y
F-15, Eagle Fighter Aircraft (Air Force)			
Avionics, Lot III	FRP	FPIF	Y
Aircraft Buy, FY78	FRP	FPIF	N
Aircraft Buy, FY77	FRP	FPIF	N
F/A-18, Hornet Fighter Aircraft (Navy)			
Engine	FSD	CP	Y
HARPOON Missile (Navy)			
Missile	FRP	FPIF	N

HELLFIRE Missile (Army)

Electronics, FY83	FRP	FPIF	Y
Missile, FY83	FRP	FPIF	Y
Missile, FY82	FRP	FPIF	N
Electronics, FY82	FRP	FPIF	Y

JSTARS (Air Force)

Avionics	FSD	FPIF	Y
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JTIDS (Air Force)

Avionics	FSD	FPIF	Y
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Landing Craft Air Cushion (Navy)

Craft 13 and 14	Const	FPIF	N
Craft 24-33	Const	FPIF	Y
Craft 15-23	Const	FPIF	N

M1A1 Abrams Tank (Army)

Tank	FSD	CP	N
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MAVERICK Missile (Air Force)

Missile	FRP	FPIF	Y
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MK-15, Phalanx Close In Weapon System (Navy)

Gun/Electronics, FY86	FRP	FPIF	Y
Gun/Electronics, FY87	FRP	FPIF	Y

Multiple Launch Rocket System

(Army)

Launch Vehicle	FOD	CP	N
System	FOD	CP	Y

NAVSTAR Global Positioning System (Air Force)

Ground Electronics	FRP	FPIF	Y
Avionics	FRP	FPIF	Y

OH-58D, Army Helicopter

Improvement Program (Army)

Aircraft	FSD	FPIF	Y
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Over the Horizon Backscatter

Radar (Air Force)

Section 4	FRP	FPIF	N
Section 5	FRP	FPIF	N

PATRIOT Missile System (Army)

Missile, FY85	FRP	FPIF	N
Production Facilities	FRP	CPIF	N
Missile, FY86	FRP	FPIF	N
Missile, FY84	FRP	FPIF	N
Missile, FY83	FRP	FPIF	Y
Ground Electronics	FRP	CP	Y
Missile, FY81	FRP	CP	Y

PEACEKEEPER ICBM (Air Force)

Assembly and Checkout	FRP	FPIF	N
Electronics, FY84	FRP	FPIF	Y
Electronics, FY86	FRP	CPFF	Y
Stage III, FY86	FRP	FPIF	N
Electronics, FY84	FRP	FPIF	N
Support Equipment	FRP	CPIF	Y
Stage IV, FY84	FRP	FPIF	N
Stage III, FY84	FRP	FPIF	N
Stage II, FY84	FRP	FPIF	Y
Stage I, FY84	FRP	FPIF	N
Re-entry System	FOD	FPIF	Y
Stage II	FOD	FPIF	N
~~Stage~~ IV	FOD	FPIF	Y
Stage III	FOD	FPIF	N
Stage I	FOD	FPIF	N
Electronics	FOD	CPIF	N
Re-entry Vehicle	FSD	FPIF	Y
Electronics	FOD	FPIF	N
Electronics	FSD	CP	Y
Re-entry System	FSD	CP	Y

PHOENIX Missile (Navy)

Electronics	FRP	FPIF	Y
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SH-60B, Seahawk Helicopter Light

Airborne Multi-Purpose System

(Navy)

Engine	FSD	CP	Y
Airframe	FSD	CP	Y
Software	FSD	CP	Y

SSN 688 Attack Submarine (Navy)

SSN 700-710	Const	FPIF	Y
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Standard Missile 2, Block II

(Navy)

Electronics	FRP	FPIF	Y
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STINGER Missile (Army)

Missile, FY85	FRP	FPIF	Y
Missile, FY86	FRP	FPIF	N
Missile	FOD	FPIF	N
Missile, FY82	FRP	FPIF	N
Missile, FY78	FRP	FPIF	Y

TOMOHAWK Missile (Navy)

Electronics, FY81	FRP	CP	Y
Electronics	FSD	CP	Y

TRIDENT II D5 Missile (Navy)

Electronics	FRP	CPIF	N
Electronics	FRP	CPFF	N
Electronics	FRP	CPIF	Y
Electronics	FRP	CPIF	Y
Electronics	FRP	CPIF	Y
Electronics	FRP	CPIF	Y

TRIDENT II Submarine (Navy)

Submarine Group V	Const	FPIF	Y
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UH-60A, Blackhawk Helicopter

(Army)

Airframe, Lot IV	FRP	FPIF	Y
Airframe, Lot III	FRP	FPIF	Y
Airframe, Lot II	FRP	FPIF	Y
Electronics	FSD	CP	Y
Electronics	FOD	CP	Y
Engine, Lot II	FRP	FPIF	Y
Engine, Lot I	FRP	FPIF	Y
Airframe, Lot I	FRP	FPIF	Y
Engine	FSD	CP	N
Airframe	FSD	CP	Y

Appendix B: Database Used

Contract Data Listed by Name, Service, System Type, Phase
and Contract Type

AH-64 APACHE HELICOPTER AVIONICS LOT III

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	FRP	FPIF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
25.4	25.5	0.7	277.6	9.2%	-0.1	-0.4%
33.9	36.7	1.1	277.9	12.2%	-2.8	-8.3%
57.2	64.2	1.1	277.9	20.6%	-7.2	-12.6%
78.2	92.9	2.4	277.9	28.4%	-14.7	-18.8%
109.4	131.1	2.1	279.3	39.5%	-21.7	-19.8%
155.7	191.5	2.1	279.3	56.2%	-35.8	-23.0%
198.5	241.2	2.2	279.3	71.6%	-42.7	-21.5%
235.5	282.9	2.2	279.4	85.0%	-47.4	-20.1%
261.0	304.0	2.9	279.4	94.4%	-43.0	-16.5%
267.6	311.8	1.8	280.1	96.2%	-44.2	-16.5%
276.2	318.1	1.2	280.1	99.0%	-41.9	-15.2%

AH-64 APACHE HELICOPTER AIRFRAME LOT II

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	FRP	FPIF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
7.7	9.3	9.0	91.7	9.3%	-1.6	-20.8%
13.8	16.8	7.9	91.7	16.5%	-3.0	-21.7%
21.7	27.7	5.8	91.9	25.2%	-6.0	-27.6%
32.0	42.5	2.0	91.9	35.6%	-10.5	-32.8%
45.7	53.7	1.7	111.0	41.8%	-8.0	-17.5%
63.6	66.0	1.4	111.0	58.0%	-2.4	-3.8%
74.3	77.9	2.8	111.0	68.7%	-3.6	-4.8%
82.5	82.3	2.8	111.0	76.2%	0.2	0.2%
87.6	87.6	2.8	111.0	81.0%	0.0	0.0%
91.1	88.5	2.8	112.9	82.7%	2.6	2.9%
96.8	94.0	2.8	113.2	87.7%	2.8	2.9%

AH-64 APACHE HELICOPTER SUP EQUIP LOT II

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	FRP	FPIF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
25.0	24.9	12.3	163.1	16.6%	0.1	0.4%
43.1	41.6	9.3	163.0	28.0%	1.5	3.5%
61.8	59.1	5.6	165.0	38.8%	2.7	4.4%
79.2	80.4	1.3	165.0	48.4%	-1.2	-1.5%
94.8	102.7	0.2	165.0	57.5%	-7.9	-8.3%
110.4	123.6	0.2	165.0	67.0%	-13.2	-12.0%
125.1	143.3	0.2	165.1	75.9%	-18.2	-14.5%
136.2	160.3	0.2	165.1	82.6%	-24.1	-17.7%
142.8	173.0	0.4	165.1	86.7%	-30.2	-21.1%
145.3	179.5	0.4	165.1	88.2%	-34.2	-23.5%
147.3	184.9	0.4	165.1	89.4%	-37.6	-25.5%
150.3	192.1	0.8	165.1	91.5%	-41.8	-27.8%

AH-64 APACHE HELICOPTER AVIONICS LOT II

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	FRP	FPIF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.1	0.3	3.6	29.4	0.4%	-0.2	-200.0%
0.7	2.0	4.9	29.5	2.8%	-1.3	-185.7%
1.9	2.6	4.6	29.5	7.6%	-0.7	-36.8%
3.4	3.1	3.6	29.4	13.2%	0.3	8.8%
4.5	4.8	4.1	29.4	17.8%	-0.3	-6.7%
5.9	6.5	1.1	28.4	21.6%	-0.6	-10.2%
8.2	9.0	2.4	28.4	31.5%	-0.8	-9.8%
11.0	11.5	2.4	28.4	42.3%	-0.5	-4.5%
14.9	15.6	2.4	28.4	57.3%	-0.7	-4.7%
16.6	17.2	2.5	28.6	63.6%	-0.6	-3.6%
22.1	22.7	2.6	29.1	83.4%	-0.6	-2.7%
25.8	26.0	1.8	28.3	97.4%	-0.2	-0.8%

AH-64 APACHE HELICOPTER SUP EQUIP LOT I

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	FRP	FPIF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.5	0.6	2.9	28.2	2.0%	-0.1	-20.0%
5.1	5.0	0.6	32.8	15.8%	0.1	2.0%
9.0	8.9	1.2	31.2	30.0%	0.1	1.1%
12.1	12.3	0.4	31.4	39.0%	-0.2	-1.7%
16.2	17.2	0.4	31.9	51.4%	-1.0	-6.2%
20.7	23.9	0.4	31.9	65.7%	-3.2	-15.5%
26.0	35.8	2.0	38.6	71.0%	-9.8	-37.7%
29.2	40.4	0.2	36.9	79.6%	-11.2	-38.4%
31.8	43.9	0.2	38.9	82.2%	-12.1	-38.1%
34.7	49.0	0.3	37.6	93.0%	-14.3	-41.2%

AMRAAM MISSILE (LEADER)

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	FSD	FPIF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
10.7	10.9	7.5	376.1	2.9%	-0.2	-1.9%
37.9	38.9	13.4	386.6	10.2%	-1.0	-2.6%
56.9	58.4	12.9	386.6	15.2%	-1.5	-2.6%
97.1	101.7	11.1	395.1	25.3%	-4.6	-4.7%
118.9	133.1	11.3	395.1	31.0%	-14.2	-11.9%
161.2	193.6	10.7	395.1	41.9%	-32.4	-20.1%
202.4	257.4	4.6	395.1	51.8%	-55.0	-27.2%
220.5	285.4	20.0	395.1	58.8%	-64.9	-29.4%
246.9	335.4	1.6	395.3	62.7%	-88.5	-35.8%
273.6	388.7	1.3	396.4	69.2%	-115.1	-42.1%
303.7	459.7	1.3	394.6	77.2%	-156.0	-51.4%
319.4	517.0	1.3	394.0	81.3%	-197.6	-61.9%
336.6	589.0	1.3	394.0	85.7%	-252.4	-75.0%
344.0	725.1	15.3	394.0	90.8%	-381.1	-110.8%
354.5	731.9	17.8	392.7	94.6%	-377.4	-106.5%
365.6	753.5	17.6	393.6	97.2%	-387.9	-106.1%
372.6	770.8	18.3	393.6	99.3%	-398.2	-106.9%
374.3	781.3	26.5	393.6	102.0%	-407.0	-108.7%

AN/SQQ-89 ANTI SUBMARINE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	FSD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
4.1	4.5	0.0	22.0	18.6%	-0.4	-9.8%
6.3	7.3	0.0	22.0	28.6%	-1.0	-15.9%
7.1	9.1	0.0	22.0	32.3%	-2.0	-28.2%
9.4	12.3	2.5	23.1	45.6%	-2.9	-30.9%
13.1	14.9	1.4	23.0	60.6%	-1.8	-13.7%
14.2	16.3	1.2	23.3	64.3%	-2.1	-14.8%
15.2	18.2	1.1	23.3	68.5%	-3.0	-19.7%
16.7	20.5	1.7	23.3	77.3%	-3.8	-22.8%
17.6	21.7	1.3	23.3	80.0%	-4.1	-23.3%
18.4	22.8	1.5	23.3	84.4%	-4.4	-23.9%
20.2	25.2	1.2	23.3	91.4%	-5.0	-24.8%
21.6	26.6	1.1	25.2	89.6%	-5.0	-23.1%
22	27.1	1.1	24.9	92.4%	-5.1	-23.2%
22.8	26.9	1.6	24.9	97.9%	-4.1	-18.0%

AN/SQQ-89 ANTI SUBMARINE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	FSD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
5.5	4.8	0.0	35.5	15.5%	0.7	12.7%
10.0	9.8	0.0	35.5	28.2%	0.2	2.0%
14.0	14.2	0.0	36.4	38.5%	-0.2	-1.4%
17.9	18.9	0.0	36.4	49.2%	-1.0	-5.6%
21.4	22.7	0.0	36.4	58.8%	-1.3	-6.1%
24.5	26.0	0.0	36.4	67.3%	-1.5	-6.1%
26.0	27.8	0.0	37.5	69.3%	-1.8	-6.9%
29.3	30.7	0.0	37.5	78.1%	-1.4	-4.8%
31.6	32.8	0.0	37.5	84.3%	-1.2	-3.8%
33.1	34.1	0.0	37.5	88.3%	-1.0	-3.0%
34.8	36.1	0.0	37.5	92.8%	-1.3	-3.7%
36.4	37.5	0.0	37.5	97.1%	-1.1	-3.0%
37.1	38.3	0.0	37.5	98.9%	-1.2	-3.2%
37.8	39.1	0.0	39.0	96.9%	-1.3	-3.4%

AIRBORNE SELF PROTECT JAMMER AVIONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	FSD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
1.1	1.1	0.0	80.8	1.4%	0.0	0.0%
6.2	5.3	3.8	80.8	8.1%	0.9	14.5%
10.4	11.1	1.9	80.8	13.2%	-0.7	-6.7%
21.3	26.7	1.5	88.1	24.6%	-5.4	-25.4%
28.6	40.2	0.0	88.1	32.5%	-11.6	-40.6%
63.7	103.6	1.9	88.7	73.4%	-39.9	-62.6%
68.1	116.9	2.2	88.7	78.7%	-48.8	-71.7%
74.9	139.4	1.6	88.8	85.9%	-64.5	-86.1%
77.0	148.8	0.7	88.8	87.4%	-71.8	-93.2%
112.8	165.0	2.0	128.3	89.3%	-52.2	-96.3%

ARMY TACTICAL MISSILE SYSTEM (MISSILE)

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	FSD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
20.4	20.0	10.7	162.7	13.4%	0.1	0.5%
27.8	27.6	11.6	162.7	18.4%	0.2	0.7%
36.4	37.1	11.6	162.8	24.1%	-0.7	-1.9%
50.4	49.7	10.4	163.0	33.0%	0.7	1.4%
59.1	59.8	10.9	163.0	38.9%	-0.7	-1.2%
70.6	71.7	9.6	163.0	46.0%	-1.1	-1.6%
92.4	96.1	6.4	163.3	58.9%	-3.7	-4.0%
99.6	104.5	5.3	164.5	62.6%	-4.9	-4.9%
112.4	117.3	3.4	165.1	69.5%	-4.9	-4.4%
122.2	130.3	1.9	165.1	74.9%	-8.1	-6.6%
132.4	141.3	1.7	165.1	81.0%	-8.9	-6.7%
142.0	152.4	0.5	165.1	86.3%	-10.4	-7.3%
149.8	162.7	0.4	165.1	91.0%	-12.9	-8.6%
155.3	171.1	0.1	165.1	94.1%	-15.8	-10.2%
159.4	178.6	0.0	165.1	96.5%	-19.2	-12.0%
163.4	178.5	0.0	165.2	98.9%	-15.1	-9.2%
164.2	180.5	0.0	165.2	99.4%	-16.3	-9.9%

ARMY TACTICAL MISSILE SYSTEM ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	FSD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
4.9	4.1	4.8	79.8	6.5%	0.8	16.3%
8.2	6.9	4.7	79.8	10.9%	1.3	15.9%
12.0	10.8	4.1	79.6	15.9%	1.2	10.0%
18.2	16.4	4.1	86.4	22.1%	1.8	9.9%
24.6	23.8	4.1	86.5	29.9%	0.8	3.3%
38.5	38.7	5.1	87.4	46.8%	-0.2	-0.5%
42.3	42.8	4.0	87.4	50.7%	-0.5	-1.2%
47.7	50.0	3.8	87.4	57.1%	-2.3	-4.8%
55.5	60.7	5.4	87.7	67.4%	-5.2	-9.4%
60.6	67.3	5.1	87.7	73.4%	-6.7	-11.1%
66.9	74.4	3.2	93.9	73.8%	-7.5	-11.2%
73.0	83.1	4.1	93.9	81.3%	-10.1	-13.8%
77.1	90.5	4.1	93.9	85.9%	-13.4	-17.4%
81.8	97.8	0.0	93.0	88.0%	-16.0	-19.6%
84.8	101.9	0.0	93.0	91.2%	-17.1	-20.2%
87.0	105.2	0.0	93.0	93.5%	-18.2	-20.9%

B1-B STRATEGIC BOMBER DEF AVIONICS LOT II

SERVICE: SYS TYPE: PHASE: CONTR TYPE: BASELINE:

AF	AVIONICS	FRP	FPIF	S		
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
1.8	1.8	0.0	129.7	1.4%	0.0	0.0%
4.4	3.9	4.0	131.6	3.4%	0.5	11.4%
9.5	9.1	4.0	131.6	7.4%	0.4	4.2%
38.5	38.8	11.8	131.9	32.1%	-0.3	-0.8%
56.9	56.9	11.6	132.0	47.3%	0.0	0.0%
79.4	84.9	5.7	132.0	62.9%	-5.5	-6.9%
88.7	94.2	7.6	132.0	71.3%	-5.5	-6.2%
101.4	112.0	6.6	132.0	80.9%	-10.6	10.5%
106.4	117.1	6.6	132.0	84.8%	-10.7	10.1%
110.9	122.7	4.3	129.9	88.3%	-11.8	10.6%
113.4	125.7	5.8	129.9	91.4%	-12.3	10.8%
119.9	126.5	5.7	129.9	96.5%	-6.6	-5.5%

BRADLEY FIGHTING VEHICLE

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
5.9	6.2	5.4	80.4	7.9%	-0.3	-5.1%
14.0	14.4	36.2	156.8	11.6%	-0.4	-2.9%
28.7	29.5	35.2	156.8	23.6%	-0.8	-2.8%
49.7	56.0	13.7	150.3	36.4%	-6.3	-12.7%
65.3	73.2	14.4	150.3	48.1%	-7.9	-12.1%
81.3	96.6	12.6	150.3	59.0%	-15.3	-18.8%
96.5	118.7	12.2	150.3	69.9%	-22.2	-23.0%
113.9	146.1	11.2	150.3	81.9%	-32.2	-28.3%
130.2	170.2	10.8	150.4	93.3%	-40.0	-30.7%
133.2	175.3	10.8	150.5	95.3%	-42.1	-31.1%

C/MH-53E STALLION HELICOPTER FY79 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.2	0.2	1.4	86.5	0.2%	0.0	0.0%
0.5	0.6	2.0	86.5	0.6%	-0.1	-20.0%
1.2	1.5	3.0	88.3	1.4%	-0.3	-25.0%
4.9	6.0	3.0	88.3	5.7%	-1.1	-22.4%
13.6	15.0	3.0	88.3	15.9%	-1.4	-10.3%
21.8	31.3	2.9	91.7	24.5%	-9.5	-43.6%
33.7	52.8	6.6	91.7	39.6%	-19.1	-56.7%
45.8	72.3	5.5	93.1	52.3%	-26.5	-57.9%
61.4	104.3	6.8	93.1	71.1%	-42.9	-69.9%
75.0	114.2	14.4	93.2	95.2%	-39.2	-52.3%
78.9	118.8	16.5	93.2	102.9%	-39.9	-50.6%

C/MH-53E STALLION HELICOPTER FY78 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
5.3	4.7	8.2	87.8	6.7%	0.6	11.3%
7.9	7.9	6.4	89.7	9.5%	0.0	0.0%
12.0	12.6	5.1	89.7	14.2%	-0.6	-5.0%
16.4	19.8	8.1	89.7	20.1%	-3.4	-20.7%
22.6	27.8	6.1	100.6	23.9%	-5.2	-23.0%
35.5	42.8	6.0	100.4	37.6%	-7.3	-20.6%
45.4	56.6	19.8	116.0	47.2%	-11.2	-24.7%
58.5	74.9	14.5	121.2	54.8%	-16.4	-28.0%
74.2	90.9	10.2	121.8	66.5%	-16.7	-22.5%
83.0	108.5	17.0	131.9	72.2%	-25.5	-30.7%
92.6	123.3	16.3	133.4	79.1%	-30.7	-33.2%
97.6	130.6	15.4	135.7	81.1%	-33.0	-33.8%
101.3	139.5	14.9	136.6	83.2%	-38.2	-37.7%
106.2	152.9	15.8	138.3	86.7%	-46.7	-44.0%
117.4	157.4	10.0	142.1	88.9%	-40.0	-34.1%
119.3	161.9	10.3	143.7	89.4%	-42.6	-35.7%
123.1	169.2	11.5	145.1	92.1%	-46.1	-37.4%

DEFENSE SATELLITE COMMUNICATIONS BOOSTER

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FF			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
2.8	2.7	0.0	48.0	5.8%	0.1	3.6%
6.0	6.0	3.7	48.0	13.5%	0.0	0.0%
11.7	10.9	3.9	48.1	26.5%	0.8	6.8%
16.4	16.0	3.1	40.8	43.5%	0.4	2.4%
20.7	20.7	2.5	40.8	54.0%	0.0	0.0%
26.3	27.5	2.7	40.8	69.0%	-1.2	-4.6%
30.6	32.9	2.6	40.8	80.1%	-2.3	-7.5%
33.3	38.1	2.0	40.8	85.8%	-4.8	-14.4%
36.0	41.3	2.0	40.8	92.8%	-5.3	-14.7%

F-15 EAGLE FIGHTER AVIONICS LOT III

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
12.3	15.1	0.0	269.8	4.6%	-2.8	-22.8%
33.2	33.2	0.0	274.3	12.1%	0.0	0.0%
46.0	44.0	0.0	274.3	16.8%	2.0	4.3%
67.0	64.3	9.5	274.3	25.3%	2.7	4.0%
85.9	84.2	10.1	274.3	32.5%	1.7	2.0%
105.8	105.4	11.6	274.8	40.2%	0.4	0.4%
123.0	130.3	1.6	274.8	45.0%	-7.3	-5.9%
149.6	160.6	1.7	282.6	53.3%	-11.0	-7.4%
172.4	195.3	3.1	282.3	61.7%	-22.9	-13.3%
202.2	238.0	1.5	282.3	72.0%	-35.8	-17.7%
222.0	262.2	1.2	285.6	78.1%	-40.2	-18.1%
240.0	285.4	2.3	286.3	84.5%	-45.4	-18.9%

F/A-18 HORNET FIGHTER AIRCRAFT ENGINE

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
4.1	4.0	0.0	330.6	1.2%	0.1	2.4%
9.6	9.5	0.0	330.6	2.9%	0.1	1.0%
22.9	23.3	0.0	330.6	6.9%	-0.4	-1.7%
38.4	38.5	0.0	309.5	12.4%	-0.1	-0.3%
52.2	52.6	9.4	309.5	17.4%	-0.4	-0.8%
74.5	74.7	9.2	309.5	24.8%	-0.2	-0.3%
94.9	97.3	8.8	309.5	31.6%	-2.4	-2.5%
110.9	111.3	7.9	309.5	36.8%	-0.4	-0.4%
126.5	127.7	1.9	309.5	41.1%	-1.2	-0.9%
145.4	144.9	2.5	309.9	47.3%	0.5	0.3%
164.8	167.9	2.3	309.9	53.6%	-3.1	-1.9%
188.9	187.9	2.0	309.9	61.4%	1.0	0.5%
209.5	211.6	2.0	309.9	68.0%	-2.1	-1.0%
229.0	230.3	1.4	309.9	74.2%	-1.3	-0.6%
257.5	261.7	2.0	309.9	83.6%	-4.2	-1.6%
275.6	279.1	1.2	309.9	89.3%	-3.5	-1.3%
281.8	288.6	1.2	310.4	91.1%	-6.8	-2.4%
292.1	296.5	0.7	311.5	94.0%	-4.4	-1.5%
299.0	303.4	0.7	311.5	96.2%	-4.4	-1.5%
304.7	310.9	0.7	311.5	98.0%	-6.2	-2.0%
305.5	315.0	0.7	317.3	96.5%	-9.5	-3.1%
308.8	321.7	0.2	317.3	97.4%	-12.9	-4.2%
309.1	323.7	1.4	317.3	97.8%	-14.6	-4.7%
311.2	329.9	0.2	317.3	98.1%	-18.7	-6.0%

HELLFIRE MISSILE FY 83 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.2	0.1	0.0	82.1	0.2%	0.1	50.0%
0.5	0.4	0.0	82.1	0.6%	0.1	20.0%
1.1	0.9	5.4	86.2	1.4%	0.2	18.2%
2.0	1.5	5.4	86.7	2.5%	0.5	25.0%
3.4	3.1	6.0	86.7	4.2%	0.3	8.8%
7.2	6.7	5.6	86.2	8.9%	0.5	6.9%
14.1	12.1	5.3	86.4	17.4%	2.0	14.2%
18.0	17.5	5.1	89.4	21.4%	0.5	2.8%
28.5	27.7	4.7	37.8	34.3%	0.8	2.8%
34.2	35.8	5.1	94.1	38.4%	-1.6	-4.7%
37.8	42.4	5.1	94.1	42.5%	-4.6	-12.2%
49.9	59.9	4.5	94.1	55.7%	-10.0	-20.0%
65.6	84.0	2.1	89.1	75.4%	-19.4	-28.0%
77.0	89.6	2.1	89.1	88.5%	-12.6	-16.4%
83.4	106.3	1.8	89.1	95.5%	-22.9	-27.5%
88.0	116.2	1.9	90.9	98.9%	-28.2	-32.0%

HELLFIRE MISSILE FY 82 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.9	0.6	0.0	40.1	2.2%	0.3	33.3%
1.9	1.5	0.0	35.7	5.3%	0.4	21.1%
3.4	3.0	2.3	35.7	10.2%	0.4	11.8%
5.4	5.2	2.3	35.8	16.1%	0.2	3.7%
8.2	7.8	2.2	35.9	24.3%	0.4	4.9%
14.4	13.3	2.2	35.9	42.7%	1.1	7.6%
19.0	19.0	2.1	35.9	56.2%	0.0	0.0%
25.8	24.1	1.6	35.9	75.2%	1.7	6.6%
29.3	28.1	0.3	35.9	82.3%	1.2	4.1%
32.2	31.7	0.3	35.9	90.4%	0.5	1.6%
32.6	33.5	0.3	35.9	91.6%	-0.9	-2.8%
33.2	35.7	0.3	35.9	93.3%	-2.5	-7.5%
33.7	38.5	0.3	35.9	94.7%	-4.8	-14.2%

JSTARS AVIONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
100.0	132.8	1.3	570.7	17.6%	-32.8	-32.8%
117.0	161.7	0.7	571.0	20.5%	-44.7	-38.2%
136.8	195.5	0.7	576.9	23.7%	-58.7	-42.9%
161.8	233.1	2.4	581.6	27.9%	-71.3	-44.1%
288.3	450.2	0.2	593.8	48.6%	-161.9	-56.2%
317.5	493.7	0.7	603.1	52.7%	-176.2	-55.5%
337.0	523.2	4.1	611.4	55.5%	-186.2	-55.3%
388.3	549.7	2.7	656.4	59.4%	-161.4	-41.6%
438.1	604.4	3.0	719.1	61.2%	-166.3	-38.0%
458.6	629.2	4.2	731.7	63.0%	-170.6	-37.2%
504.8	683.0	4.2	733.2	69.2%	-178.2	-35.3%
536.5	722.1	3.8	737.6	73.1%	-185.6	-34.6%
566.3	764.2	3.8	745.5	76.4%	-197.9	-34.9%
609.7	816.5	3.4	747.9	81.9%	-206.8	-33.9%

JTIDS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
6.3	5.7	3.5	38.5	18.0%	0.6	9.5%
14.0	13.1	3.1	38.9	39.1%	0.9	6.4%
17.5	17.1	3.2	38.9	49.0%	0.4	2.3%
22.1	22.1	1.7	38.9	59.4%	0.0	0.0%
26.4	27.0	1.1	39.6	68.6%	-0.6	-2.3%
30.6	30.9	0.5	39.6	78.3%	-0.3	-1.0%
33.3	33.9	0.5	39.6	85.2%	-0.6	-1.8%
34.7	36.7	0.2	39.6	88.1%	-2.0	-5.8%
36.8	39.5	0.0	38.9	94.6%	-2.7	-7.3%
37.5	41.1	0.0	38.9	96.4%	-3.6	-9.6%

LANDING CRAFT AIR CUSHION CRAFT 24-33

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
2.9	3.0	0.0	151.5	1.9%	-0.1	-3.4%
12.9	14.4	6.2	151.5	8.9%	-1.5	-11.6%
22.6	24.4	6.2	151.5	15.6%	-1.8	-8.0%
33.0	35.1	6.4	151.5	22.7%	-2.1	-6.4%
53.2	58.1	10.7	151.5	37.8%	-4.9	-9.2%
68.2	74.7	7.4	151.6	47.3%	-6.5	-9.5%
78.9	86.5	8.2	152.0	54.9%	-7.6	-9.6%
88.3	96.3	9.1	152.2	61.7%	-8.0	-9.1%
105.0	113.9	9.1	152.3	73.3%	-8.9	-8.5%
116.4	124.2	10.3	152.3	82.0%	-7.8	-6.7%
127.2	133.8	10.0	152.4	89.3%	-6.6	-5.2%
133.1	141.1	6.4	153.9	90.2%	-8.0	-6.0%

MAVERICK MISSILE

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
8.3	7.5	2.6	133.3	6.4%	0.8	9.6%
20.7	19.5	4.1	133.6	16.0%	1.2	5.8%
34.6	31.8	3.4	133.6	26.6%	2.8	8.1%
49.7	48.2	2.9	133.6	38.0%	1.5	3.0%
66.3	65.2	2.9	136.6	49.8%	1.1	1.7%
81.8	82.9	2.9	136.6	61.5%	-1.1	-1.3%
95.1	99.5	2.4	136.6	71.2%	-4.4	-4.6%
111.1	116.9	2.7	136.0	83.3%	-5.8	-5.2%
119.0	124.7	2.7	135.9	89.3%	-5.7	-4.8%
130.5	134.9	2.6	136.4	97.5%	-4.4	-3.4%

MK15 CLOSE IN WEAPON 1986

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
7.7	7.9	3.8	173.3	4.5%	-0.2	-2.6%
27.7	32.3	0.1	196.2	14.1%	-4.6	-16.6%
40.8	44.2	0.1	196.2	20.8%	-3.4	-8.3%
89.1	92.4	3.2	197.3	45.9%	-3.3	-3.7%
129.1	139.8	1.9	200.0	65.2%	-10.7	-8.3%
161.0	170.3	0.1	200.5	80.3%	-9.3	-5.8%
171.1	181.8	1.2	203.3	84.7%	-10.7	-6.3%
179.5	194.0	-0.4	203.3	88.1%	-14.5	-8.1%
184.9	202.1	1.6	203.0	91.8%	-17.2	-9.3%

MK15 CLOSE IN WEAPON 1987

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
9.9	9.0	0.2	151.5	6.5%	0.9	9.1%
18.0	20.1	8.9	151.5	12.6%	-2.1	-11.7%
28.0	29.6	5.0	151.5	19.1%	-1.6	-5.7%
66.3	66.2	0.9	153.6	43.4%	0.1	0.2%
86.5	86.7	0.6	153.6	56.5%	-0.2	-0.2%
108.6	109.3	1.4	154.6	70.9%	-0.7	-0.6%
121.4	125.4	1.7	160.0	76.7%	-4.0	-3.3%
128.4	142.0	1.0	160.0	80.8%	-13.6	-10.6%
144.3	158.2	3.5	160.0	92.2%	-13.9	-9.6%
147.3	163.9	3.6	160.0	94.2%	-16.6	-11.3%
148.4	166.1	3.5	160.0	94.8%	-17.7	-11.9%

MULTIPLE LAUNCH ROCKET SYSTEM (SYSTEM)

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
6.0	5.1	6.0	104.6	6.1%	0.9	15.0%
15.6	16.5	3.5	103.9	15.5%	-0.9	-5.8%
26.9	27.6	3.0	101.9	27.2%	-0.7	-2.6%
42.2	45.4	5.2	105.0	42.3%	-3.2	-7.6%
54.7	62.0	4.2	107.7	52.9%	-7.3	-13.3%
68.1	79.8	3.5	109.4	64.3%	-11.7	-17.2%
82.8	95.2	0.3	118.6	70.0%	-12.4	-15.0%
91.3	108.7	0.6	119.6	76.7%	-17.4	-19.1%
101.9	118.5	2.6	118.5	87.9%	-16.6	-16.3%
108.1	126.7	2.5	118.5	93.2%	-18.6	-17.2%
112.4	132.4	2.5	118.2	97.1%	-20.0	-17.8%

NAVSTAR GLOBAL POSITIONING SYSTEM GROUND ELECT

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	GROUND	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.4	0.7	0.0	58.2	0.7%	-0.3	-75.0%
6.6	6.3	11.4	58.2	14.1%	0.3	4.5%
10.0	9.7	8.2	64.5	17.8%	0.3	3.0%
14.9	16.1	3.7	64.5	24.5%	-1.2	-8.1%
20.1	23.6	3.9	65.3	32.7%	-3.5	-17.4%
22.3	27.8	4.8	65.3	36.9%	-5.5	-24.7%
27.7	34.4	4.6	65.3	44.5%	-7.4	-27.4%
35.3	45.7	3.6	65.5	57.0%	-10.4	-29.5%
39.3	52.5	3.3	65.5	63.2%	-13.2	-33.6%
42.9	57.3	3.3	65.6	68.9%	-14.4	-33.6%
45.1	61.9	3.7	65.6	72.9%	-16.8	-37.3%
47.4	65.7	3.6	67.1	74.6%	-18.3	-38.6%
51.9	73.7	2.5	67.1	80.3%	-21.1	-40.7%
57.9	79.4	2.6	69.0	87.2%	-21.5	-37.1%
61.4	85.2	0.0	69.0	89.0%	-23.8	-38.8%
62.2	86.8	0.0	69.0	90.1%	-24.6	-39.5%
63.4	89.6	0.0	69.0	91.9%	-26.2	-41.3%
64.3	93.2	0.0	69.0	93.2%	-28.9	-44.9%

NAVSTAR GLOBAL POSITIONING SYSTEM AVIONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
2.7	2.5	3.3	62.3	4.6%	0.2	7.4%
6.9	7.0	2.6	68.6	10.5%	-0.1	-1.4%
9.6	10.3	2.7	68.6	14.6%	-0.7	-7.3%
13.9	15.7	2.7	68.6	21.1%	-1.8	-12.9%
18.6	21.5	3.7	69.3	28.4%	-2.9	-15.6%
21.7	25.7	3.9	70.3	32.8%	-4.0	-18.4%
26.8	31.8	3.5	69.3	40.7%	-5.0	-18.7%
31.2	37.3	3.7	69.7	47.3%	-6.1	-19.6%
35.9	42.8	2.7	69.7	53.6%	-6.9	-19.2%
40.7	48.9	1.8	69.7	59.9%	-8.2	-20.1%
45.4	55.2	1.5	71.7	64.7%	-9.8	-21.6%
49.4	60.7	1.2	71.8	70.0%	-11.3	-22.9%
52.7	63.9	1.2	71.8	74.6%	-11.2	-21.3%
57.1	68.8	1.4	72.9	79.9%	-11.7	-20.5%
60.5	72.5	1.1	73.1	84.0%	-12.0	-19.8%
63.7	77.5	1.1	73.1	88.3%	-13.8	-21.7%
64.7	79.1	1.1	73.1	89.9%	-14.4	-22.3%
66.3	81.3	0.0	73.1	90.7%	-15.0	-22.6%
68.1	83.3	0.0	73.1	93.2%	-15.2	-22.3%

OH-58D HELICOPTER IMPROVEMENT PROGRAM

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
14.4	16.5	0.8	135.6	10.7%	-2.1	-14.6%
23.5	28.3	0.8	138.4	17.1%	-4.8	-20.4%
37.7	45.9	3.7	138.4	28.0%	-8.2	-21.8%
50.9	64.5	2.8	138.4	37.5%	-13.6	-26.7%
67.8	85.7	0.8	139.0	49.1%	-17.9	-26.4%
79.8	107.7	0.9	139.0	57.8%	-27.9	-35.0%
92.7	121.9	0.8	139.2	67.0%	-29.2	-31.5%
104.9	129.2	0.5	139.2	75.6%	-24.3	-23.2%
122.9	151.7	0.9	144.4	85.6%	-28.8	-23.4%
129.8	157.8	1.0	144.4	90.5%	-28.0	-21.6%
131.8	159.5	0.8	144.4	91.8%	-27.7	-21.0%
139.3	166.5	0.8	146.9	95.3%	-27.2	-19.5%
139.5	167.0	0.9	146.9	95.5%	-27.5	-19.7%

PATRIOT MISSILE SYSTEM FY 83 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:
ARMY GROUND PROD FP

BCWP	ACWP	MR	CBB	%COMP	CV	CV%
17.3	17.9	0.0	227.0	7.6%	-0.6	-3.5%
46.3	50.4	0.0	256.2	18.1%	-4.1	-8.9%
84.9	87.2	0.0	425.1	20.0%	-2.3	-2.7%
126.9	125.1	4.9	425.1	30.2%	1.8	1.4%
171.3	170.1	4.7	425.1	40.7%	1.2	0.7%
207.7	211.7	16.7	435.8	49.6%	-4.0	-1.9%
253.7	258.9	13.9	435.8	60.1%	-5.2	-2.0%
297.3	302.9	13.4	435.8	70.4%	-5.6	-1.9%
335.1	346.3	13.3	435.8	79.3%	-11.2	-3.3%
365.1	376.3	13.3	435.8	86.4%	-11.2	-3.1%
384.0	398.0	13.3	436.2	90.8%	-14.0	-3.6%
402.3	423.8	13.3	436.2	95.1%	-21.5	-5.3%
404.4	432.8	15.0	436.2	96.0%	-28.4	-7.0%
410.6	434.1	14.9	436.2	97.5%	-23.5	-5.7%
411.0	434.7	14.9	436.2	97.6%	-23.7	-5.8%

PATRIOT MISSILE SYSTEM ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:
ARMY GROUND PROD CP

BCWP	ACWP	MR	CBB	%COMP	CV	CV%
3.7	13.4	0.0	345.1	1.1%	-9.7	-262.2%
33.5	35.1	0.0	345.1	9.7%	-1.6	-4.8%
60.2	62.7	0.0	345.4	17.4%	-2.5	-4.2%
102.2	98.9	22.7	345.4	31.7%	3.3	3.2%
142.7	137.2	22.7	345.4	44.2%	5.5	3.9%
189.2	180.9	22.7	345.4	58.6%	8.3	4.4%
226.0	221.7	22.7	346.2	69.9%	4.3	1.9%
259.7	256.0	22.7	346.2	80.3%	3.7	1.4%
275.2	284.5	22.4	346.2	85.0%	-9.3	-3.4%
287.6	301.1	22.4	351.6	87.4%	-13.5	-4.7%
300.3	315.3	21.1	351.6	90.9%	-15.0	-5.0%
310.8	326.2	21.1	351.6	94.0%	-15.4	-5.0%
318.0	333.4	20.7	351.6	96.1%	-15.4	-4.8%
320.1	337.0	20.7	351.6	96.7%	-16.9	-5.3%

PATRIOT MISSILE SYSTEM FY 81 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
19.2	27.9	3.5	220.3	8.9%	-8.7	-45.3%
52.9	54.6	17.0	297.7	18.8%	-1.7	-3.2%
79.6	77.2	17.0	220.3	39.2%	2.4	3.0%
107.2	101.5	16.0	220.3	52.5%	5.7	5.3%
135.9	128.9	16.2	219.4	66.9%	7.0	5.2%
159.9	157.4	16.5	219.4	78.8%	2.5	1.6%
175.9	180.9	16.6	219.4	86.7%	-5.0	-2.8%
185.5	191.7	16.6	219.4	91.5%	-6.2	-3.3%
192.6	202.1	16.0	219.4	94.7%	-9.5	-4.9%
195.9	210.5	16.0	219.4	96.3%	-14.6	-7.5%
196.1	214.1	15.8	219.4	96.3%	-18.0	-9.2%
196.6	215.1	15.4	219.4	96.4%	-18.5	-9.4%

PEACEKEEPER ICBM ELECTRONICS FY 84 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
16.7	16.5	6.1	235.0	7.3%	0.2	1.2%
28.6	26.5	8.1	235.0	12.6%	2.1	7.3%
44.0	40.5	8.9	235.0	19.5%	3.5	8.0%
65.8	63.0	9.4	235.0	29.2%	2.8	4.3%
95.0	94.4	10.2	236.0	42.1%	0.6	0.6%
149.4	153.4	7.3	297.3	51.5%	-4.0	-2.7%
192.9	199.6	8.8	298.9	66.5%	-6.7	-3.5%
210.7	217.3	4.8	298.9	71.6%	-6.6	-3.1%
237.4	250.6	4.5	299.6	80.4%	-13.2	-5.6%
263.5	296.5	4.5	300.4	88.9%	-33.0	-12.5%
275.0	320.5	3.7	300.5	92.7%	-45.5	-16.5%

PEACEKEEPER ICBM ELECTRONICS FY 86 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
22.0	25.5	18.4	176.9	13.9%	-3.5	-15.9%
36.2	41.1	17.5	180.6	22.2%	-4.9	-13.5%
55.2	61.7	13.0	198.9	29.7%	-6.5	-11.8%
87.0	101.2	13.8	211.1	44.1%	-14.2	-16.3%
110.5	122.8	16.9	215.0	55.8%	-12.3	-11.1%
127.7	143.3	16.4	223.3	61.7%	-15.6	-12.2%
146.3	169.3	17.1	224.0	70.7%	-23.0	-15.7%
164.4	193.4	16.4	224.0	79.2%	-29.0	-17.6%
175.4	205.5	18.3	224.0	85.3%	-30.1	-17.2%
188.1	218.0	18.3	221.5	92.6%	-29.9	-15.9%

PEACEKEEPER ICBM SUPPORT EQUIP

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	GROUND	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
102.4	109.6	26.2	525.1	20.5%	-7.2	-7.0%
172.6	175.2	31.1	529.6	34.6%	-2.6	-1.5%
266.6	273.5	26.0	601.8	46.3%	-6.9	-2.6%
308.5	323.2	18.8	595.2	53.5%	-14.7	-4.8%
375.2	393.7	11.6	595.4	64.3%	-18.5	-4.9%
462.7	485.1	11.6	598.2	78.9%	-22.4	-4.8%
473.9	496.0	5.1	598.7	79.8%	-22.1	-4.7%
520.9	553.2	7.1	610.0	86.4%	-32.3	-6.2%
553.1	588.5	8.6	638.5	87.8%	-35.4	-6.4%

PEACEKEEPER ICBM STAGE II FY 84 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
7.4	6.6	6.1	112.0	7.0%	0.8	10.8%
10.1	9.0	6.9	112.0	9.6%	1.1	10.9%
24.4	21.6	9.7	112.0	23.7%	2.8	11.5%
39.9	37.2	13.1	112.0	40.3%	2.7	6.8%
55.0	52.8	13.3	112.7	55.3%	2.2	4.0%
68.9	69.8	15.5	115.0	69.2%	-0.9	-1.3%
84.8	91.1	14.8	119.2	81.2%	-6.3	-7.4%
87.1	94.5	14.7	119.2	83.3%	-7.4	-8.5%
91.2	99.7	17.7	113.5	95.2%	-8.5	-9.3%

PEACEKEEPER ICBM RE-ENTRY SYSTEM

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
5.5	5.5	8.2	80.9	7.6%	0.0	0.0%
14.1	14.6	4.5	82.2	18.1%	-0.5	-3.5%
29.1	31.3	3.5	83.8	36.2%	-2.2	-7.6%
35.1	37.9	4.3	89.0	41.4%	-2.8	-8.0%
44.9	48.4	3.4	92.5	50.4%	-3.5	-7.8%
54.3	58.4	2.7	93.0	60.1%	-4.1	-7.6%
66.7	70.4	3.0	92.0	74.9%	-3.7	-5.5%
76.6	81.1	2.6	92.3	85.4%	-4.5	-5.9%
82.9	86.9	2.5	92.4	92.2%	-4.0	-4.8%

PEACEKEEPER ICBM STAGE IV

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
43.3	43.0	26.3	267.1	18.0%	0.3	0.7%
53.2	53.2	30.3	267.1	22.5%	0.0	0.0%
72.8	75.0	25.7	265.3	31.7%	-2.2	-3.0%
91.4	94.3	33.7	269.9	38.7%	-2.9	-3.2%
120.1	124.4	32.8	269.6	50.7%	-4.3	-3.6%
133.2	138.8	31.1	271.2	55.5%	-5.6	-4.2%
152.1	160.6	32.2	268.6	64.3%	-8.5	-5.6%
174.4	183.4	34.5	269.0	74.4%	-9.0	-5.2%
197.4	207.7	34.2	269.3	84.0%	-10.3	-5.2%
211.8	224.7	34.2	269.5	90.0%	-12.9	-6.1%
221.0	234.8	38.7	269.5	95.8%	-13.8	-6.2%

PEACEKEEPER ICBM RE-ENTRY VEHICLE

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	FP			
BCWP	ACWP	MR	CBE	%COMP	CV	CV%
6.2	4.6	2.3	44.9	14.6%	1.6	25.8%
34.2	34.4	22.4	216.6	17.6%	-0.2	-0.6%
47.8	47.5	25.6	213.2	25.5%	0.3	0.6%
61.2	60.9	21.5	211.5	32.2%	0.3	0.5%
91.3	93.1	18.7	213.2	46.9%	-1.8	-2.0%
107.2	110.0	9.8	212.9	52.8%	-2.8	-2.6%
122.6	127.0	9.9	222.6	57.6%	-4.4	-3.6%
141.8	150.6	8.1	231.4	63.5%	-8.8	-6.2%
150.0	159.1	4.5	232.6	65.8%	-9.1	-6.1%
161.9	172.5	4.0	231.9	71.0%	-10.6	-6.5%
173.5	188.1	4.0	232.3	76.0%	-14.6	-8.4%
192.5	202.3	3.5	232.7	84.0%	-9.8	-5.1%
203.3	212.6	7.6	235.8	89.1%	-9.3	-4.6%
211.9	219.8	9.2	235.7	93.6%	-7.9	-3.7%

PEACEKEEPER ICBM ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
50.3	54.0	13.8	309.9	17.0%	-3.7	-7.4%
67.3	73.8	11.9	312.5	22.4%	-6.5	-9.7%
83.2	93.6	13.5	313.3	27.8%	-10.4	-12.5%
97.6	110.8	45.6	312.4	36.6%	-13.2	-13.5%
113.1	125.2	43.3	313.3	41.9%	-12.1	-10.7%
126.8	136.8	8.8	266.7	49.2%	-10.0	-7.9%
140.3	149.7	8.8	266.7	54.4%	-9.4	-6.7%
164.1	163.6	4.0	234.3	71.3%	0.5	0.3%
181.4	180.1	2.6	234.3	78.3%	1.3	0.7%
198.0	196.4	2.4	234.3	85.4%	1.6	0.8%

PEACEKEEPER ICBM RE-ENTRY SYSTEM

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

AF	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
31.4	30.0	0.0	157.6	19.9%	1.4	4.5%
49.0	48.8	0.9	163.8	30.1%	0.2	0.4%
60.8	60.8	0.6	167.5	36.4%	0.0	0.0%
74.2	74.7	3.8	169.0	44.9%	-0.5	-0.7%
90.0	91.2	3.3	169.1	54.3%	-1.2	-1.3%
102.3	104.1	0.0	169.1	60.5%	-1.8	-1.8%
114.5	118.7	0.1	169.3	67.7%	-4.2	-3.7%
123.8	132.3	0.2	172.3	71.9%	-8.5	-6.9%
133.6	145.0	1.0	181.6	74.0%	-11.4	-8.5%
145.3	157.3	3.3	180.8	81.9%	-12.0	-8.3%
154.2	167.9	2.0	181.4	86.0%	-13.7	-8.9%
165.3	182.3	3.4	182.0	92.6%	-17.0	-10.3%
169.6	188.1	3.4	182.6	94.6%	-18.5	-10.9%

PHOENIX MISSILE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
10.4	9.1	0.0	170.7	6.1%	1.3	12.5%
16.2	15.3	0.0	170.7	9.5%	0.9	5.6%
49.7	47.8	0.0	170.7	29.1%	1.9	3.8%
62.5	62.3	0.0	170.7	36.6%	0.2	0.3%
82.6	82.1	0.0	170.7	48.4%	0.5	0.6%
95.8	97.2	0.0	169.0	56.7%	-1.4	-1.5%
110.3	112.3	0.0	152.1	72.5%	-2.0	-1.8%
120.4	124.9	4.1	152.1	81.4%	-4.5	-3.7%
127.7	134.6	4.1	152.1	86.3%	-6.9	-5.4%

SH-60B SEAHAWK HELICOPTER MULTI PURPOSE SYSTEM ENGINE

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
2.8	2.6	0.0	28.7	9.8%	0.2	7.1%
5.5	5.3	0.0	28.7	19.2%	0.2	3.6%
7.4	7.8	0.0	28.7	25.8%	-0.4	-5.4%
13.1	14.0	0.0	28.7	45.6%	-0.9	-6.9%
15.9	17.4	0.0	28.7	55.4%	-1.5	-9.4%
18.6	20.5	0.0	28.7	64.8%	-1.9	-10.2%
21.8	24.7	0.0	28.8	75.7%	-2.9	-13.3%
24.1	26.5	0.0	28.8	83.7%	-2.4	-10.0%
25.3	27.8	0.0	30.1	84.1%	-2.5	-9.9%
26.5	29.2	0.0	30.4	87.2%	-2.7	-10.2%
27.7	30.7	0.0	30.4	91.1%	-3.0	-10.8%
28.7	32.4	0.0	30.4	94.4%	-3.7	-12.9%
29.7	34.1	0.0	30.4	97.7%	-4.4	-14.8%
30.0	35.0	0.0	30.4	98.7%	-5.0	-16.7%
30.3	38.0	0.0	30.4	99.7%	-7.7	-25.4%

SH-60B SEAHAWK HELICOPTER MULTI PURPOSE SYSTEM AIRFRAME

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
8.7	8.4	14.6	98.4	10.4%	0.3	3.4%
12.6	12.3	13.2	98.5	14.8%	0.3	2.4%
17.5	18.1	11.1	96.0	20.6%	-0.6	-3.4%
22.9	25.0	11.4	98.7	26.2%	-2.1	-9.2%
28.6	32.5	11.4	98.9	32.7%	-3.9	-13.6%
34.8	42.4	13.1	99.8	40.1%	-7.6	-21.8%
44.5	52.4	11.4	101.3	49.5%	-7.9	-17.8%
53.5	63.0	10.2	104.5	56.7%	-9.5	-17.8%
64.1	76.4	6.4	107.4	63.5%	-12.3	-19.2%
70.9	85.4	5.7	107.5	69.6%	-14.5	-20.5%
77.4	93.7	5.0	107.5	75.5%	-16.3	-21.1%
82.8	99.8	3.8	107.5	79.8%	-17.0	-20.5%
87.1	105.5	3.4	107.5	83.7%	-18.4	-21.1%
90.8	108.5	2.6	107.5	86.6%	-17.7	-19.5%
97.6	114.6	1.4	108.8	91.6%	-17.0	-17.4%
100.4	117.3	2.3	109.2	93.9%	-16.9	-16.8%
101.3	119.6	1.7	109.5	94.0%	-18.3	-18.1%

SH-60B SEAHAWK HELICOPTER MULTI PURPOSE SYSTEM SOFTWARE

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
27.7	26.3	0.0	208.0	13.3%	1.4	5.1%
41.6	42.3	0.2	214.1	19.4%	-0.7	-1.7%
60.0	61.2	1.1	210.3	28.7%	-1.2	-2.0%
72.6	76.8	5.4	208.9	35.7%	-4.2	-5.8%
85.6	91.6	5.2	205.7	42.7%	-6.0	-7.0%
97.7	105.2	5.7	206.0	48.8%	-7.5	-7.7%
113.4	121.6	10.7	212.5	56.2%	-8.2	-7.2%
123.1	136.6	7.5	212.3	60.1%	-13.5	-11.0%
136.5	151.4	1.8	212.0	64.9%	-14.9	-10.9%
146.7	163.6	2.4	214.5	69.2%	-16.9	-11.5%
156.4	172.6	1.5	211.5	74.5%	-16.2	-10.4%
167.4	184.3	1.2	213.3	78.9%	-16.9	-10.1%
177.1	195.2	0.9	225.4	78.9%	-18.1	-10.2%
187.9	208.2	0.2	227.4	82.7%	-20.3	-10.8%
197.8	219.7	0.0	227.8	86.8%	-21.9	-11.1%
206.4	230.7	0.0	229.1	90.1%	-24.3	-11.8%
209.7	236.7	0.0	229.1	91.5%	-27.0	-12.9%
215.6	243.0	0.1	229.2	94.1%	-27.4	-12.7%
219.3	248.0	0.0	229.0	95.8%	-28.7	-13.1%
221.0	251.4	0.0	228.4	96.8%	-30.4	-13.8%

SSN-688 ATTACK SUB

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
20.0	20.4	0.0	688.1	2.9%	-0.4	-2.0%
60.0	163.3	0.0	688.1	8.7%	-103.3	-172.2%
150.3	436.1	27.9	708.5	22.1%	-285.8	-190.2%
789.1	798.1	48.7	1708.4	47.5%	-9.0	-1.1%
836.1	867.0	47.3	1709.4	50.3%	-30.9	-3.7%
897.6	944.5	32.1	1709.3	53.5%	-46.9	-5.2%
968.6	1020.6	20.5	1714.6	57.2%	-52.0	-5.4%
1016.4	1091.7	39.4	1735.5	59.9%	-75.3	-7.4%
1090.2	1159.7	25.6	1758.8	62.9%	-69.5	-6.4%
1176.3	1251.4	40.2	1786.8	67.4%	-75.1	-6.4%
1241.8	1340.5	40.3	1816.5	69.9%	-98.7	-7.9%
1308.2	1417.5	35.6	1779.0	75.0%	-109.3	-8.4%
1381.7	1494.2	32.6	1780.9	79.0%	-112.5	-8.1%
1449.1	1562.2	0.0	1772.7	81.7%	-113.1	-7.8%
1496.1	1624.6	0.0	1775.7	84.3%	-128.5	-8.6%
1532.3	1679.3	0.0	1776.7	86.2%	-147.0	-9.6%
1590.6	1730.9	1.5	1794.8	88.7%	-140.3	-8.8%
1630.0	1785.2	0.0	1795.7	90.8%	-155.2	-9.5%
1668.2	1829.1	0.0	1797.5	92.8%	-160.9	-9.6%
1706.9	1871.0	0.0	1798.5	94.9%	-164.1	-9.6%
1737.8	1899.2	0.0	1798.3	96.6%	-151.4	-9.3%

STANDARD MISSILE 2 BLOCK II

SERVICE: SYS TYPE: PHASE: CONTR TYPE::

NAVY	SEA	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
10.9	10.6	2.8	95.8	11.7%	0.3	2.8%
23.1	23.2	2.6	95.8	24.8%	-0.1	-0.4%
30.3	32.0	2.6	95.8	32.5%	-1.7	-5.6%
43.1	45.3	2.2	95.8	46.0%	-2.2	-5.1%
56.2	60.9	2.0	95.8	59.9%	-4.7	-8.4%
65.0	74.7	2.0	95.8	69.3%	-9.7	-14.9%
68.5	82.8	2.0	95.8	73.0%	-14.3	-20.9%
72.5	90.3	2.0	95.8	77.3%	-17.8	-24.6%
78.4	102.2	2.0	95.8	83.6%	-23.8	-30.4%
83.4	113.5	2.0	95.8	88.9%	-30.1	-36.1%
88.2	118.9	2.0	95.8	94.0%	-30.7	-34.8%
88.7	121.8	2.0	95.8	94.6%	-33.1	-37.3%
92.7	126.5	2.0	95.8	98.8%	-33.8	-36.5%
93.7	129.5	2.0	95.8	99.9%	-35.8	-38.2%

STINGER MISSILE FY 85 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
3.2	3.0	0.0	203.6	1.6%	0.2	6.3%
3.8	3.6	28.3	206.3	2.1%	0.2	5.3%
9.2	8.9	16.9	200.2	5.0%	0.3	3.3%
26.6	26.2	9.9	200.2	14.0%	0.4	1.5%
51.4	51.7	7.1	200.6	26.6%	-0.3	-0.6%
68.3	68.4	2.7	201.1	34.4%	-0.1	-0.1%
99.3	104.0	2.8	201.5	50.0%	-4.7	-4.7%
157.7	176.4	4.2	202.9	79.4%	-18.7	-11.9%
176.3	199.7	5.0	202.7	89.2%	-23.4	-13.3%
190.7	207.8	4.5	203.6	95.8%	-17.1	-9.0%

STINGER MISSILE FY 78 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	GROUND	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.2	0.2	0.0	19.4	1.0%	0.0	0.0%
2.0	1.6	2.0	19.4	11.5%	0.4	20.0%
6.9	7.1	1.8	19.4	39.2%	-0.2	-2.9%
10.1	11.3	1.7	19.4	57.1%	-1.2	-11.9%
12.3	14.4	1.7	19.4	69.5%	-2.1	-17.1%
14.5	16.8	1.7	19.6	81.0%	-2.3	-15.9%
15.9	19.1	1.7	19.6	88.8%	-3.2	-20.1%
16.8	20.7	1.5	19.6	92.8%	-3.9	-23.2%
17.2	23.8	1.7	19.7	95.6%	-6.6	-38.4%
17.6	24.6	1.8	19.8	97.8%	-7.0	-39.8%

TOMOHAWK MISSILE ELECTRONICS FY 81 BUY

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
10.3	13.7	0.3	64.4	16.1%	-3.4	-33.0%
18.8	19.1	0.4	63.2	29.9%	-0.3	-1.6%
28.4	29.2	3.2	72.3	41.1%	-0.8	-2.8%
35.9	37.1	3.2	80.5	46.4%	-1.2	-3.3%
41.3	47.2	2.7	83.2	51.3%	-5.9	-14.3%
54.7	57.9	2.4	91.8	61.2%	-3.2	-5.9%
60.0	63.5	2.4	90.0	68.5%	-3.5	-5.8%
65.9	65.9	2.5	97.3	69.5%	0.0	0.0%
97.5	97.2	2.8	102.6	97.7%	0.2	0.3%

TOMOHAWK MISSILE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	SEA	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
11.9	12.6	0.0	73.0	16.3%	-0.7	-5.9%
18.8	19.5	0.0	73.0	25.8%	-0.7	-3.7%
25.9	26.3	0.0	76.7	33.8%	-0.4	-1.5%
33.1	37.5	0.4	91.6	36.3%	-4.4	-13.3%
40.5	46.5	0.7	105.4	38.7%	-6.0	-14.8%
49.1	55.6	1.9	104.0	48.1%	-6.5	-13.2%
54.9	62.1	1.8	99.8	56.0%	-7.2	-13.1%
73.4	79.8	5.1	104.1	74.1%	-6.4	-8.7%
76.3	83.1	4.4	104.4	76.3%	-6.8	-8.9%
83.1	90.2	3.4	103.7	82.9%	-7.1	-8.5%
88.0	95.2	3.8	101.5	90.1%	-7.2	-8.2%
90.0	97.6	3.8	101.5	92.1%	-7.6	-8.4%
90.7	99.2	3.8	102.3	92.1%	-8.5	-9.4%

TRIDENT II D5 MISSILE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
4.2	4.5	4.2	315.7	1.3%	-0.3	-7.1%
7.1	7.8	0.0	315.7	2.2%	-0.7	-9.9%
27.0	30.7	43.6	315.7	9.9%	-3.7	-13.7%
39.8	44.5	41.4	315.7	14.5%	-4.7	-11.8%
50.6	61.5	42.2	321.1	18.1%	-10.9	-21.5%
65.4	81.2	34.8	321.1	22.8%	-15.8	-24.2%
85.7	103.4	35.7	296.5	32.9%	-17.7	-20.7%
105.8	130.5	24.9	298.7	38.6%	-24.7	-23.3%
132.4	152.3	24.3	302.0	47.7%	-29.9	-22.6%
158.7	188.4	19.6	307.0	55.2%	-29.7	-18.7%
173.8	200.8	19.6	306.8	60.5%	-27.0	-15.5%
207.9	227.9	8.3	307.1	69.6%	-20.0	-9.6%
224.2	251.4	2.3	306.4	73.7%	-27.2	-12.1%
250.8	266.1	1.1	307.5	81.9%	-15.3	-6.1%
265.8	282.3	2.0	306.9	87.2%	-16.5	-6.2%
272.3	289.8	1.9	306.9	89.3%	-17.5	-6.4%
278.7	295.2	1.8	306.8	91.4%	-16.5	-5.9%
292.7	310.3	1.7	308.8	95.3%	-17.6	-6.0%
298.7	316.4	1.1	308.7	97.1%	-17.7	-5.9%
304.1	321.5	1.7	308.7	99.1%	-17.4	-5.7%
307.2	324.0	1.0	308.8	99.8%	-16.8	-5.5%
308.8	325.8	0.3	309.0	100.0%	-17.0	-5.5%
309.0	327.4	1.6	308.8	100.6%	-18.4	-6.0%

TRIDENT II D5 MISSILE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
107.0	112.4	11.6	5303.9	2.0%	-5.4	-5.0%
183.3	183.6	11.6	5303.9	3.5%	-0.3	-0.2%
913.6	927.9	362.9	5312.7	18.5%	-14.3	-1.6%
1087.8	1119.1	349.1	5308.8	21.9%	-31.3	-2.9%
1232.2	1291.6	349.1	5307.7	24.8%	-59.4	-4.8%
1432.6	1475.5	339.7	5296.3	28.9%	-42.9	-3.0%
1584.9	1635.7	273.7	5296.5	31.6%	-50.8	-3.2%
1912.8	2017.8	297.0	5296.9	38.3%	-105.0	-5.5%
2172.8	2338.8	314.9	5312.3	43.5%	-166.0	-7.6%
2387.7	2555.6	305.3	5313.5	47.7%	-167.9	-7.0%
2350.6	2539.1	306.8	5323.8	46.9%	-188.5	-8.0%
2484.7	2676.2	389.2	5340.7	50.2%	-191.5	-7.7%
2625.5	2838.6	397.9	5377.9	52.7%	-213.1	-8.1%
2833.8	3063.7	320.1	5377.7	56.0%	-229.9	-8.1%
3029.9	3280.6	325.7	5382.4	59.9%	-250.7	-8.3%
3302.8	3581.3	307.3	5398.5	64.9%	-278.5	-8.4%
3439.0	3750.5	399.7	5347.1	69.5%	-311.5	-9.1%
3641.5	3983.6	446.5	5350.5	74.3%	-342.1	-9.4%
3990.2	4374.7	454.6	5359.0	81.4%	-384.5	-9.6%
4186.1	4580.4	614.7	5363.5	88.2%	-394.3	-9.4%
4360.6	4786.3	618.3	5369.4	91.8%	-425.7	-9.8%
4487.2	4949.3	617.2	5368.9	94.4%	-462.1	-10.3%
4603.9	5111.8	615.4	5372.2	96.8%	-501.9	-11.0%
4743.1	5233.7	603.2	5373.2	99.4%	-41.6	-10.3%
4777.9	5268.1	603.6	5373.6	100.2%	-1.2	-10.3%
4806.3	5299.2	564.7	5372.1	100.0%	-492.9	-10.3%

TRIDENT II D5 MISSILE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
237.3	256.1	120.7	1478.3	17.5%	-18.8	-7.9%
290.1	300.2	116.1	1481.6	21.2%	-10.1	-3.5%
374.9	385.9	112.6	1497.6	27.1%	-11.0	-2.9%
422.0	441.0	119.0	1446.5	31.8%	-19.0	-4.5%
518.5	554.3	119.0	1448.4	39.0%	-35.8	-6.9%
723.5	774.0	120.1	1451.5	54.5%	-50.5	-7.0%
850.8	907.5	226.0	1454.2	69.3%	-56.7	-6.7%
970.9	1051.3	225.7	1458.9	78.7%	-80.4	-8.3%
1083.1	1186.1	226.1	1486.5	85.9%	-103.0	-9.5%
1157.3	1283.5	225.0	1490.4	91.5%	-126.2	-10.9%
1260.1	1371.2	201.8	1490.4	97.8%	-111.1	-8.8%
1278.5	1388.2	202.0	1490.8	99.2%	-109.7	-8.6%
1293.3	1389.0	156.2	1490.3	96.9%	-95.7	-7.4%

TRIDENT II D5 MISSILE ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

NAVY	AIR	PROD	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
7.7	7.0	0.0	354.0	2.2%	0.7	9.1%
18.5	18.4	0.0	354.0	5.2%	0.1	0.5%
69.6	78.3	10.6	363.3	19.7%	-8.7	-12.5%
86.4	97.7	19.1	369.9	24.6%	-11.3	-13.1%
105.3	121.7	19.0	379.9	29.2%	-16.4	-15.6%
134.4	147.7	18.4	380.8	37.1%	-13.3	-9.9%
149.4	160.7	15.0	381.0	40.8%	-11.3	-7.6%
170.3	181.2	18.0	394.8	45.2%	-10.9	-6.4%
199.4	210.5	17.0	400.6	52.0%	-11.1	-5.6%
224.4	235.3	11.1	400.8	57.6%	-10.9	-4.9%
238.1	249.8	10.3	404.1	60.5%	-11.7	-4.9%
259.2	277.0	10.0	406.1	65.4%	-17.8	-6.9%
288.0	312.2	11.2	410.0	72.2%	-24.2	-8.4%
310.2	338.1	10.0	418.4	76.0%	-27.9	-9.0%
330.9	362.4	12.5	418.9	81.4%	-31.5	-9.5%
340.3	370.6	12.7	427.4	82.1%	-30.3	-8.9%
354.4	387.2	12.9	429.7	85.0%	-32.8	-9.3%
371.3	407.9	14.7	428.7	89.7%	-36.6	-9.9%
382.0	419.2	17.3	428.2	93.0%	-37.2	-9.7%
391.4	424.4	18.6	430.2	95.1%	-33.0	-8.4%
395.2	428.4	17.4	427.8	96.3%	-33.2	-8.4%

UH-60 BLACKHAWK HELICOPTER AIRFRAME LOT IV

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.1	0.1	0.0	233.9	0.0%	0.0	0.0%
0.6	0.5	18.7	233.9	0.3%	0.1	16.7%
1.6	1.6	27.8	233.9	0.8%	0.0	0.0%
8.1	6.6	22.4	233.8	3.8%	1.5	18.5%
17.6	17.4	11.4	233.8	7.9%	0.2	1.1%
50.8	51.5	13.8	233.8	23.1%	-0.7	-1.4%
91.8	93.0	11.3	236.2	40.8%	-1.2	-1.3%
144.0	160.2	9.8	237.0	63.4%	-16.2	-11.2%
204.9	221.5	0.4	237.0	86.6%	-16.6	-8.1%
225.0	236.7	1.8	237.0	95.7%	-11.7	-5.2%

UH-60 BLACKHAWK HELICOPTER AIRFRAME LOT III

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.5	0.5	6.8	198.9	0.3%	0.0	0.0%
3.1	2.5	23.9	199.4	1.8%	0.6	19.4%
11.1	11.1	51.7	212.7	6.9%	0.0	0.0%
32.8	34.1	18.8	212.7	16.9%	-1.3	-4.0%
57.5	67.3	15.3	212.7	29.1%	-9.8	-17.0%
109.4	133.6	7.2	212.7	53.2%	-24.2	-22.1%
147.5	185.8	1.6	212.7	69.9%	-38.3	-26.0%
180.1	227.9	2.6	212.7	85.7%	-47.8	-26.5%
192.1	235.2	3.8	212.7	92.0%	-43.1	-22.4%

UH-60 BLACKHAWK HELICOPTER AIRFRAME LOT II

SERVICE: SYS TYPE: PHASE: CONTR TYPE: BASELINE:

BCWP	ACWP	MR	CBB	%COMP	CV	CV%
1.2	1.2	14.9	117.3	1.2%	0.0	0.0%
4.3	4.6	16.1	118.4	4.2%	-0.3	-7.0%
15.6	17.0	0.0	118.4	13.2%	-1.4	-9.0%
41.7	56.6	14.1	129.8	36.0%	-14.9	-35.7%
62.2	91.4	5.5	135.2	48.0%	-29.2	-46.9%
86.2	125.3	5.9	135.2	66.7%	-39.1	-45.4%
104.2	150.3	6.5	135.4	80.9%	-46.1	-44.2%
115.8	163.3	5.8	135.4	89.4%	-47.5	-41.0%
121.1	166.2	7.4	135.8	94.3%	-45.1	-37.2%
122.7	165.5	6.8	135.6	95.3%	-42.8	-34.9%

UH-60 BLACKHAWK HELICOPTER ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	DEV				
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
1.9	2.0	0.9	15.6	12.9%	-0.1	-5.3%
5.9	6.3	1.1	15.6	40.7%	-0.4	-6.8%
9.0	10.2	1.6	15.6	64.3%	-1.2	-13.3%
11.3	12.5	1.8	15.6	81.9%	-1.2	-10.6%
12.7	13.8	1.4	15.6	89.4%	-1.1	-8.7%
13.3	14.8	1.6	15.7	94.3%	-1.5	-11.3%
14.0	15.4	1.0	15.8	94.6%	-1.4	-10.0%
14.2	15.8	1.2	16.2	94.7%	-1.6	-11.3%
14.7	16.0	1.3	16.2	98.7%	-1.3	-8.8%
14.9	16.1	1.3	16.2	100.0%	-1.2	-8.1%

UH-60 BLACKHAWK HELICOPTER ELECTRONICS

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
1.1	1.2	3.3	43.0	2.8%	-0.1	-9.1%
4.7	5.1	2.9	43.3	11.6%	-0.4	-8.5%
7.9	10.1	3.5	43.3	19.8%	-2.2	-27.8%
13.2	16.5	2.4	43.3	32.3%	-3.3	-25.0%
19.9	24.3	1.1	43.3	47.2%	-4.4	-22.1%
25.9	32.9	1.3	43.4	61.5%	-7.0	-27.0%
31.1	40.3	0.9	43.4	73.2%	-9.2	-29.6%
34.0	47.3	0.9	44.2	78.5%	-13.3	-39.1%
35.9	50.9	1.3	45.1	82.0%	-15.0	-41.8%
40.8	55.6	0.9	45.1	92.3%	-14.8	-36.3%
41.9	58.0	1.0	45.2	94.8%	-16.1	-38.4%
42.7	60.4	1.0	45.2	96.6%	-17.7	-41.5%

UH-60 BLACKHAWK HELICOPTER ENGINE LOT II

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.6	0.5	1.6	64.9	0.9%	0.1	16.7%
1.7	1.5	1.6	64.9	2.7%	0.2	11.8%
2.9	2.7	0.5	64.9	4.5%	0.2	6.9%
4.3	4.3	0.5	64.9	6.7%	0.0	0.0%
8.6	8.5	0.1	64.9	13.3%	0.1	1.2%
19.0	20.2	0.2	64.9	29.4%	-1.2	-6.3%
31.0	35.5	0.0	64.9	47.8%	-4.5	-14.5%
48.4	53.4	0.0	65.0	74.5%	-5.0	-10.3%
59.4	64.7	0.0	65.0	91.4%	-5.3	-8.9%
63.0	69.6	0.0	65.0	96.9%	-6.6	-10.5%

UH-60 BLACKHAWK HELICOPTER ENGINE LOT I

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.7	0.7	1.5	31.7	2.3%	0.0	0.0%
2.1	1.8	1.5	31.7	7.0%	0.3	14.3%
4.0	3.9	0.4	31.7	12.8%	0.1	2.5%
6.6	6.7	0.3	31.7	21.0%	-0.1	-1.5%
13.9	14.6	0.2	32.5	43.0%	-0.7	-5.0%
21.6	22.6	0.1	32.5	66.7%	-1.0	-4.6%
25.2	26.4	0.1	32.5	77.8%	-1.2	-4.8%
29.8	30.2	0.0	32.6	91.4%	-0.4	-1.3%
30.9	31.2	0.0	32.6	94.8%	-0.3	-1.0%
32.0	31.6	0.0	32.6	98.2%	0.4	1.2%

UH-60 BLACKHAWK HELICOPTER AIRFRAME LOT I

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	PROD	FP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
0.4	0.3	7.2	75.7	0.6%	0.1	25.0%
1.9	1.6	6.0	75.7	2.7%	0.3	15.8%
4.4	4.5	7.4	75.7	6.4%	-0.1	-2.3%
10.2	10.6	7.3	75.7	14.9%	-0.4	-3.9%
19.7	20.4	4.2	75.6	27.6%	-0.7	-3.6%
29.4	33.6	4.2	75.4	41.3%	-4.2	-14.3%
39.0	49.5	1.9	75.9	52.7%	-10.5	-26.9%
48.5	61.7	3.5	76.4	66.5%	-13.2	-27.2%
56.7	73.5	0.4	76.4	74.6%	-16.8	-29.6%
66.0	89.9	1.7	76.4	88.4%	-23.9	-36.2%
70.6	95.5	0.7	75.9	93.9%	-24.9	-35.3%

UH-60 BLACKHAWK HELICOPTER AIRFRAME

SERVICE: SYS TYPE: PHASE: CONTR TYPE:

ARMY	AIR	DEV	CP			
BCWP	ACWP	MR	CBB	%COMP	CV	CV%
3.1	3.2	4.2	58.6	5.7%	-0.1	-3.2%
10.6	11.4	4.0	58.9	19.3%	-0.8	-7.5%
16.8	20.3	5.1	58.9	31.2%	-3.5	-20.8%
24.5	29.0	4.2	58.9	44.8%	-4.5	-18.4%
32.6	38.1	2.5	58.9	57.8%	-5.5	-16.9%
39.2	46.7	2.9	59.1	69.8%	-7.5	-19.1%
44.7	55.6	1.9	59.2	78.0%	-10.9	-24.4%
46.7	60.1	2.4	60.4	80.5%	-13.4	-28.7%
50.6	66.9	2.6	61.3	86.2%	-16.3	-32.2%
56.8	74.2	2.3	61.4	96.1%	-17.4	-30.6%

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Vita

Captain Brian D. Wilson was born on 2 January 1962 in Norman Oklahoma. He graduated from Norman High School and attended the University of Oklahoma, graduating with a Bachelor of Science in Accounting in May 1986. He received his commission in the USAF through the Officer Training School in October 1986 and was assigned to Aeronautical Systems Division at Wright-Patterson AFB, Ohio. His first assignment was as a cost analyst in the Aeronautical Equipment System Program Office (SPO). His next two assignments were as the lead Research and Development Cost Analysis Officer for the Advanced Tactical Aircraft and Financial Manager for the Electronic Combat and Reconnaissance SPO. Upon completion of these assignments he entered the School of Systems and Logistics, Air Force Institute of Technology, in May 1991.

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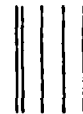
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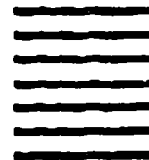
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