(2)

IDA PAPER P-2613

# CONSIDERATIONS IN A COMPREHENSIVE TOTAL FORCE COST ESTIMATE



James L. Wilson, *Project Leader*
Waynard C. Devers
Thomas P. Frazier
Matthew S. Goldberg
Stanley A. Horowitz
John J. Kane



November 1992

*Prepared for*
Office of the Assistant Secretary of Defense
(Force Management and Personnel)



IDA
INSTITUTE FOR DEFENSE ANALYSES
1801 N. Beauregard Street, Alexandria, Virginia 22311-1772

## DEFINITIONS

IDA publishes the following documents to report the results of its work.

### Reports

Reports are the most authoritative and most carefully considered products IDA publishes. They normally embody results of major projects which (a) have a direct bearing on decisions affecting major programs, (b) address issues of significant concern to the Executive Branch, the Congress and/or the public, or (c) address issues that have significant economic implications. IDA Reports are reviewed by outside panels of experts to ensure their high quality and relevance to the problems studied, and they are released by the President of IDA.

### Group Reports

Group Reports record the findings and results of IDA established working groups and panels composed of senior individuals addressing major issues which otherwise would be the subject of an IDA Report. IDA Group Reports are reviewed by the senior individuals responsible for the project and others as selected by IDA to ensure their high quality and relevance to the problems studied, and are released by the President of IDA.

### Papers

Papers, also authoritative and carefully considered products of IDA, address studies that are narrower in scope than those covered in Reports. IDA Papers are reviewed to ensure that they meet the high standards expected of refereed papers in professional journals or formal Agency reports.

### Documents

IDA Documents are used for the convenience of the sponsors or the analysts (a) to record substantive work done in quick reaction studies, (b) to record the proceedings of conferences and meetings, (c) to make available preliminary and tentative results of analyses, (d) to record data developed in the course of an investigation, or (e) to forward information that is essentially unanalyzed and unevaluated. The review of IDA Documents is suited to their content and intended use.

The work reported in this document was conducted under contract MDA 903 89 C 0003 for the Department of Defense. The publication of this IDA document does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

This Paper has been reviewed by IDA to assure that it meets high standards of thoroughness, objectivity, and appropriate analytical methodology and that the results, conclusions and recommendations are properly supported by the material presented.

UNCLASSIFIED

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | November 1992 | Final Report, Mar 1990 - Nov 1992 |

**4. TITLE AND SUBTITLE**
Considerations in a Comprehensive Total Force Cost Estimate

**5. FUNDING NUMBERS**
C-MDA-903-89C-0003
T-L7-795

**6. AUTHOR(S)**
James L. Wilson, Waynard C. Devers, Thomas P. Frazier,
Matthew S. Goldberg, Stanley A. Horowitz, and John J. Kane

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Institute for Defense Analyses
1801 N. Beauregard Street
Alexandria, VA 22311-1772

**8. PERFORMING ORGANIZATION REPORT NUMBER**
IDA-P-2613

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
ASD(FM&P)
Room 3E764, Pentagon
Washington, DC 20301

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

**12A. DISTRIBUTION/AVAILABILITY STATEMENT**
Approved for public release; distribution unlimited.

**12B. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

The Department of Defense Total Force Policy Study Group was convened to review the practices used to evaluate and establish Total Force policies. Part of the group's work was to identify appropriate methods for estimating costs of alternative force structures, especially those with different mixes of active and reserve components. This study developed and applied a framework for estimating the full cost effects of policy decisions that involve changes in the size and composition of U.S. forces. This framework considers the full range of direct and indirect costs and describes procedures for making consistent estimates of force costs in any service or component. The study goes beyond the traditional focus on peacetime unit operating cost by including the capital costs associated with changes in force size, secondary impacts on direct support programs, and the cost effects of force changes on defense infrastructure activities. The paper also categorizes and identifies one-time costs that have an impact on the net total cost of alternative policies and that must be considered when transitioning from one force structure to another. By applying the recommended framework to examples from each service, the study demonstrates that the relative costs of active and reserve component units vary significantly for a variety of reasons.

**14. SUBJECT TERMS**
Cost Estimates, Military Forces, Total Force, Costs

**15. NUMBER OF PAGES**
74

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| Unclassified | Unclassified | Unclassified | SAR |

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

UNCLASSIFIED

IDA PAPER P-2613

# CONSIDERATIONS IN A COMPREHENSIVE TOTAL FORCE COST ESTIMATE

James L. Wilson, *Project Leader*
Waynard C. Devers
Thomas P. Frazier
Matthew S. Goldberg
Stanley A. Horowitz
John J. Kane

November 1992



INSTITUTE FOR DEFENSE ANALYSES
Contract MDA 903 89 C 0003
Task T-L7-795

# PREFACE

This paper was prepared by the Institute for Defense Analyses (IDA) for the Office of the Assistant Secretary of Defense (Force Management and Personnel), under contract MDA 903 89 C 0003, Task Order T-L7-795, issued 5 March 1990. The objective of the task was to develop a comprehensive cost estimating framework that can be applied to all services and components to estimate the cost effects of a wide range of defense force structures, especially those with alternative mixes of active and reserve units.

This work was reviewed within IDA by Paul F. Goree and Timothy J. Graves, and by Frank L. McDonald of the Office of the Assistant Secretary of Defense (Program Analysis and Evaluation).

# ACKNOWLEDGMENTS

This report summarizes the work of many IDA and Department of Defense personnel who worked on the Total Force Policy study team. Contributions were made by Col. Garret Mahsman (USAFR), Col. Dick Combs (USMC), Cmdr. Don Beech (USN), Lt.Col. Jack Sova (USA), Capt. Tadd Wilson (USMC), Mr. Bill Wallenhorst (USMC) and others. Paul Goree of IDA went far beyond the contribution of most reviewers and deserves special credit for the final form of the report. Andrea Zimmet spent many hours preparing the manuscript and incorporating innumerable changes.

# CONTENTS

## FIGURES



## TABLES

# I. INTRODUCTION

## A. OVERVIEW

Total force policy analyses consider a wide range of alternative force structures with different total force sizes and varying mixes of active and reserve forces. Each alternative structure has its own costs, capabilities, and risks. Alternatives with very low military risk are generally unaffordable while the lowest cost alternatives often have unacceptable risks. Policy makers trade military risks and the costs of owning and operating a given force mix to obtain a force with an acceptable level of risk within cost constraints that are often externally imposed. When alternatives include different mixes of active and reserve forces, the estimating procedures used must provide consistent and balanced comparisons of the total cost impacts. When changes to the size of the total force are being analyzed, a broad range of costs must be considered.

Decisions on force composition affect a large portion of the defense budget. For this reason, force cost estimates must not underestimate the impacts of force structure changes by considering only a subset of the total cost of owning, operating, and supporting the primary force elements. It is equally important that cost estimates be based only on those defense costs that are affected by force structure decisions. To make informed trade-offs between the many force mixes, the Department of Defense (DoD) requires a complete framework for estimating the costs of alternative force configurations, especially those with varying mixes of active and reserve forces. This study defines and applies a framework that meets these objectives and identifies methods and databases that can be used to provide complete and consistent force cost estimates.

A broad perspective of defense program costs includes the direct and indirect costs of owning, operating, and supporting forces and recognizes there are both short- and long-term effects on defense funding. Estimating techniques that focus only on direct, recurring operating costs can understate the total cost impacts of major force structure changes, especially when changes in the size of the total force are being considered. When changes in defense force structure are considered, the effects on military pay and on the operating costs of primary force elements (e.g., divisions, regiments, wings, and naval combatants)

are nearly immediate. Inappropriately, these costs are sometimes the only ones considered, giving an incomplete picture of the funding implications of alternative force structures. Changes to the primary force elements can also effect other units and programs that directly support those elements. Likewise, force structure changes can influence defense infrastructure costs and spending needed to replace the inventory of defense systems. Significant, one-time ("nonrecurring") costs can also be incurred during the transition to a new structure. All of these potential cost impacts must be considered in Total Force policy deliberations.

A balanced approach to force costing also recognizes that some portions of defense program funding do not necessarily change with force size or mix. The framework described in this report segregates portions of the defense budget that can be expected to change if force size or mix change from those which vary as a result of other policy choices. For example, funding for national command and control and foreign intelligence programs may not change even if the size of the total force is reduced or if the active-reserve mix is changed. In general, funding for major research, development, test, and evaluation (RDT&E) and the science and technology program are driven by threat estimates, technology issues, and even fiscal limitations, but not directly by the size of the force that ultimately will be modernized. For example, the need to develop a next-generation tactical fighter does not diminish if the size of the fighter force is reduced, nor does the need to deploy an improved attack submarine necessarily reflect the number of submarines in the Navy inventory. Similarly, policy decisions that affect funding for military space programs, national intelligence programs, and foreign aid are not closely related to force size. Force-costing methodologies should not link the costs of these programs to Total Force policy decisions as an automatic consequence of force structure changes. For these and other reasons, it would be incorrect to assume that all defense costs are variable with force size. Viewed from another perspective, defense policy embraces more than force size. Only when changes occur in these other dimensions of policy are the costs of the programs that support those policies affected.

Figure 1 illustrates one way to conceptualize the defense funding perspective discussed above. The defense program shown consists of three major components: force structure programs, non-force-related programs, and infrastructure programs which support many defense activities. Force structure programs consist of those programs referred to as primary mission elements (e.g., divisions, air wings, etc.) and those that provide direct support to primary forces (e.g., mission-specific command, control,

communications, etc.). Infrastructure programs are those programs that provide services and support to a broad cross-section of service activities rather than to a specific, identifiable set of customers. Non-force related programs are those programs whose composition and funding are not generally affected by the size or mix of the primary forces (e.g., national-level command, control, and intelligence programs).

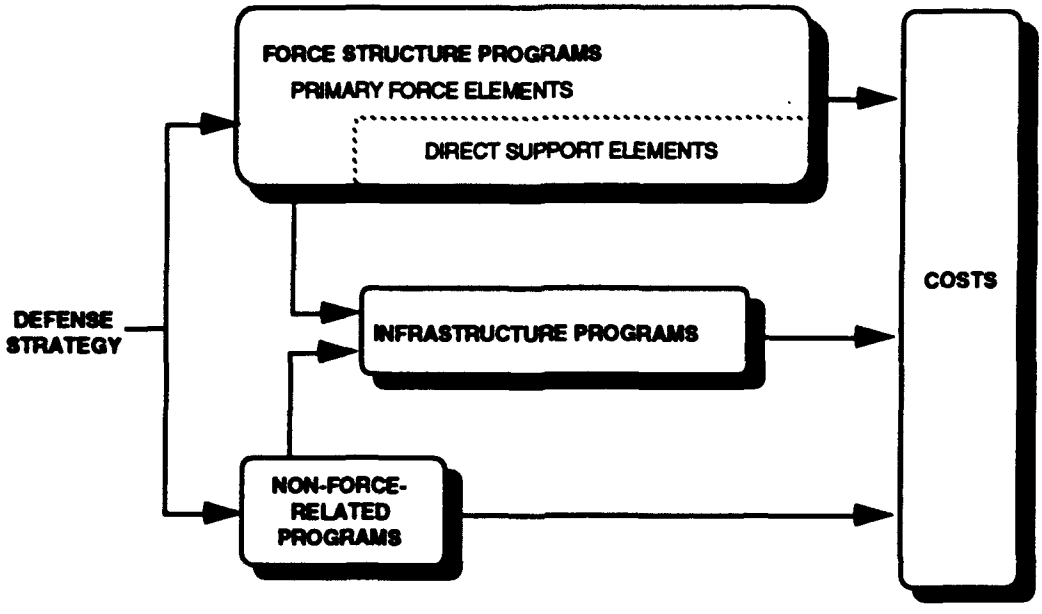


**Figure 1. Total Force Cost Framework**

Total force policy alternatives focus on changes to force structure programs that consist of primary force elements and direct support elements. The cumulative effects of changes in primary force and direct support elements impact infrastructure costs. Non-force-related programs do not change automatically with force size and mix, but form a portion of the defense program base to which infrastructure costs are allocated.

Force structure program costs, often referred to as "unit costs," are discussed in Section II and III. Direct support elements are defined and addressed more fully in Section IV. In Section V, infrastructure programs and an approach for estimating their cost relationship with force programs are discussed.

The importance of considering more than just the pay and operating costs of units affected by changes in force structure is illustrated in Table 1. In the 1980s, for example, the operating and support (O&S) costs of primary defense missions accounted for only 23

percent of the budgets of the military departments. Cost estimates that consider only these expenses will understate the total, long-term cost effects of changes in total force size. Investment programs supporting force structure programs provide for the replacement and modernization of military equipment and made up 28 percent of the defense budget during the 1980s. Since the quantity of equipment purchased over the long term is related to the size of the total force, impacts on investment costs should be considered when changes in force size are evaluated. Infrastructure costs constituted 35 percent of defense spending over the past decade. While these costs are made up of both fixed and variable components, the variable portion is significant and should be considered in total force costing.

**Table 1. Composition of Defense Spending in the 1980s**

| | Average Spending 1980s (FY91$B) | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Marines | Air Force | DoD |
| **Force Structure Programs** | | | | | |
| O&S | | | | | |
| Primary Forces | 20,070 | 15,512 | 4,007 | 13,757 | 53,346 |
| Direct Support | 2,958 | 7,407 | 481 | 5,207 | 16,053 |
| | 23,028 | 22,919 | 4,488 | 18,965 | 69,400 |
| | *28%* | *24%* | *33%* | *18%* | *23%* |
| Investment | | | | | |
| Primary Forces | 13,508 | 23,769 | 3,085 | 23,832 | 64,194 |
| Direct Support | 4,033 | 8,996 | 1,376 | 5,421 | 19,826 |
| | 17,542 | 32,765 | 4,460 | 29,253 | 84,020 |
| | *21%* | *35%* | *33%* | *28%* | *28%* |
| **Infrastructure Programs** | | | | | |
| Investment | 3,518 | 2,732 | 504 | 3,533 | 10,287 |
| O&S | 32,797 | 26,417 | 3,937 | 30,685 | 93,837 |
| | 36,316 | 29,149 | 4,441 | 34,218 | 104,124 |
| | *44%* | *31%* | *33%* | *32%* | *35%* |
| **Non-Force-Related Programs** | | | | | |
| Investment | 5,063 | 8,766 | 155 | 20,933 | 34,916 |
| O&S | 1,305 | 831 | 34 | 2,953 | 5,123 |
| | 6,368 | 9,597 | 189 | 23,886 | 40,039 |
| | *8%* | *10%* | *1%* | *22%* | *13%* |
| SERVICE TOTAL | 83,253 | 94,430 | 13,579 | 106,321 | 297,583 |

The data in Table 1 are based on actual service expenditures from 1980 to 1989. Force structure programs are defined as the programs in major force programs (MFPs) 1, 2, 4, 5, and 11, except for activities that provide for the operation of bases and headquarters. Infrastructure programs are from MFPs 7, 8, and 9, together with operating costs of bases and headquarters. Funding in the non-force-related category is for national-level command, control, communications, and intelligence programs; space activities; aid to foreign nations (MFP 10); and major RDT&E programs (MFP 6).

## B. STEPS IN TOTAL FORCE COSTING

Policy-level force structure decisions tend to focus on primary defense mission components such as divisions, wings, and naval combatants. For this reason, total force costing begins with the estimation of the costs directly related to those elements. These expenses, referred to as "direct unit costs," include the compensation of unit personnel, the day-to-day operating costs of units, and the long-term recurring investments required to replace unit equipment.

Changes in the size of primary force elements can have secondary effects on spending for other programs, such as war reserve procurement, training activities, and deployable support. These "direct support costs" must be examined on a program-by-program basis because their relationship to the total force is highly scenario-dependent. Their budgetary impacts can be properly assessed only after all changes in primary force elements are identified and must be based on knowledge of how the current funding level for these programs relate to force size.

Major changes in force size or mix affect the size and cost of the defense infrastructure. An approximation of the effect on these costs can be based on the observation that, historically, the size of the DoD infrastructure program has varied with the funding for the personnel and day-to-day operation of force structure programs. Estimates of changes in infrastructure funding can therefore be projected based on changes in the pay and day-to-day operating portions of affected units.

As a final step in estimating the costs of any significant force change, the one-time costs that arise in implementing changes in force structure need to be identified and estimated. Unit activations, deactivations, and transfers between active and reserve forces can run into the hundreds of millions of dollars, potentially overshadowing the savings that will occur for many years.

Because of the variety of cost relationships associated with defense funding, our framework for total force cost estimation considers four types of costs: direct unit costs, direct support costs, infrastructure costs, and transition costs. These cost categories are summarized as follows:

- Direct Unit Costs. Funding for personnel compensation, for the day-to-day operation of force structure units, and for the replacement of equipment in units that are primary force elements (e.g., ground divisions and battalions, including their deploying support forces; air wings and squadrons; and naval combatants).
- Direct Support Costs. Funding for programs and units that provide war reserve materiel (WRM) and non-centrally managed support benefiting specific portions of primary force elements (e.g., weapon system qualification training, tactical training, deployable mission command and control elements, and deployable material-handling units).
- Infrastructure Costs. Funding for activities that benefit multiple primary force structure units, including installation operations, headquarters, and centrally managed support activities.
- Transition Costs. One-time expenses associated with equipment, facilities, and personnel required to implement a force structure change.

The sections that follow discuss the methods used to calculate costs in each category and shows how expenditures are affected by changes in force mix and size.

# II. DIRECT UNIT COST METHODOLOGY

## A. OVERVIEW

Direct unit costs are the fiscal resources required to own and operate primary force elements in peacetime and are closely associated with the size and activities of these elements. The units of primary interest are the divisions/battalions, wings/squadrons, naval combatants, and Marine forces that are the primary focus of Total Force policy decisions. (Units that deploy with combat forces such as nondivisional combat and tactical support forces associated with Army combat divisions and Marine Force Service Support Group (FSSG) elements are considered to be part of force structure in the estimation of direct unit costs.) The calculations take into account the costs of personnel assigned to units, the day-to-day expenses of operating the forces, and the long-term average costs of replacing and upgrading unit equipment. Direct unit costs are driven by manning, equipping, and training policies (i.e., operating tempos) of individual units. Differences in these "cost drivers" explain the major differences in direct unit costs of active and reserve components. Unit operating tempos and manning decisions are affected by a combination of desired readiness levels, the experience level of unit personnel, and the nature of the equipment used by the unit.

Consistency in cost comparisons is important but often difficult to achieve, given the multiplicity of data-gathering systems and models in use throughout the DoD. The first step in attaining some degree of uniformity is to establish a common set of cost elements to be considered, keeping in mind that all elements are not relevant to all kinds of units. Table 2 shows the basic cost elements that should be included in unit costing. These cost elements are those that are typically included within the DoD's program budgets for specific units. There are alternative ways to group and combine the details of any estimating structure. The hierarchy of the structure is not nearly as important as the totality of its contents. Estimating structures are affected by how organizations account for resources and, unfortunately, how data are collected and made available for estimating. As these administrative mechanisms evolve, so will the details of the estimating format. The following subsections discuss the three major components of unit costs: manpower, operating, and equipment-related costs.

## B. MANPOWER COSTS

Unit manpower costs are calculated based on individual pay, allowances, and the accrual value of retirement pay. The cost calculations cover all full-time and part-time military members and all civilian personnel who are assigned to units. Often, current actual manning is less than a unit's fully authorized wartime manning level. Personnel costs should be estimated on the basis of current and planned manning policies, reflecting the personnel resource levels that will actually drive budgeted costs rather than on authorized unit manning levels.

**Table 2. Elements of Direct Unit Costs**

| |
|---|
| Manpower Costs |
| Pays and allowances |
| Accrual for retirement pay |
| Operating Costs |
| Fuel and other POL (petroleum, oil, and lubricants) |
| Replenishment parts (organization and intermediate maintenance) |
| Consumable parts and supplies (organization and intermediate maintenance) |
| Other sources of intermediate maintenance |
| Other unit training costs |
| Unit-funded transportation to training |
| Consumables such as ammunition and tactical missiles |
| Unit-funded contract services |
| Equipment-Related Costs |
| Replacement of mission equipment |
| Major overhauls of primary mission equipment funded on a unit basis |
| Modifications |
| Replacement of support equipment |

Total compensation costs include amounts set aside for the annuities that military members receive when they retire. Accrual rates differ for full-time active or reserve personnel and part-time reservists. Currently, full-time personnel accrue retirement pay at the rate of 43.9 percent of basic pay and part-time reserve personnel at the rate of 13.4 percent. This differential will gradually change as the new military retirement laws affect larger proportions of military members. The rates are projected to stabilize at 36.6 percent and 12.0 percent, respectively, for active and reserve personnel.

Total manpower costs are generally less for reserve units than for active units because the annual number of paid duty days is significantly higher in most active units.

There are at least three interacting conditions that affect the relative compensation costs of active and reserve personnel. Reserve units generally have a large proportion of their personnel serving in a part-time capacity, and those in a part-time status receive proportionally smaller direct compensation. Furthermore, reserve personnel accrue a smaller percentage of their base pay for retirement. Offsetting these two factors is the tendency for reserve component units to have a higher experience level and therefore higher compensation costs per day of duty. Service members with more years of service are paid at a higher rate than those of identical rank with less service. Table 3 shows the percentage of senior enlisted and officer personnel in each service and component as well as the average years of service. These data support the general notion that a day's pay for reserve personnel may be higher than for comparable active duty personnel.

**Table 3. FY 1990 Manpower Longevity Data**

| | Enlisted | | Officers | | Component Total |
|---|---|---|---|---|---|
| | E5-E9 | Average Years Service | O4-O6 | Average Years Service | Average Years Service |
| Army | 44% | 6.5 | 36% | 9.7 | 6.9 |
| Army Reserve | 40% | 8.0 | 44% | 13.9 | 8.9 |
| Army National Guard | 48% | 9.2 | 28% | 12.5 | 9.5 |
| Navy | 47% | 6.4 | 37% | 8.8 | 6.7 |
| Navy Reserve | 52% | 8.6 | 60% | 14.3 | 9.8 |
| Marine Corps | 31% | 5.9 | 30% | 10.2 | 6.3 |
| Marine Corps Reserve | 24% | 5.1 | 52% | 15.6 | 5.8 |
| Air Force | 51% | 8.1 | 36% | 9.7 | 8.4 |
| Air Force Reserve | 78% | 11.3 | 53% | 15.0 | 11.8 |
| Air National Guard | 35% | 12.0 | 54% | 15.9 | 12.5 |

Source: *Manpower Requirements Report*, FY1992, February 1991.

To demonstrate how these three factors interact, a hypothetical example is shown in Table 4. This table shows that the use of part-time manning, even when only a small fraction of the total, offsets higher average pay rates for reservists. In the example, the average total compensation of five notional units, with a range of part-time manning from zero to 100 percent, is calculated based on the current accrual rates and an assumed 10 percent premium for higher reserve component base pay rates. Algebraically, it can be shown that the effect of the different accrual rates dominates base pay differences until the pay difference exceeds 25 percent. (When the new accrual rates are fully realized, the

margin will drop to 20 percent.) While there may be specific instances where this could occur, it is unlikely to be a situation that is frequently encountered. The most significant influence on reserve versus active unit manpower costs is the amount of part-time manning.

**Table 4. Effects of Compensation Differences on Average Personnel Costs**

| % Unit Full-Time: | 100% | 75% | 50% | 25% | 0% |
|---|---|---|---|---|---|
| % Unit Part-Time: | 0% | 25% | 50% | 75% | 100% |
| Average Base Pay | | | | | |
| Full-Timers | $30,000 | $22,500 | $15,000 | $7,500 | $0 |
| Part-Timers | 0 | 1,650 | 3,300 | 4,950 | 6,600 |
| Subtotal | $30,000 | $24,150 | $18,300 | $12,450 | $6,600 |
| Average Accrual | | | | | |
| Full-Timers | $13,170 | $9,878 | $6,585 | $3,293 | $0 |
| Part-Timers | 0 | 221 | 442 | 663 | 884 |
| Subtotal | $13,174 | $10,099 | $7,027 | $3,956 | $884 |
| Average Total Comp | $43,170 | $34,249 | $25,327 | $16,406 | $7,484 |

Assumptions: Days per year part-timer vs. full-timer=20%; pay per duty day part-timer = 110%.
Average annual base pay = $30,000, full-time (44% accrual rate); $6,600, part-time (13% accrual rate).

Table 4 shows that the proportion of part-time manning has a major effect on the relative compensation costs of active and reserve units. It would always be less expensive to have a high proportion of part-time personnel. However, the operational characteristics of some types of reserve units limit the extent to which part-time manning can be used and/or operating tempos can be reduced. Safe peacetime operation of complex weapon systems can require relatively high operating tempos, which lead to high levels of full-time manning in these reserve units. For example, the technical complexity of aviation units limits the extent to which manning levels and operating tempos in reserve aviation squadrons can be reduced below active levels.[1]

The higher operating tempo encountered in reserve aviation units affects maintenance and general support requirements and leads to a relatively high level of full-time manning. Reductions below active flying-hour rates are possible where the skill level of reservists is relatively high (because of prior active-duty training and experience), where

[1] Operating tempos are not permitted to fall below certain levels to maintain crew proficiency and ensure the safety of peacetime training operations. Total flying experience is the most important component in developing sufficient skills to enable pilots to attain desired proficiency. Low annual flying-hour programs prevent young pilots from gaining the desired total flying experience.

skills can be recovered reasonably quickly following mobilization, or where civilian employment provides some degree of transferable proficiency.

Full-time manning and peacetime training levels in reserve units also are affected by readiness requirements, mission complexity, the complimentary nature of civilian job skills, and the type of equipment employed by the units. In the case of naval combatants, the need to keep reserve ships ready for sea training and deployment requires a relatively high level of recurring maintenance. This limits the amount of part time manning or requires increases in full-time support from shore-based support activities (i.e., shore-based intermediate maintenance activities or SIMAs). If the lead-time from peacetime to active involvement in hostile operations is long, or all ships are not required for reserve crew training, ships can be maintained differently or laid up during peacetime and the amount of full-time manning can be greatly reduced.

The conditions that determine minimum operating tempos limit the use of part time manning and the cost savings possible from active-to-reserve transfers. Despite these limitations, savings are still achieved in most reserve aviation squadrons and naval units, even though they are not nearly as high as in many other types of forces.

## C. OPERATING COSTS

The second major component of direct unit costing is the estimation of day-to-day operation and cost of forces. The costs of fuel, repair parts, supplies, and training consumables (e.g., ammunition, tactical missiles, etc.) account for the majority of these expenditures and apply to all types of units. In cases where intermediate maintenance is provided by organizations that are not part of the primary force element (e.g., SIMAs in the Navy), the associated expenditures should be estimated and included as direct unit costs (this applies to manpower costs as well as operating costs). Also included in this cost category are expenses that are unique to a unit's operation, such as the support contract services for naval combatants in foreign ports. Where units regularly incur costs to travel to training locations, these expenditures also are counted as direct unit costs. This is especially important when conversion from active to reserve units involves geographic dispersion of units that train together.

Each of the military services has its own methods for estimating unit operating costs. These methodologies are not always consistent across services because they often include different cost elements. These inconsistencies need to be avoided when force structure changes with multiple service impacts are being considered. Even though service

methods differ, the databases and algorithms possess many of the basic elements required to estimate unit operating costs. The cost element structure shown in Table 2 can provide a useful checklist to ensure that the all relevant costs are included and to avoid including costs that are best considered in another part of the overall estimate, (e.g., centrally managed support program costs). These guidelines are designed to ensure that comparisons of active and reserve forces are consistent. To compare operating costs of active and reserve units, it is essential that the estimating methods take into account differences in active and reserve unit operating tempos. Differences in active and reserve operating rates have major effects on day-to-day operating costs. Section III contains example estimates of direct unit cost that apply modified forms of the service's data and methods to specific units.

## D. EQUIPMENT-RELATED COSTS

Estimates of manpower and operating costs capture the most apparent and immediate budgetary effects of force changes. These costs often affect defense expenditures immediately and always within one to two years of the time a force structure change is made. Equipment-related cost impacts are not as closely linked in time, but they can have a major long-term effect on defense spending. These costs are relevant in decisions related to the affordability of forces of different sizes. Understanding the costs of both equipping and operating units also helps place the relative costs of active and reserve units in better perspective.

Equipment-related costs include the expenditures associated with replacing primary and support equipment, conducting major overhauls where they are a routine and essential aspect of owning a class of equipment (e.g., ships), and modifying and upgrading equipment to maintain utility over the projected lifetime.

Major force elements require a large investment in expensive equipment. As Table 1 shows, mission investment costs in the 1980s (which were essentially for procurement of new equipment) outpaced operating and support costs as a share of defense spending. Even during the 1970s, investment in replacement of defense weapon systems was the same general magnitude as the spending on unit operations and personnel. A force costing methodology that omits procurement and major modification costs will underestimate the long-term costs of owning and maintaining a total force of a given size. We include these costs in our consideration of Total Force policy decisions with the caveat that the full impact of equipment-related costs on defense budgets sometimes is not felt in the near term.

Over the long term, force structure reductions are accompanied by a roughly proportional change in the total number of weapon systems procured annually. A 20-percent reduction in aviation units will, in the long run, lead to a 20-percent reduction in the number of aircraft procured. However, from a near-term budgetary perspective, cost savings must be viewed in the context of the current acquisition profiles for weapon systems. If procurement plans do not provide for the normal replacement of the equipment of existing forces, proportional savings in procurement will not necessarily be realized. If current plans do not even support the lower alternative total force size, it is possible that no procurement savings will be realized in the budget years. In the extreme, it is possible that no new systems of a given class will be planned for procurement over the current budget period. In that case, there is no rationale for projecting budget savings associated with procurement of those systems, yet the long-term impact will be realized when procurement of that equipment resumes.

To be more specific, consider an aviation force in any of the services. If the force consisted of 1,000 aircraft with a projected lifetime of 30 years, approximately 33 new aircraft would be bought each year (on average). If the current procurement budget for these aircraft contained only 25 purchases annually and a force reduction to 750 aircraft were being evaluated, it would be inappropriate to forecast procurement savings because the new force requires procurement of 25 per year to maintain the average age of the fleet.

Not all types of equipment are bought as part of a regular, annual modernization program. Some replacement equipment is procured only periodically as threats change or new technologies emerge. Moreover, to reduce production costs, these purchases often are made in lot sizes larger than the long-term annual average replacement rate. A methodology that assumed an automatic reduction in procurement spending where none is currently programmed or budgeted would be incorrect. Conversely, a force reduction during a production run could lead to a greater than proportional cut in procurement. An accurate methodology requires a more careful examination of the actual procurement programs for affected classes of equipment.

Replacement costs cannot be estimated precisely, but instead reflect the approximate long-term average funding impacts. These costs are estimated based on the current replacement costs of like equipment and the expected average inventory life. Using the average annual replacement costs provides essentially the same impact as applying a straight-line depreciation to the capital assets of the unit.

When equipment-replacement cost effects are relevant, they should incorporate any differences that could arise from dissimilar operating practices in active and reserve units (e.g., average annual operating tempos). Some equipment is replaced or subject to major overhaul when it reaches a milestone with respect to total operating hours. The number of years required to reach this point could be higher in reserve units if the equipment were used less. This would cause the equipment replacement costs in some types of reserve units to be lower than corresponding active units. Strategic mobility units are an example of the type of unit where replacement costs would be different. Airlift is generally replaced when it has aged, not when it no longer counters a threat.

Over the long term, funding for the procurement of new equipment is related primarily to the size of the total force and only to a much lesser degree to the mix of active and reserve units within the force. A larger total force will require larger recurring investments to replace and modify equipment. The conversion of units from one component to another does not significantly affect equipment replacement needs (with the exception discussed above). A total force of a particular type of unit will, in general, require roughly the same average amount of equipment to be replaced annually, whether the force contains 70 percent active and 30 percent reserve personnel or 30 percent active-duty personnel and 70 percent reservists.

Equipment-replacement and other major costs associated with keeping military materiel ready for operation account for a major share of defense spending. These costs can be affected by Total Force policy decisions but in ways that vary from one time frame to another and from one type of unit to another. These differences in circumstances require an informed use of this element of direct unit costs.

## E. THE RELATIONSHIP BETWEEN UNIT COST DRIVERS AND UNIT CAPABILITY

The factors that underlie direct unit costs—the "cost drivers"—are levels of manning, tempos of operation, and equipage. Manning levels for full-time and part-time personnel drive manpower costs; operating tempos (e.g., flying hours, steaming hours, training miles) strongly influence unit operating costs; and equipment types and quantities largely determine recurring investment costs. The factors that drive unit costs are also the basic factors that determine unit capability and readiness. Figure 2 illustrates this relationship.


**Figure 2. Relationship Between Unit Cost Drivers and Unit Capability**

Direct unit costs are lower for force elements that have lower full-time manning levels, smaller equipment inventories, and lower operating tempos. The same factors that allow the cost of one unit to be lower than that of another also tend to limit unit capability and readiness, but this is not always the case. Many factors interact in determining how unit capabilities are affected by reduced operating tempos. Mission and equipment complexity, unit personnel stability, average experience levels, transferability of civilian skills, and the relative importance of unit-level and individual skills all influence how annual training rates affect unit capability. While not generally the case, it is possible for active and reserve units with different operating tempos to have essentially the same readiness, given the right combination of conditions. Some aviation units (e.g., fighter, tanker, and strategic airlift) and certain medical units are cases in point.

In other instances, reduced manpower training and support resources prevent some types of reserve units from being as ready as their active counterparts. For example, it has been estimated that, while an active Army division with a Status of Resources and Training System (SORTS) rating of C-1 is ready to deploy immediately, a SORTS status C-4 National Guard division might not be able to deploy effectively until six months after mobilization, depending on the nature and extent of its readiness deficiencies. Similarly, it is not practical for reserve naval aircrews to remain qualified for night carrier landings given their low peacetime operating levels, although they would require less than a month to requalify upon activation. The lower immediate readiness of many reserve units reflects their part-time manning and lower operating tempos in peacetime. Active and reserve units have a spectrum of SORTS ratings and active unit ratings are not axiomatically higher.

The following section uses the guidelines and framework discussed above to adapt existing service cost databases to several examples. These examples compare active and reserve component units based on the assumption that each unit possesses the same types and quantities of equipment and has the same total manning. Comparisons of the costs of

units with dissimilar manning and equipment are not a good basis for estimating relative costs of active and reserve units.

# III. COMPARISON OF ACTIVE AND RESERVE UNIT COSTS

The following section applies the methods described previously to examples of active and reserve units from each service. The examples adapt available DoD data sources and methods to the cost element structure in Table 2 to provide consistent comparisons of active and reserve units. In each comparison, total manning and equipage are held constant between active and reserve units and operating tempos are set at levels typically found in each type of unit. By setting the type and amount of equipment and the total manning to the same level, one obtains a comparison of units with the same potential capability. The degree to which units with different training levels actually achieve equal capability is a matter for other types of research.

## A. UNIT COSTING FOR THE ARMY

Policy-level decisions involving the Army's size and component mix are most often characterized in terms of changes in combat divisions and brigades. However, characteristics of actual Army force design make it difficult to accurately estimate the cost of Army force structure changes described only as additions, deactivations, or conversions of some number of divisions. Army divisions differ in ways that greatly affect costs. An armored division in Europe can cost two times as much to own and operate as a light infantry division stationed in the continental United States (CONUS). Divisions nominally of the same type are often manned and equipped differently. Active combat divisions have different mixes of active and reserve support. The character and amount of support also varies from corps to corps and theater to theater.

At a minimum, force costing for the Army requires identification of the type (e.g., armored, light infantry, etc.), theater, and component affiliation (i.e., active or reserve) of the affected combat units; the mix of active and reserve support units at echelons above the division level; the anticipated manning and equipage levels; and a general sense of the operating tempos of the affected units. These latter parameters (i.e., manning, equipage, and operating tempo) can be approximated by selecting a fully resourced unit as a baseline and, if desired, adjusting manning and operating tempos for different readiness

levels. For example, Authorized Levels of Organization (ALO) 3 units are manned at 80 percent of ALO 1 units.

Estimating Army direct unit costs is a two-step process. The first step is to identify the type of combat division, (e.g., armor, light infantry), the theater where the division is stationed, and the division's component affiliation (i.e., active, Army National Guard, Army Reserve) or the combat units being evaluated. First, the manpower, day-to-day operating, and equipment-related costs of the combat units can be estimated. After the costs of the combat division are estimated, costs of supporting units above the division level (i.e., non-divisional combat increment (NDCI) and the tactical support increment (TSI)) can be estimated and added to the cost of the combat unit. These two non-division components make up what is called a "division slice." In the case of active divisions, support above the division level typically consists of a mix of active and reserve units. Reserve combat divisions are supported by reserve component units.

Estimating the costs of support from echelons above the division level requires a approach that allows for a wide variety of mixes of active and reserve support. This is achieved by costing a 100 percent active and a 100 percent reserve support slice and taking a portion of each to represent the alternative being considered.

Support above the division level comes from corps- and theater-level units. Corps-level support requirements change roughly proportionally with the number and size of the combat units requiring support within the corps. Removing one of five combat divisions in a corps would be accompanied by roughly a 20-percent reduction in support from nondivisional combat and tactical support units. The same proportionality does not necessarily hold true for theater-level units and assets. Neither of these two generalizations is completely accurate, but errors arising from the assumption of fixed corps-level support are balanced by the fact that not all of the theater-level support is completely fixed. A reasonable approximation for total force costing can be obtained by treating corps-level support as variable with the number of combat units in a corps while assuming theater-level support is essentially fixed.

If major reductions in theater-level forces are considered as part of an alternative, they need to be specifically identified and costs estimated as if they were "stand alone" units. An example is the 32nd Air Defense Command (ADCOM) in Europe. This unit provides theater-level combat support to all ground divisions in Europe. It is possible that a large number of U.S. combat divisions in Europe could be withdrawn, while leaving a

major portion of the 32nd ADCOM in place to provide air defense for NATO. If theater-level air defense were to be reduced as part of a European force structure change, the cost impact of these changes should be calculated separately, not as part of the division-level changes.

To estimate the support portion of a division slice, representative "generic" corps are defined based on their planned warfighting structures. The examples that follow are based on the unit structures of V Corps and a generic CONUS-based corps composed of light and heavy divisions. The European-based V Corps is large, well-resourced, heavily mechanized, and highly modernized with an extensive corps-level support structure. The generic CONUS-based corps has a mix of light and heavy divisions and less extensive corps-level support. These two corps were included in this study to demonstrate the wide differences in Army unit costs and to help illustrate the need to identify the specific types of Army units.

To assess the cost impact of various mixes of active and reserve units within a corps, two nominal baselines were constructed: a 100 percent active corps and a 100 percent reserve corps. To evaluate units with different capabilities, baselines were formed for C-1/ALO 1 and C-3/ALO 3 active and reserve units with appropriate manning and operating tempo levels. Cost estimates for the division slice of any mix of active and reserve units can be developed from these baselines.

The baseline corps include all of the units (division as well as corps level) that would be attached to the corps in wartime. Thus, our 100 percent active baseline V Corps includes the active equivalent of two Army National Guard (ARNG) combat divisions and their associated support. The CONUS generic corps consists of three active heavy divisions, one active light division, the active equivalent of a reserve mechanized division, and all corps-level support. The active baselines then serve as the foundation from which 100 percent reserve baselines are formed. In an actual estimate, there will be a mix of costs of combat, non-divisional combat, and tactical support units constructed from the 100 percent active and reserve nominal cases.

Data to support this type of costing are constantly being updated and improved. The principal source of unit manpower data for existing units is The Army Force Builder database. Data on manpower costs and asset values for active units are obtained from the Army Force Cost System (TAFCS), developed by the U.S. Army Cost and Economic Analysis Center. Manpower cost factors for U.S. Army Reserve (USAR) and ARNG

units are from the Army Budget Office and the National Guard Bureau, respectively. Military pay and allowance (MPA) costs are computed using separate cost factors for six categories of personnel: Active outside CONUS, USAR ready reserve, ARNG Ready Reserve, Active CONUS, USAR Active Guard Reserve (AGR), and ARNG AGR. Reserve units are assumed to consist of 4 percent AGR and 96 percent Ready Reservists (including 4 percent also serving as civilian military technicians). Army National Guard units are assumed to have 5 percent AGR personnel, and 5 percent of the Ready Reservists are assumed to be civilian military technicians.

Operations and maintenance (O&M) costs are computed using the Training Resources Model (TRM),[2] employed by the Office of the Army Deputy Chief of Staff for Operations and Plans. The TRM model estimates O&M costs on the basis of readiness levels (expressed in terms of operating tempo), authorized equipment levels, and personnel levels. Costs are divided into two basic categories: those that are driven by unit operating tempo and those that are not. Non-operating-tempo-driven costs are assumed to be a function of numbers of personnel. TRM calculates operating-tempo-driven costs in three categories: petroleum, oil, and lubricants (POL); spares and repair parts; and other equipment-related operating costs. Operating-tempo-driven costs are derived from factors from Army battalion-level training models (BLTMs). BLTMs specify the training levels required to achieve given readiness levels at given ALOs.[3]

Models of 100 percent active corps were constructed based on the V Corps in Europe and a generic CONUS-based corps using the current TRM structure as a baseline. For the all-active V Corps baseline, we added active equivalents of the reserve units that would be attached to V Corps in the event of war. For the all-active, generic CONUS corps baseline, we added active versions of reserve units, and active support units associated with wartime support of the corps.

---

2 The TRM model is currently used by the Department of the Army to compute its program and budget requirements. TRM is oriented toward providing detailed cost information at the level of the Army Management Decision Package (MDEP). Each active division constitutes an MDEP; thus, the MDEP process provides a relatively simple and consistent way of estimating costs at the level of the division and below.

3 Force structure is modeled in TRM by assigning BLTMs to an MDEP. For example, an armored division would be assigned BLTMs representing a division headquarters and headquarters company, six M1A1 tank battalions, four Bradley mechanized infantry battalions, a main support battalion, three forward support battalions, and so forth. For each modeled BLTM, TRM has associated cost factors representing operating-tempo-driven costs.

TRM cost factors vary from year to year, reflecting changes in Army support policies. The most significant changes for cost-estimating purposes are those associated with the transition to unit funding of depot-level repairable (DLR) items via the stock fund. The impact of changes associated with the stock fund are expected to stabilize by FY 1995. The baseline figures shown below use factors that reflect these changes at the steady-state level that includes DLRs in the unit costs.

Training ammunition costs are derived from the TAFCS database, which in turn, is based on actual training ammunition consumption. Asset values for active divisions are also from the TAFCS database. These values are amortized over a 15-year period for each division.

To provide a consistent comparison, costs of USAR or purely ARNG division slices are based on the unit definitions of the active division slices. Military pay costs are computed using the same total manning levels but applying USAR or ARNG pay factors. Unit operations and equipment costs assume that all units have the same quantities of major end items. Operating-tempo-driven O&M and training ammunition costs are scaled to reflect the reduced operating tempo rates associated with reserve component units. Currently, USAR units operate at 25 percent of the tempo of equivalent active units for the same nominal readiness level (i.e., C-rating); ARNG units operate at 36 percent. Non-operating tempo costs are based on the number of duty-days for the reserve component in question.

Baseline data are presented in Tables 5 to 10. Each table shows the costs of the combat division, the non-divisional combat increment, and the tactical support increment, separately. Separate tables are provided for each component and for two different readiness levels. (The examples include a full spectrum of division and support units in the active and reserve components. The full complement has been included for illustrative purposes only, as not all types of units are currently found in each of the components. Reserve component units shown under the "Europe" label are intended to represent reserve units with the same equipment and total manning of the active component units in Europe.) Following the tables is an example demonstrating how to combine information from the tables to estimate the savings that result from a variety of force posture alternatives.

The data in Tables 5 through 10 show that 80 to 90 percent of annual recurring operating costs for Army units are driven by manpower. Fuel, parts, travel, and ammunition associated with peacetime training are an important but small fraction of the

total cost of both active and reserve component units. Over the long term, equipment costs range from 5 to 28 percent of the recurring operating costs. As a result, reserve component forces with very high percentages of part-time personnel have significantly lower annual operating costs. The examples also show the range of the cost of different types of divisions. Heavy divisions can have 50 percent more personnel than light infantry divisions and cost twice as much to operate on an annual basis. For this reason, it is not good practice to treat the cost of Army divisions as if they were all interchangeable, generic units.

The data in the tables show that 100 percent reserve component CONUS mechanized divisions, manned and equipped the same as active units, operate at roughly one-third the total costs as an active division over the long term. The overwhelming, largest source of these savings is lower manpower costs. Infantry division unit costs are more labor-intensive than armored units, and reserve infantry units cost 27 to 30 percent of comparably manned and equipped active divisions. Details are presented in the tables. As stated in the introduction to Section III, although these cost comparisons are made on the basis of units with the same manning and equipage, this study does not assert that units with different training levels have equal capabilities.

Table 11 demonstrates how the data from Tables 5 through 10 can be used to evaluate the cost impacts of several total force alternatives. Table 11 repeats the total costs for baseline (i.e., 100 percent), mechanized, and infantry divisions in the active and ARNG components. Two examples have been constructed from these data. Example 1 is based on the active component providing all combat brigades, 85 percent of the non-divisional combat increment, and 75 percent of the tactical support increment. Example 2 differs in that one third of the combat brigades, one third of the NDCI, and half of the TSI are assumed to be in the ARNG. The costs were calculated for the mechanized division in example 1 as follows:

| | | | | | |
|---|---|---|---|---|---|
| Combat Units | (Active) | = | 829 × 100% | = | 829 |
| NDCI | (Active) | = | 422 × 85% | = | 359 |
| TSI | (Active) | = | 512 × 75% | = | 384 |
| | | | | | 1,572 |
| NDCI | (ARNG) | = | 154 × 15% | = | 23 |
| TSI | (ARNG) | = | 166 × 25% | = | 42 |
| | | | | | 65 |
| | | | | | 1637 |

## Table 5. Army Direct Unit Costs, 100% Active (C1/ALO 1)

| | Europe | | CONUS | |
|---|---|---|---|---|
| | Armored Division | Mechanized Division | Mechanized Division | Infantry Division |
| **Division Only** | | | | |
| Manning | 17,302 | 16,744 | 16,753 | 10,969 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 617 | 597 | 566 | 371 |
| Unit Operations | 184 | 136 | 125 | 29 |
| Annual Recurring | 801 | 733 | 691 | 400 |
| Equipment-Related[a] | 175 | 104 | 138 | 31 |
| Long-Term Average Unit Cost | 976 | 837 | 829 | 431 |
| **Non-divisional Combat Increment** | | | | |
| Manning | 10,615 | 10,273 | 9,039 | 5,820 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 379 | 366 | 306 | 197 |
| Unit Operations | 74 | 52 | 59 | 15 |
| Annual Recurring | 453 | 418 | 365 | 212 |
| Equipment-Related[a] | 57 | 34 | 57 | 13 |
| Long-Term Average Unit Cost | 510 | 452 | 422 | 225 |
| **Tactical Support Increment** | | | | |
| Manning | 14,322 | 13,860 | 12,195 | 7,853 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 511 | 494 | 412 | 266 |
| Unit Operations | 76 | 49 | 56 | 17 |
| Annual Recurring | 587 | 543 | 468 | 283 |
| Equipment-Related[a] | 38 | 23 | 44 | 10 |
| Long-Term Average Unit Cost | 625 | 566 | 512 | 293 |

[a] Based on the costs of replacing equipment in these units over a 15-year period. Equipment types differ for the two mechanized divisions shown.

## Table 6. Army Direct Unit Costs, 100% Active (C3/ALO 3)

| | Europe | | CONUS | |
|---|---|---|---|---|
| | Armored Division | Mechanized Division | Mechanized Division | Infantry Division |
| **Division Only** | | | | |
| Manning | 13,751 | 13,642 | 13,402 | 8,775 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 494 | 486 | 453 | 297 |
| Unit Operations | 127 | 94 | 85 | 22 |
| Annual Recurring | 621 | 580 | 538 | 319 |
| Equipment-Related[a] | 175 | 104 | 138 | 31 |
| Long-Term Average Unit Cost | 796 | 684 | 676 | 350 |
| **Non-divisional Combat Increment** | | | | |
| Manning | 8,492 | 8,218 | 7,231 | 4,656 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 303 | 293 | 245 | 157 |
| Unit Operations | 51 | 35 | 39 | 11 |
| Annual Recurring | 354 | 328 | 284 | 168 |
| Equipment-Related[a] | 57 | 34 | 57 | 13 |
| Long-Term Average Unit Cost | 411 | 362 | 341 | 181 |
| **Tactical Support Increment** | | | | |
| Manning | 11,458 | 11,088 | 9,756 | 6,282 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 409 | 395 | 330 | 212 |
| Unit Operations | 57 | 37 | 41 | 13 |
| Annual Recurring | 466 | 432 | 371 | 225 |
| Equipment-Related[a] | 38 | 23 | 44 | 10 |
| Long-Term Average Unit Cost | 504 | 455 | 415 | 235 |

[a] Based on the costs of replacing equipment in these units over a 15-year period. Equipment types differ for the two mechanized divisions shown.

## Table 7. Army Direct Unit Costs, 100% ARNG (C1/ALO 1)

| | Europe | | CONUS | |
|---|---|---|---|---|
| | Armored Division | Mechanized Division | Mechanized Division | Infantry Division |
| **Division Only** | | | | |
| Manning | 17,302 | 16,744 | 16,753 | 10,969 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 145 | 140 | 140 | 92 |
| Unit Operations | 66 | 49 | 45 | 11 |
| Annual Recurring | 211 | 189 | 185 | 103 |
| Equipment-Related[a] | 175 | 104 | 138 | 31 |
| Long-Term Average Unit Cost | 386 | 293 | 323 | 134 |
| **Non-divisional Combat Increment** | | | | |
| Manning | 10,615 | 10,273 | 9,039 | 5,820 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 89 | 86 | 76 | 49 |
| Unit Operations | 27 | 19 | 21 | 5 |
| Annual Recurring | 116 | 105 | 97 | 54 |
| Equipment-Related[a] | 57 | 34 | 57 | 13 |
| Long-Term Average Unit Cost | 173 | 139 | 154 | 67 |
| **Tactical Support Increment** | | | | |
| Manning | 14,322 | 13,860 | 12,195 | 7,853 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 120 | 116 | 102 | 66 |
| Unit Operations | 27 | 18 | 20 | 6 |
| Annual Recurring | 147 | 134 | 122 | 72 |
| Equipment-Related[a] | 38 | 23 | 44 | 10 |
| Long-Term Average Unit Cost | 185 | 157 | 166 | 82 |

[a] Based on costs of replacing equipment in those units over a 15-year period. Equipment types differ for the two mechanized divisions shown.

## Table 8. Army Direct Unit Costs, 100% ARNG (C3/ALO 3)

| | Europe | | CONUS | |
|---|---|---|---|---|
| | Armored Division | Mechanized Division | Mechanized Division | Infantry Division |
| **Division Only** | | | | |
| Manning | 13,751 | 13,642 | 13,402 | 8,775 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 116 | 114 | 112 | 73 |
| Unit Operations | 46 | 33 | 31 | 8 |
| Annual Recurring | 162 | 147 | 143 | 81 |
| Equipment-Related[a] | 175 | 104 | 138 | 31 |
| Long-Term Average Unit Cost | 337 | 251 | 281 | 112 |
| **Non-divisional Combat Increment** | | | | |
| Manning | 8,492 | 8,218 | 7,231 | 4,656 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 71 | 69 | 60 | 39 |
| Unit Operations | 18 | 12 | 14 | 4 |
| Annual Recurring | 89 | 81 | 74 | 43 |
| Equipment-Related[a] | 57 | 34 | 57 | 13 |
| Long-Term Average Unit Cost | 146 | 115 | 131 | 56 |
| **Tactical Support Increment** | | | | |
| Manning | 11,458 | 11,088 | 9,756 | 6,282 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 96 | 93 | 82 | 53 |
| Unit Operations | 21 | 13 | 15 | 5 |
| Annual Recurring | 117 | 106 | 97 | 58 |
| Equipment-Related[a] | 38 | 23 | 44 | 10 |
| Long-Term Average Unit Cost | 155 | 129 | 141 | 68 |

[a] Based on the costs of replacing equipment in those units over a 15-year period. Equipment types differ for the two mechanized divisions.

## Table 9. Army Direct Unit Costs, 100% USAR (C1/ALO 1)

| | Europe | | CONUS | |
|---|---|---|---|---|
| | Armored Division | Mechanized Division | Mechanized Division | Infantry Division |
| **Division Only** | | | | |
| Manning | 17,302 | 16,744 | 16,753 | 10,969 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 132 | 127 | 127 | 83 |
| Unit Operations | 50 | 37 | 34 | 8 |
| Annual Recurring | 182 | 164 | 161 | 91 |
| Equipment-Related[a] | 175 | 104 | 138 | 31 |
| Long-Term Average Unit Cost | 357 | 268 | 299 | 122 |
| **Non-divisional Combat Increment** | | | | |
| Manning | 10,615 | 10,273 | 9,039 | 5,820 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 81 | 78 | 69 | 44 |
| Unit Operations | 20 | 14 | 16 | 4 |
| Annual Recurring | 101 | 92 | 85 | 48 |
| Equipment-Related[a] | 57 | 34 | 57 | 13 |
| Long-Term Average Unit Cost | 158 | 126 | 142 | 61 |
| **Tactical Support Increment** | | | | |
| Manning | 14,322 | 13,860 | 12,195 | 7,853 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 109 | 105 | 93 | 60 |
| Unit Operations | 20 | 13 | 15 | 5 |
| Annual Recurring | 129 | 118 | 108 | 65 |
| Equipment-Related[a] | 38 | 23 | 44 | 10 |
| Long-Term Average Unit Cost | 167 | 141 | 152 | 75 |

[a] Based on the costs of replacing equipment in these units over a 15-year period. Equipment differ for the two mechanized divisions shown.

## Table 10. Army Direct Unit Costs, 100% USAR (C3/ALO 3)

| | Europe | | CONUS | |
|---|---|---|---|---|
| | Armored Division | Mechanized Division | Mechanized Division | Infantry Division |
| **Division Only** | | | | |
| Manning | 13,751 | 13,642 | 13,402 | 10,969 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 105 | 104 | 102 | 67 |
| Unit Operations | 34 | 25 | 23 | 6 |
| Annual Recurring | 139 | 129 | 125 | 73 |
| Equipment-Related[a] | 175 | 104 | 138 | 31 |
| Long-Term Average Unit Cost | 314 | 233 | 263 | 104 |
| **Non-divisional Combat Increment** | | | | |
| Manning | 8,492 | 8,218 | 7,231 | 4,656 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 65 | 62 | 55 | 35 |
| Unit Operations | 14 | 9 | 11 | 3 |
| Annual Recurring | 79 | 71 | 66 | 38 |
| Equipment-Related[a] | 57 | 34 | 57 | 13 |
| Long-Term Average Unit Cost | 136 | 105 | 123 | 51 |
| **Tactical Support Increment** | | | | |
| Manning | 11,458 | 11,088 | 9,756 | 6,282 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 87 | 84 | 74 | 48 |
| Unit Operations | 15 | 10 | 11 | 4 |
| Annual Recurring | 102 | 94 | 85 | 52 |
| Equipment-Related[a] | 38 | 23 | 44 | 10 |
| Long-Term Average Unit Cost | 140 | 117 | 129 | 62 |

[a] Based on the costs of replacing equipment in these units over a 15-year period. Equipment types differ for the two mechanized divisions shown.

**Table 11. Army Unit Operating Cost Comparison—Long-Term Effects**

| Component: | Active | ARNG | Active | ARNG |
|---|---|---|---|---|
| Unit Type: | Mechanized | Mechanized | Infantry | Infantry |
| Theater: | CONUS | CONUS | CONUS | CONUS |
| Readiness Level: | C1/ALO 1 | C1/ALO 1 | C1/ALO 1 | C1/ALO 1 |
| Source: | Table 5 | Table 7 | Table 5 | Table 7 |
| Nominal Costs (FY92$ in billions) | | | | |
| Combat Division | 829 | 323 | 431 | 134 |
| Non-divisional Combat Increment | 422 | 154 | 225 | 67 |
| Tactical Support Increment | 512 | 166 | 293 | 82 |
| Total Cost | 1,763 | 643 | 949 | 283 |
| Example 1 | | | | |
| Combat Division | 100% | 0% | 100% | 0% |
| Non-divisional Combat Increment | 85% | 15% | 85% | 15% |
| Tactical Support Increment | 75% | 25% | 75% | 25% |
| Cost by Component | 1,572 | 65 | 842 | 31 |
| Total Cost Example 1 | | 1,637 | | 873 |
| Example 2 | | | | |
| Combat Division | 67% | 33% | 67% | 33% |
| Non-divisional Combat Increment | 67% | 33% | 67% | 33% |
| Tactical Support Increment | 50% | 50% | 50% | 50% |
| Cost by Component | 1,087 | 243 | 582 | 108 |
| Total Cost Example 2 | | 1,330 | | 690 |

The data in Table 11 could be used to answer questions about many alternatives. Table 12 shows the costs and savings for deactivating active and mixed active/reserve divisions and several examples of changing active and reserve mixes.

**Table 12. Cost Estimates of Army Force Structure Alternatives**

| | | Millions of FY 1991 Dollars | | |
|---|---|---|---|---|
| Original Condition | New Condition | Original Cost | New Cost | Costs (Savings) |
| Mechanized Division CONUS-based, C1/AL O1 | | | | |
| 100% Active | Deactivate | 1,763 | 0 | (1,763) |
| A/R mix per Ex 1 | Deactivate | 1,637 | 0 | (1,637) |
| A/R mix per Ex 1 | 100% Reserve | 1,637 | 643 | (994) |
| 100% Active | A/R mix per Ex 2 | 1,763 | 1,330 | (433) |
| Mechanized Division CONUS-based, C1/AL O1 | | | | |
| 100% Active | Deactivate | 949 | 0 | (949) |
| A/R mix per Ex 1 | Deactivate | 873 | 0 | (873) |
| 100% Active | 100% Reserve | 949 | 283 | (666) |
| 100% Active | A/R mix per Ex 2 | 949 | 690 | (259) |

Data from Table 5 through 10 can be used to estimate the cost impact of a wide range of Army force structure changes. Data in Table 11 also show that the cost impact of changes in infantry divisions is significantly less than in mechanized divisions. This reinforces the assertion made at the beginning of the section that costing Army Total Force policies requires more than generalizations about how many divisions are affected.

## B. UNIT COSTING FOR THE NAVY

The Navy maintains information that permits consistent unit costing of Total Force policy alternatives. This information was used to develop unit costing examples for naval forces. In this subsection, personnel costs, operating costs, and equipage costs are assessed for ship and aviation forces. It is necessary to draw on different sources to analyze ship and aircraft squadron costs.

For ships, the source of operating and support cost data is the VAMOSC (Visibility and Management of Operating Support Costs) data system. VAMOSC contains annual historical data on many categories of costs for every active ship in the Navy. Information is available by ship class on active manning levels, active personnel costs, fuel costs, hours underway, maintenance performed at all levels, ammunition and other stores used in training, and fleet modernization costs. Data on equipment replacement costs are available from the Naval Sea Systems Command. Properly used, these data are consistent with the cost element framework shown previously in Table 2, Section II. Manning data for active and reserve units of various types are available from VAMOSC and other sources in the Navy. Examples in this section are based on recent manning practices.

Table 13 provides estimates of the comparative cost of active and reserve ships of the FFG-7 class of frigates. The estimates were derived for ships whose manning and operating tempo levels are representative of those historically associated with frigates of that class. (Manning and operating tempos are currently being increased to permit reserve FFGs to participate in anti-drug activities. These increases are not reflected in the table.)

Compared with active FFGs, reserve FFGs save money on both manpower and operating costs. The reserve ships have 35 percent fewer full-time personnel (saving $1.8 million a year) and lower operating tempos (saving $1.3 million annually). These savings are, however, offset in part by increases in other support activities. The Navy has found that it must increase the level of manning at shore-based intermediate maintenance activities (SIMAs) in order to accomplish required preventive maintenance on reserve ships. Up to 45 additional enlisted personnel may be needed for this task. These extra SIMA personnel

can erode as much as $1.4 million of the manpower savings from an active-to-reserve transfer. A recent change in Navy manning practices has increased the full-time manning of reserve FFGs to 72 percent of total ship manning to support drug interdiction. This will further erode potential savings.

**Table 13. FFG-7 Comparison**

| | Active | Reserve | |
|---|---|---|---|
| | | Ship | SIMA |
| Manning | | | |
| Active Officer | 16 | 7 | |
| Active Enlisted | 194 | 65 | Up to 23 |
| TAR Officer[a] | - | 3 | |
| TAR Enlisted[a] | | 64 | Up to 22 |
| Selected Reserve Officer | - | 6 | |
| Selected Reserve Enlisted | 4 | 69 | |
| Total | 214 | 214 | Up to 45 |
| Operating Tempo | 2,700 hrs/yr (36 days/qtr) | 1,350 hrs/yr (18 days/qtr) | |
| Cost (millions of FY 1992 dollars) | | | |
| Manpower | 6.8 | 5.0 | Up to 6.4 |
| Operations | | | |
| Fuel | 1.1 | 0.5 | |
| Materials | 3.4 | 2.7 | |
| Purchased Services | 0.3 | 0.4 | |
| Other Maintenance | 0.6 | 0.5 | |
| Subtotal | 5.4 | 4.1 | |
| Annual Recurring | 12.2 | 9.1 | Up to 10.5 |
| Equipment-Related | | | |
| Overhauls | 1.1 | 1.1 | |
| Modifications | 2.8 | 2.8 | |
| Replacement[b] | 8.5 | 8.5 | |
| Subtotal | 12.4 | 12.4 | |
| Long-Term Average Unit Cost | 24.6 | 21.5 | Up to 22.9 |

[a] TAR means Training and Administration of the Naval Reserves.

[b] Ship cost is $297.9 million in FY 1992 dollars. Service life is 30 years.

Although different data sources are used to estimate aircraft squadron costs, the analytic techniques are quite similar. Personnel costs are based on current manning practices. To a greater extent than is the case with FFGs, reserve personnel augment active

naval air squadrons, which are not manned at their full wartime requirements. These costs are included in the active unit's estimate.

Operating costs are driven by the costs of fuel, maintenance, repair, and training munitions. The first two of these cost elements are assumed to be proportional to flying hours. This is consistent with the results of past studies of the determinants of aircraft operation and repair costs. Navy planning documents show that training munition requirements are roughly the same for active and reserve squadrons and can be obtained from the VAMOSC Air database. Fuel and maintenance cost data were obtained from Navy budget submissions.

Equipment costs include replacement and aircraft modification costs. Replacement costs are incurred as aircraft wear out, become obsolete, or are lost in accidents. Reserve squadrons have fewer accidents because they fly less and despite the lower operating tempo of reserve squadrons, their accident rate is no higher than active squadrons because their pilots are more experienced on average. Aircraft procurement costs are available from published sources. Data on the cost of modifications, the last element of equipment-related costs, were obtained from the VAMOSC Air database.

Depot-level rework costs for aircraft are treated as infrastructure costs rather than as direct program costs. This is unlike the treatment of ship overhaul costs. The reason for this methodological variation is practical rather than theoretical. The cost of ship overhauls is associated with individual ship types in the program element structure of the Planning, Programming, and Budgeting System. This is not possible for aircraft reworks for either the Navy or the Air Force. A consistent treatment is used for the active and reserve units.

Table 14 presents an illustrative cost comparison of F-14 squadrons in the active and reserve components. As the table shows, the manning of active and reserve squadrons is extremely similar. Manpower costs in the reserve squadron are $3.7 million less, however, because of the use of part-time personnel. The lower operating tempo of the reserve squadron reduces its annual operating cost by $4.4 million relative to that of the active squadron. The equipment-related costs of the reserve squadron are $4.7 million less because of lower expected attrition.

Over the long term, a reserve F-14 squadron has an average cost of $12.8 million per year less than an active squadron. Therefore, over the long term, a reserve squadron costs 79 percent as much as an active squadron. Approximately $8.1 million of the cost differential represents nearly immediate savings in manpower and operating costs. When

only these categories are considered, a reserve squadron costs 59 percent as much as an active squadron. Due to the greater manpower savings and because maintenance costs are more sensitive to operating tempo, naval aviation offers greater relative cost savings from active-to-reserve transfers than do ships. No assertion is intended in this analysis that these units do or do not have comparable capabilities.

**Table 14. F-14 Comparison**

| | Active | Reserve |
|---|---|---|
| Manning | | |
| Active Officer | 33 | - |
| Active Enlisted | 227 | - |
| TAR Officer[a] | - | 6 |
| TAR Enlisted[a] | - | 124 |
| Selected Reserve Officer | 6 | 33 |
| Selected Reserve Enlisted | 39 | 142 |
| Total | 305 | 305 |
| Operating Tempo | 4,018 hrs/yr | 2,203 hrs/yr |
| Cost (millions of FY 1992 dollars) | | |
| Manpower | 9.1 | 5.4 |
| Operations | | |
| Fuel | 3.0 | 1.7 |
| Parts and Supplies | 7.0 | 3.9 |
| Training Stores | 0.7 | 0.7 |
| Subtotal | 10.7 | 6.3 |
| Annual Recurring | 19.8 | 11.7 |
| Equipment-Related Replacement | | |
| Normal[b] | 23.9 | 23.9 |
| Attrition | 10.4 | 5.7 |
| Modifications | 5.7 | 5.7 |
| Subtotal | 40.0 | 35.3 |
| Long-Term Average Unit Cost | 59.8 | 47.0 |

[a] TAR means Training and Administration of the Naval Reserves.

[b] Replacement costs are calculated based on an average life of 25 years and a unit procurement cost of $49.8 million.

## C. UNIT COSTING FOR THE MARINE CORPS

Marine forces are composed of three basic elements: land forces, air wings, and Force Service Support Groups (FSSGs). This structure serves as the basic organization for peacetime force management and training. Combat forces are assembled from these

elements and organized into Marine Air Ground Task Forces (MAGTFs). MAGTFs take three basic forms: Marine Expeditionary Forces (MEFs), Marine Expeditionary Brigades (MEBs), and Marine Expeditionary Units (MEUs). A MEF, numbering nearly 45,000 personnel, consists roughly of a division, an air wing, and an FSSG. A MEB, with about 16,000 personnel, is composed of a regimental landing team (i.e., an infantry regiment with supporting artillery, tank, and other combat support units), a Marine air group (about 36 attack aircraft, 40 helicopters, and support aviation units), and a MEB service support group. A MEU, totaling approximately 2,400 personnel, normally consists of a battalion landing team (BLT), a composite air squadron made up primarily of helicopters and AV-8B aircraft, and a MEU service support group. MEFs, MEBs, and MEUs vary in composition depending on the specific mission of the task force. The forces are assembled from regimental, battalion, battery, and company units, and squadrons, from divisions, air wings, and FSSGs.

The Marine Reserve has essentially the same peacetime structure as the active force. In crises and wartime, Marine reserve units would be called on to augment and reinforce existing task forces. Reserve infantry units would be integrated with active infantry battalions; reserve tank units would augment tank battalions. In all but extraordinary conditions, Marine reserves would not mobilize and deploy as task forces made up only of reservists. Because Marine task forces contain a mix of units (e.g., infantry, artillery, tank, combat engineer, etc.) tailored to the requirements of specific missions, it is more useful to estimate Marine force costs at the battalion or squadron level rather than as a cross-section of a MEB or MEF.

Marine forces include both Marine Corps and Navy manning. Operations involving air wing elements are funded from both Marine Corps and Navy operations and maintenance (O&M). Cost estimates should reflect these practices by including costs from all funding sources. Funding for naval support that is integral to Marine unit operations is included as part of Marine force costing. Marine amphibious operations also depend on support from Navy amphibious ships and other amphibious elements, such as mobile construction battalions, cargo-handling groups, beach groups, and miscellaneous other support. However, amphibious lift and naval amphibious support units are not tied on a one-for-one basis with Marine Corps forces. Therefore, changes in Marine force size and mix do not always produce corresponding changes in naval amphibious support. For this reason, force structure impacts on Navy amphibious ships and support units are considered in separate policy decisions and are addressed in Navy unit costing.

Data on the direct costs of Marine Corps units were obtained from the Marine Cost Factors Manual and U.S. Marine Corps Headquarters. Estimates derived from these data showing the costs of an infantry battalion, tank battalion, and aviation squadron are presented in Tables 15 through 17. Manning levels have been set at approximately 90 percent of the Fleet Marine Forces Table of Organization. Active and reserve manning reflect current policies within the Marine Corps.

Over the long term, reserve Marine Corps infantry battalions operate for $24 million per year less than their active counterparts. This reflects nearly a 70-percent savings, essentially the same as the relative savings of reserve component Army infantry divisions. Of these savings, $20 million arise from the use of part-time personnel, and the remaining savings result from lower annual training rates. Reserve tank battalions can operate at a total annual savings of $23 million and have costs that are 45 percent of an active unit over the long term. This pattern is similar to armored combat divisions in the Army. A Marine CH-46 squadron operates at 72 percent of the long-term costs of its active counterpart and saves $7.4 million per year while flying about half of the flying hours. The relative operating savings are comparable to Navy and Air Force aviation units. The differences in costs may or may not also be accompanied by differences in capabilities.

**Table 15. Marine Infantry Battalion Direct Unit Cost**

| | Active | | Reserve | |
|---|---|---|---|---|
| | USMC | Navy | USMC | Navy |
| Manning | | | | |
| Active Officers | 40 | 3 | 6 | - |
| Active Enlisted | 775 | 59 | 34 | - |
| Full-Time Reserve Officers | - | - | 1 | - |
| Full-Time Reserve Enlisted | - | - | 14 | - |
| Part-Time Reserve Officers | - | - | 40 | 3 |
| Part-Time Reserve Enlisted | - | - | 775 | 59 |
| Total | 815 | 62 | 870 | 62 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 24.9 | | 4.5 | |
| Unit Operations | 8.9 | | 5.3 | |
| Annual Recurring | 33.8 | | 9.8 | |
| Equipment-Related[a] | 0.6 | | 0.6 | |
| Long-Term Average Unit Cost | 34.4 | | 10.4 | |

[a] Based on the costs of replacing equipment in these units over a 15-year period.

## Table 16. Marine Tank Battalion Direct Unit Cost

| | Active | | Reserve | |
|---|---|---|---|---|
| Number of Tanks | 70 | | 70 | |
| | USMC | Navy | USMC | Navy |
| Manning | | | | |
| Active Officers | 45 | 2 | 6 | - |
| Active Enlisted | 874 | 16 | 56 | - |
| Full-Time Reserve Officers | - | - | - | - |
| Full-Time Reserve Enlisted | - | - | 14 | - |
| Part-Time Reserve Officers | - | 45 | 45 | 2 |
| Part-Time Reserve Enlisted | - | - | 874 | 16 |
| Total | 919 | 18 | 995 | 18 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 26.4 | | 5.2 | |
| Unit Operations | 7.7 | | 5.7 | |
| Annual Recurring | 34.1 | | 10.9 | |
| Equipment-Related[a] | 7.2 | | 7.2 | |
| Long-Term Average Unit Cost | 41.3 | | 18.1 | |

[a] Based on the costs of replacing equipment in these units over a 15-year period.

## Table 17. Marine CH-46 Squadron Direct Unit Cost

| | Active | | Reserve | |
|---|---|---|---|---|
| Number of CH-46s | 12 | | 12 | |
| Operating Tempo | 4,056 | | 2,041 | |
| | USMC | Navy | USMC | Navy |
| Manning | | | | |
| Active Officers | 32 | 1 | 2 | - |
| Active Enlisted | 173 | 3 | 71 | - |
| Full-Time Reserve Officers | - | - | 5 | - |
| Full-Time Reserve Enlisted | - | - | 35 | - |
| Part-Time Reserve Officers | - | - | 25 | 1 |
| Part-Time Reserve Enlisted | - | - | 67 | 3 |
| Total | 205 | 4 | 205 | 4 |
| Cost (millions of FY 1992 dollars) | | | | |
| Manpower | 6.7 | | 4.1 | |
| Unit Operations | 5.3 | | 2.1 | |
| Annual Recurring | 12.0 | | 6.2 | |
| Equipment-Related[a] | 14.4 | | 12.8 | |
| Long-Term Average Unit Cost | 26.4 | | 19.0 | |

[a] Based on aircraft cost of $18.93 million (in FY 1991 dollars) and a service life of 20 years.

## D. UNIT COSTING FOR THE AIR FORCE

Air Force Regulation 173-13, U.S. Air Force Cost and Planning Factors, provides a costing methodology and cost factors that support assessments of many of the components of direct unit costs. The methodology is based on years of research to develop models and data for estimating the budgetary requirements of active and reserve forces. Properly applied, this methodology permits direct unit costing of alternative force structures and provides meaningful squadron-level comparisons between active and reserve components. One of the models in AFR 173-13, designated SABLE (for Systematic Approach to Better Long-Range Estimating), provides a reasonable representation of personnel and operating costs that is sensitive to manning, operating tempo, and equipage practices. The SABLE model does not, however, address all of the costs of replacing and upgrading mission equipment. Additionally, it includes some indirect costs that are treated as part of infrastructure (as opposed to direct unit) costing in this paper.

SABLE uses a mixture of active and reserve cost factors to estimate Air Force Reserve (AFR) and Air National Guard (ANG) squadron operating and support (O&S) costs. Some factors are common to active and reserve components, while others are specific to a particular component. For application to total force costing, the SABLE model provides estimates of personnel costs, fuel, supplies, repairable exchangeables, training munitions, contracted services, reliability and maintainability modifications, and support equipment replacement.

The two direct unit cost elements that the SABLE model does not estimate are the replacement costs of primary mission equipment and mission enhancement modifications. An average annualized total procurement cost (i.e., total procurement costs/expected inventory life) for replacement equipment is needed to compare force alternatives properly. The expected lifetime of aircraft varies by system: fighters last 20 to 25 years, while strategic airlift aircraft, bombers, and tankers tend to last longer.

Differences in the direct unit costs of active and reserve component units are almost wholly driven by their respective flying-hour programs and the closely related manning practices. Reserve component units are able to retain required pilot proficiency and readiness levels with fewer total flying hours because the experience level of reservists is higher, on average, than that of active-duty personnel. If reserve units were required to fill aircrew positions with a lower percentage of prior-service pilots (e.g., insufficient numbers of active component pilots joined reserve units), overall experience levels would decrease and the flying-hour program would have to be increased to maintain the same capability.

A comparison of the direct costs of active and reserve component F-16 squadrons is presented in Table 18. The manning includes a share of wing and group staff personnel, and flying-hour totals include proficiency flying for rated staff. Differences in flying hours and peacetime manning levels drive the direct unit cost differences reflected in the table. Reserve component F-16 squadrons with 24 primary authorized aircraft (PAA) fly, on average, 4,682 to 5,062 hours per year compared to 8,134 hours for active squadrons with the same number of PAA. The reserve forces' lower flying hours result in a 40-percent reduction in expenditures for fuel and other materials. The differences in manpower costs reflect the fact that reserve squadrons contain a mix of full-time and drill personnel, whereas active squadrons rely exclusively on full-time personnel. The $2 million difference in recurring investment between the active and reserve components reflects the lower peacetime aircraft attrition rates of reserve squadrons resulting from lower flying-hour programs. In sum, an active squadron (which trains at a higher peacetime rate with 100 percent full-time manning) will have an annual recurring operating cost of $34 million versus $23 million for an AFR unit and $20 million for an ANG squadron. Over the longer term, the costs are $65 million for the active squadron versus $52 million for the AFR unit and $49 million for the ANG squadron.

A similar comparison for active and reserve component KC-135R tanker squadrons is shown in Table 19. A notional 10-aircraft tanker squadron was selected for comparison of costs. As with the F-16, flying hours and peacetime manning levels are the two major determinants of differences in the direct costs of active and reserve component units. The AFR and ANG average 3,801 hours and 3,500 hours of flight time, respectively, per year compared to 2,840 hours for an active squadron. The requirement to provide alert aircraft results in a reserve component crew ratio of 1.5 versus 1.27 for active squadrons, resulting in 660 more flying hours for the ANG and 961 more for the AFR. ANG and AFR units also have different staff flying-hour requirements, and this accounts for the differences between the two reserve components. As readiness and alert conditions change in response to new global conditions, crew ratios and other factors that affect peacetime flying will change.

In the active force, tanker squadrons traditionally have been supported at the same facility as bomber squadrons. Unit collocation permits efficiencies in unit staff sizes, maintenance manning, and especially aircraft security personnel in active units that were not achieved in the 1980s in reserve units. The higher flying hours and manpower costs cause the annual recurring direct unit costs of reserve squadrons to exceed those of active

squadrons. This could change significantly if basing policies or security requirements changed for tanker aircraft. Equipment-related costs for active and reserve component squadrons are essentially the same, with the small differences resulting from the lower attrition rates associated with the active component's lower flying hours.

**Table 18. F-16C/D Direct Unit Cost Comparison**

| | | Reserve | |
|---|---|---|---|
| | Active | AFR | ANG |
| Aircraft per Squadron | 24 | 24 | 24 |
| Total Flying Hours | 8.134 | 4,682 | 5,064 |
| Manning | | | |
| Active Officers | 48 | - | 4 |
| Active Enlisted | 573 | - | 30 |
| Drill Officers | - | 87 | 58 |
| Drill Enlisted | - | 679 | 537 |
| Civilians | - | 273 | 162 |
| Total | 621 | 1039 | 791 |
| Cost (millions of FY 1992 dollars) | | | |
| Manpower | | | |
| Active Military | 20.2 | - | 1.5 |
| Reserve Military | - | 4.1 | 3.4 |
| Civilian | - | 10.5 | 6.2 |
| Subtotal | 20.2 | 14.6 | 11.1 |
| Unit Operations | | | |
| Fuel | 4.9 | 2.8 | 3.1 |
| Consumable Supplies | 2.5 | 1.4 | 1.5 |
| Recoverable | 5.5 | 3.2 | 3.4 |
| Training (munitions) | 0.9 | 0.9 | .9 |
| Subtotal | 13.8 | 8.3 | 8.9 |
| Annual Recurring | 34.0 | 22.9 | 20.0 |
| Equipment-Related[a] | | | |
| Modifications/Overhauls | 1.6 | 1.6 | 1.6 |
| Replacement Support Equipment | 1.3 | 1.3 | 1.3 |
| Primary Equipment Aircraft | 22.7 | 22.7 | 22.7 |
| Attrition Aircraft | 5.1 | 2.9 | 3.1 |
| Subtotal | 30.7 | 28.5 | 28.7 |
| Long-Term Average Unit Cost | 64.7 | 51.4 | 48.7 |

[a] Based on an aircraft cost of $18.93 million (FY 1992 dollars) and a service life of 20 years.

## Table 19. KC-135R Direct Unit Cost Comparison

| | Active | Reserve AFR[b] | Reserve ANG[b] |
|---|---|---|---|
| Aircraft per Squadron | 10 | 10 | 10 |
| Total Flying Hours | 2,840 | 3,801 | 3,500 |
| Manning | | | |
| Active Officers | 49 | - | 18 |
| Active Enlisted | 139 | 56 | 68 |
| Drill Officers | - | 90 | 65 |
| Drill Enlisted | - | 435 | 424 |
| Civilians | - | 206 | 115 |
| Total | 188 | 787 | 690 |
| Cost (millions of FY 1992 dollars) | | | |
| Manpower | | | |
| Active Military | 7.4 | 1.8 | 4.1 |
| Reserve Military | - | 3.1 | 3.0 |
| Civilian | - | 7.9 | 4.4 |
| Subtotal | 7.4 | 12.8 | 11.5 |
| Unit Operations | | | |
| Fuel | 2.5 | 4.2 | 3.8 |
| Consumable Supplies | 0.7 | 1.1 | 1.0 |
| Recoverable | 2.9 | 2.7 | 2.5 |
| Subtotal | 6.1 | 8.0 | 7.3 |
| Annual Recurring | 13.5 | 20.8 | 18.8 |
| Equipment-Related[a] | | | |
| Modifications/Overhauls | 1.7 | 1.7 | 1.7 |
| Replacement Support Equipment | 0.2 | 0.2 | 0.2 |
| Primary Equipment Aircraft | 19.9 | 19.9 | 19.9 |
| Attrition Aircraft | 1.2 | 1.6 | 1.5 |
| Subtotal | 23.0 | 23.4 | 23.3 |
| Long-Term Average Unit Cost | 35.5 | 44.2 | 42.1 |

[a] Based on an aircraft cost of $79.6 million (FY 1992 dollars) and a service life of 40 years.

[b] Assumes that tanker squadron is not collocated with other units to share security manning.

It is important to realize that the KC-135 is not typical of the relative costs of active and reserve AF units. It does illustrate, however, that under some conditions, reserve component ownership of a mission can be more costly than active ownership.

# IV. DIRECT SUPPORT COSTS

Each service has programs and support units that are affected indirectly by changes to the primary mission forces. Changes in primary mission forces can affect training units managed and funded by operational commands (e.g., naval readiness groups and Air Force combat crew training wings); procurement of war reserve material (e.g., ammunition, tactical missiles, fuel); and support units that deploy and perform specialized (often theater- or task-force-oriented) tasks in wartime (e.g., tactical communications, support ships, cargo-handling, heavy runway repairs). Force structure changes to strategic mobility forces can have secondary effects on other units' operating costs, which must be considered. Because these secondary effects must be considered on a program-by-program basis, they are sometimes overlooked in force cost analyses. Increases and decreases in total force size may be accompanied by changes in direct support programs but they often are not proportional changes. Conversion of primary forces from one component to another may also be accompanied by comparable conversions of direct support units.

## A. NON-CENTRALIZED TRAINING

Training for specific weapon systems that is oriented toward combat tactics and operator qualification is generally conducted by operational commands rather than as part of the central training programs of the services. The throughput of these programs is related to the total size of the force and the mix of active and reserve units. Combat crew training programs in the Air Force provide the means for crew members to make the transition from one aircraft type to another and for new pilots to qualify in their first combat system. Historically, the Air Force has required one training aircraft for every four aircraft in active fighter squadrons and one trainer for every eight fighters in reserve squadrons. (Reserve requirements have historically been lower because new reserve crew members are often already qualified in the aircraft operated by their unit, and pilot assignments are more stable. These historical patterns would change if the active-reserve mix changed to the point that the number of pilots leaving active duty and joining the reserves was insufficient to meet reserve manning requirements and the reserves were forced to train larger numbers of new pilots). When significant changes in the number of active or reserve aviation units occur, the size of the combat crew training program should be adjusted, as long as all other

factors (e.g., crew ratios, pilot rotation policies) remain the same. Similar changes to non-centrally managed training programs (e.g., Readiness Groups) should be considered for other weapon-system-intensive forces.

## B. WAR RESERVE MATERIAL

WRM and tactical missile procurement programs purchase material that is largely stored for use between the time hostilities arise and wartime production rates are archived. Some of these purchases are related to force size and should be considered when evaluating major changes in the size of the total force. These programs are not normally affected by changes in force mix and so are not primary considerations in active/reserve mix decisions. Adjustments to WRM procurement programs should not be made on a proportional basis. Procurement levels for many WRM items are driven by war reserve total inventory objectives based on threats rather than U.S. force size. Because it takes several years of procurement to achieve total war reserve inventory requirements for any given item, procurement plans in the budget period may not be affected by reductions in force structure. Even if the total requirement changes proportionally, the amount purchased during the budget years may not be reduced if the item is new and high priority. Conversely, if the item has been in production several years, a small force reduction could lead to cancellation of the remaining procurement. For these reasons, WRM programs must be assessed separately and should not be automatically or proportionally adjusted.

## C. OTHER DIRECT SUPPORT ACTIVITIES

Deployable support activities provide tactical support such as command, control, communications, and intelligence and a variety of logistics services. These units normally support several combat elements, often under theater control. Changes in the number of the units do not automatically follow changes in the number of primary mission units. Changes in the forward-deployed status of primary mission units can also affect the need to keep direct support units forward. Therefore, conversions of primary forces from active to reserve could be accompanied by comparable changes in direct support activities. Again, there is a need to examine impacts on these types of units on a program-by-program basis in the context of total force changes.

## D. SECONDARY EFFECTS ON OTHER UNIT COSTS

Where a unit's operating tempo provides both unit training and industrially funded reimbursable services, additional consideration must be given to the impact that changes in

these units will have on total defense spending (e.g., the cost of providing these services by other means). The cost of providing these services in other ways must be examined in evaluating the total cost effects of a force-mix decision. The most apparent (but not necessarily the only) example is the conversion of a strategic mobility program from active to reserve status. If the active unit provides peacetime airlift that will have to be replaced by other sources, the additional costs of providing these services should be considered. Similar conditions could apply to other programs or activities that provide peacetime support services, such as some communications or civil engineering activities.

Direct support programs, such as those identified above, must be examined for cost impacts but should not be automatically changed. It is important that these programs not be treated as a form of proportionally related indirect cost. Systematic consideration of these "ripple effects" tailored to each service's operating structure is an integral part of total force costing. This portion of force costing is difficult and depends on a working knowledge of how each service organizes its total war-fighting force.

# V. INFRASTRUCTURE COSTS

Approximately one-third of the military services' budgets goes to provide funds for centrally managed services, bases, and headquarters, whereas only one-fourth goes for operating and manning the mission forces. Because of the size of the infrastructure program, the recognition that it provides essential support to mission forces, and the belief that changes in force posture affect infrastructure, these costs are included in total force cost estimates.

There are, however, many difficulties in trying to estimate the impact of changes in force composition on the defense infrastructure. The lack of definitions, poorly documented and frequently changing accounting practices, and the difficulty of associating infrastructure spending with specific units makes the estimation process less than precise. Because these programs provide products or services that indirectly sustain many diverse units and organizations, an allocation technique is required to associate infrastructure costs with the end users they support. With even the best allocation techniques, there is always uncertainty in a specific scenario as to whether the assignment of allocated costs represents the true marginal costs of a service that supports many diverse activities. Ideally, estimates of the impact of force structure changes on infrastructure funding would be based on detailed cost-estimating factors for each major type of indirect cost. However, cost-estimating factors have not been developed for the full spectrum of infrastructure costs in all services, and descriptions of force structure alternatives in the policy-making environment often do not provide sufficient detail to apply the relationships that have been developed. Despite these problems, it is important to estimate the approximate impact that force structure changes will likely have on defense infrastructure costs, and a broadly applicable approach is required for multi-service application in policy-making circumstances.

One of the major problems encountered in estimating infrastructure costs is the lack of a generally accepted definition of what constitutes infrastructure in the DoD program. The closest the DoD comes to having a chart of accounts is the program structure for its Future-Years Defense Program (FYDP), and, even there, direct and indirect costs are not completely segregated. Using the FYDP as a starting point, we identified seven general

types of indirect support. Table 20 lists these categories along with a short list of the types of specific programs that occur within each.

**Table 20. Basic Infrastructure Activities**

| |
|---|
| Installation Support |
| Base Operating Support |
| Real Property Maintenance |
| Base-Level Communications |
| Central Logistics Activities |
| Depot-Level Support Activities in Major Force Program 7 |
| Central Training Activities |
| Training in Major Force Program 8 |
| Force Management and Administration |
| Departmental and Management Headquarters |
| Operational Headquarters |
| Central Medical Programs |
| Regional Hospitals |
| CHAMPUS |
| Central Communications Programs |
| Central Personnel Programs |
| Personnel Management |
| Recruiting and Examining |
| Commissary Operations |
| Family Housing |
| Permanent Change of Station Funding |
| Holding Accounts for Transient Status Personnel |

The approach we have taken to allocating infrastructure costs to force changes recognizes that these costs are not totally variable with changes in the size of the force, especially in the short term. Estimates of infrastructure costs also recognize that active and reserve component units do not receive the same range of indirect support and that the active components fund support activities that benefit both active and reserve units. It would be wrong not to acknowledge that reserve component units receive essential support from training, logistics, and other centrally-funded programs provided by the active service components.

## A. HISTORICAL RELATIONSHIPS

Even though detailed cost-estimating factors for the full spectrum of indirect support costs are not available, it is possible to approximate the general relationship between infrastructure costs and force size using historical FYDP data. Figure 3 shows how infrastructure spending in the services and spending on the operations and support of defense mission programs varied throughout the 1980s. Historical funding data show that expenditures for infrastructure programs have varied with changes in O&S spending for defense mission forces. When spending on mission forces O&S increased, so did the infrastructure funding. Likewise, when funding for force operations declined after FY 1987, infrastructure spending declined.

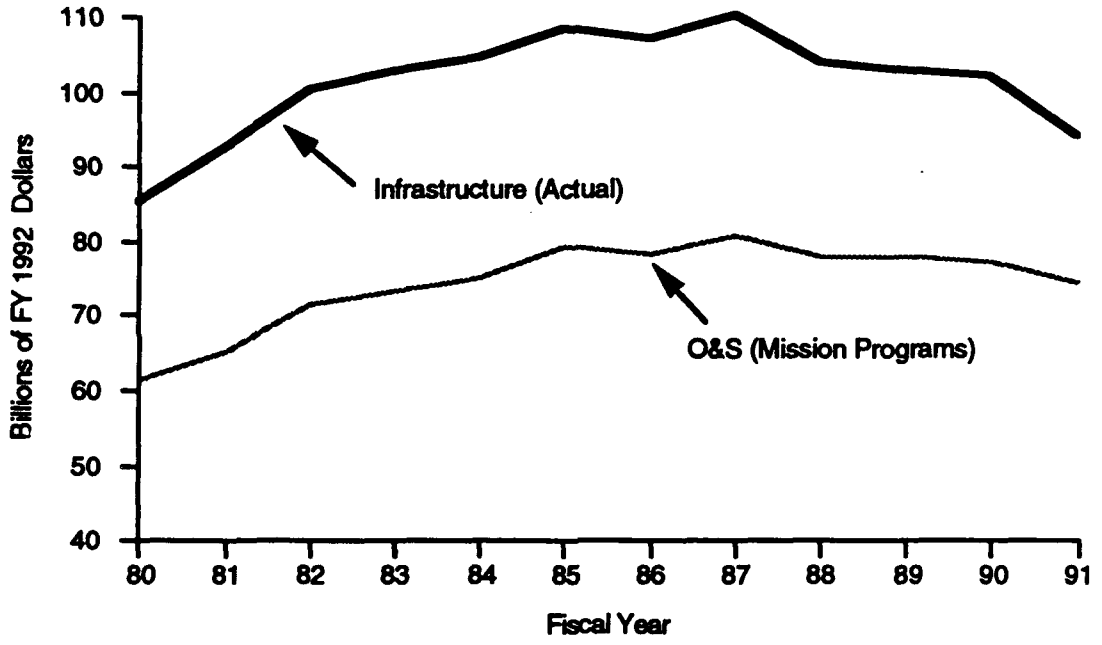


**Figure 3. Service Infrastructure and Mission O&S Funding**

Table 21 shows the services' spending for infrastructure and mission O&S. Table 22 shows the statistical relationship of infrastructure and mission spending (segregated between mission O&S and mission investment). Even though the time frame is too short to draw strong conclusions, the data show a significant relationship. Table 23 uses those results to estimate the approximate proportion of infrastructure spending that varied with mission O&S spending. This rough analysis seems to indicate that about 50 percent of infrastructure spending varied as mission O&S changed, about one-third was fixed, and

there was another component of variation related to changes in spending in the investment accounts (i.e., procurement and RDT&E).

**Table 21. Service Spending, FY 1980-91**

| | Billions of FY 1991 Dollars | | |
|---|---|---|---|
| FY | Infrastructure | Mission O&S | Mission Investment |
| 1980 | 85.19 | 61.48 | 75.19 |
| 1981 | 92.35 | 65.12 | 91.08 |
| 1982 | 100.14 | 71.55 | 113.07 |
| 1983 | 102.85 | 73.28 | 129.18 |
| 1984 | 104.45 | 74.86 | 137.40 |
| 1985 | 108.23 | 79.18 | 143.59 |
| 1986 | 106.96 | 78.35 | 135.06 |
| 1987 | 109.85 | 80.61 | 127.99 |
| 1988 | 103.91 | 77.86 | 122.67 |
| 1989 | 102.80 | 77.73 | 114.14 |
| 1990 | 102.02 | 77.08 | 108.76 |
| 1991 | 93.83 | 74.22 | 82.87 |
| Average | 101.05 | 74.28 | 115.08 |

**Table 22. Infrastructure Regression Results, FY 1980-91**

| Variable | Coefficient | St. Error | t-Value | Sig. Level |
|---|---|---|---|---|
| Intercept | 33.9890 | 5.5307 | 6.1456 | 0.00017 |
| Mission O&S | 0.6213 | 0.0990 | 6.2752 | 0.00015 |
| Mission Investment | 0.1817 | 0.0260 | 7.0027 | 0.00006 |

| N | $R^2$ | Adj. $R^2$ | Sigma | DW |
|---|---|---|---|---|
| 12 | 0.9743 | 0.9685 | 1.2784 | 1.977 |

Note: Dependent Variable = Infrastructure Funding. See formulation in Table 23.

**Table 23. Portion of Infrastructure Spending Attributable to Various Factors**

| | Average FY 1980-91 | | Regression Coefficient | Predicted Average |
|---|---|---|---|---|
| Fixed | | $b_0$ | 33.99 | 34 |
| Mission O&S | 74 | $b_1$ | 0.62 | 46 |
| Mission Investment | 115 | $b_2$ | 0.18 | 21 |
| Infrastructure | 101 | | | 101 |

The regression results shown in Table 23 are based on the following model:

$$\text{Infrastructure} = b_0 + (b_1 \times \text{Msn O\&S}) + (b_2 \times \text{Msn Invest})$$

Using these results, one can estimate the elasticity of infrastructure spending with respect to mission O&S spending as follows:

$$\frac{\text{\% Change Infrastructure}}{\text{\% Change Msn O\&S}} = \left(\frac{\delta\,(\text{Infrastructure})}{\delta\,(\text{Msn O\&S})}\right) \times \left(\frac{\text{Msn O\&S}_{avg}}{\text{Infrastructure}_{avg}}\right)$$

$$= .62 \times (74 + 101)$$

$$= .45 \text{ or } 45\%$$

The correlation between infrastructure spending and mission O&S has both a causal link and what can be called a budget-level component. That is, it is almost certainly true that the factors that cause mission O&S spending to vary, such as changes in force size and changes in peacetime training levels, cause the level of services delivered by infrastructure activities to change. Increases in force size and training level generally occur during times when DoD funding levels are increasing. This overall trend may also impact decisions about marginal spending in infrastructure activities. Resources for infrastructure investment and operations may be more available during times of increasing or relatively high defense spending and therefore spending in these areas may increase for reasons other than increased demands for services. For example, an increase in force size may increase the demand for the number of vehicle mechanics trained each year. Adding instructors would increase the cost of central training. This can be thought of as the causal component of increased infrastructure spending. But it is also possible that student-teacher ratios may also be increased because funding levels are relatively high and this action will produce better trained graduates. Increasing the student-teacher ratio adds to the growth in funding for central training. Teachers added to increase the number of graduates can be said to be caused by the increase in force size. Teachers added to improve quality may reflect nothing more than the increased availability of funding. We currently cannot segregate these two effects, but the historical pattern of spending behavior strongly suggests that about half of the total infrastructure spending will increase proportionally to the increase in mission O&S—whatever the dynamic.

Table 22 shows that infrastructure spending changes are also correlated with changes in spending on investment programs—primarily procurement and RDT&E. This relationship undoubtedly has both causal and budgetary components. However, in the case

of investment spending, it is harder to develop an overarching rationale that links changes in procurement and RDT&E programs to increased demands for infrastructure services. There are certainly some causal links to areas like central logistics and central training, but it is hard to connect increased investment spending with other support activities like central medical and headquarters activities. It is even more difficult to make the case that changes in active-reserve mix are closely related to investment costs. For this reason, we have set aside the effect of investment on infrastructure spending for this study. It may, however, be appropriate to include it if the change in force composition were accompanied by a significant change in total force size and therefore a need to increase or decrease procurement of new hardware. If it were included, infrastructure spending would vary roughly 20 percent with changes in defense investment.

The relationship between infrastructure spending and mission O&S fluctuations can be used with the estimates of changes in direct unit O&S cost to approximate the marginal infrastructure costs associated with having a unit. Specifically, we will say that for every dollar spent to man and operate a unit, there is some corresponding amount of funding for infrastructure support activities. Table 1 in Section I showed that infrastructure spending was significantly different in each service. At one extreme, the Army spent $1.58 on infrastructure for each dollar spent to man and operate its mission forces and at the other end of the distribution, the Navy spent only $1.27. The next subsection uses the variability and the average infrastructure spending in each service to estimate the change in infrastructure spending that can be associated with each dollar of change in unit O&S spending.

## B. CONSIDERATIONS IN ALLOCATING COSTS

The allocation of infrastructure costs in estimating total force cost must recognize the differences in the kinds of support provided to active and reserve units. Reservists do not use family housing, they do not have the same medical benefits or the same access to commissaries as do their active-duty counterparts, and they do not regularly change assignments as do active-duty personnel.

In addition, there are differences in the ways in which each type of infrastructure program is funded. There are infrastructure activities that each component funds and also major support activities that the active component funds to the benefit of both active and reserve units. To account for the different ways that infrastructure activities are funded, infrastructure funding has been segregated into three categories: active-only, reserve-only,

and joint support. The total effect of a force change on infrastructure takes both the component-unique and joint support impacts into account, depending on the specific components involved.

Where infrastructure programs exist primarily to support active forces, the variable portion of their cost is allocated solely to active units. Such programs include, but are not limited to, permanent change of station travel, family housing, medical services, and commissaries. The variable portion of infrastructure activities funded by reserve component budgets for reserve component support are allocated only to the reserve component. Activities such as central communication, central logistics, and central training are largely funded by the active component, but serve both active and reserve requirements. A portion of the costs of these centrally managed programs is allocated to both active and reserve units based on the O&S costs of active and reserve units. Figure 4 illustrates our approach to allocating infrastructure costs and recognizes the similarities and differences in supporting active and reserve forces.

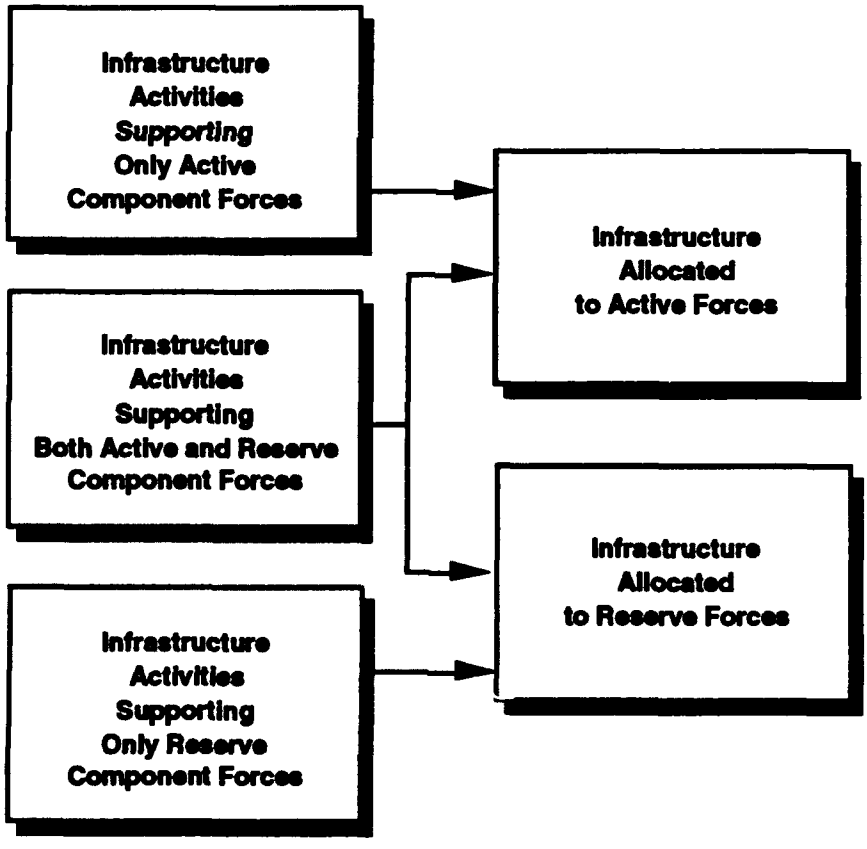


**Figure 4. Allocation of Infrastructure Costs**

Data from the past 12 years (i.e., FY 1980 to FY 1991) demonstrate that while a portion of infrastructure costs is fixed, significant portions vary with total force size. The results of the defense-wide relationship of infrastructure and mission O&S costs can be applied to approximate the short- to intermediate-term impacts of force structure changes. In the long run (maybe 10 to 20 years), it may well be that the percentage of variable costs is closer to 100 percent, but historical data do not support using this level of variability.

## C. ESTIMATES OF INFRASTRUCTURE FACTORS

The services differ in the magnitude and the organization of infrastructure activities. Cost-estimating methodologies developed for this study allow for the ways each service and component provides indirect support. Table 24 presents data on infrastructure spending by all four services for each infrastructure category during the 1980s. The table shows expenditures for the major types of infrastructure by component affiliation (i.e., active-only, reserve-only, and joint support). Table 25 shows total infrastructure spending and the average amount spent on mission O&S. From these two, one can estimate the average total infrastructure spending per dollar of O&S spending. If infrastructure spending were 100-percent variable, this average could be used directly to allocate infrastructure costs to forces, using the O&S spending of each unit as the allocation basis. However, the relationship of infrastructure spending and mission O&S from 1980 to 1991 do not support treating infrastructure costs as wholly variable and further adjustments are required to estimate the variable portion of these costs.

Before making further calculations of the variable portion, we need to separately consider medical support because it supports more than the current size of the force. Medical costs have been broken out as a separate part of active-only support in the tables because their variability differs from other types of support. Unlike other kinds of infrastructure, medical programs serve a large retired military population as well as full-time personnel. Indirect (i.e., centrally-funded) medical cost factors vary by service, partly due to differences in the proportions of military members with dependents and partly because of the level of medical support delivered directly through the unit's funded activities (e.g., carriers at sea provide medical support under their own unit funding).

Because total force alternatives potentially cover such a broad spectrum of possible scenarios, we assume that, in the general case, infrastructure costs are 50-percent fixed and 50-percent variable. This is consistent with but not necessarily proven by the historical relationship documented in Table 22.

**Table 24. Average Infrastructure Spending in the 1980s**

| | Billions of FY 1991 Dollars | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Marine Corps | Air Force | DoD |
| Infrastructure funding by active component for active-only support | | | | | |
| Installation Support | 5.7 | NA[a] | 1.3 | 8.4 | 15.4 |
| Force Management | 1.2 | NA[a] | 0.1 | 1.3 | 2.5 |
| Central Personnel | 4.5 | 3.1 | 0.9 | 3.2 | 11.7 |
| | 11.4 | 3.1 | 2.2 | 12.9 | 29.6 |
| Central Medical Support | 4.1 | 3.0 | NA[b] | 3.6 | 10.7 |
| Infrastructure funding by reserve component for reserve-only support | | | | | |
| Installation Support | 0.7 | NA[a] | 0.0[c] | 0.6 | 1.3 |
| Force Management | 0.2 | NA[a] | 0.0[c] | 0.1 | 0.3 |
| Central Personnel | 0.4 | NA[a] | 0.0[c] | 0.1 | 0.5 |
| | 1.3 | NA[a] | 0.0 | 0.8 | 2.1 |
| Infrastructure funding supporting both active and reserve components | | | | | |
| Installation Support | 0.4 | 4.9 | 0.0 | 0.5 | 5.8 |
| Force Management | 1.5 | 2.0 | 0.3 | 1.2 | 5.0 |
| Central Personnel | 0.4 | 0.2 | 0.0 | 0.1 | 0.7 |
| Central Training[d] | 7.5 | 4.4 | 1.3 | 3.4 | 16.5 |
| Central Logistics | 7.8 | 9.3 | 0.6 | 9.1 | 26.9 |
| Central Communications | 1.5 | 1.2 | 0.0 | 1.8 | 4.6 |
| | 19.1 | 22.0 | 2.2 | 16.1 | 59.3 |
| Total | 35.9 | 28.1 | 4.4 | 33.3 | 101.7 |

[a] So little of the Navy's primary forces have been in the reserve component that it was not possible to develop a separate reserve-only infrastructure component. To maintain consistency, the only infrastructure costs retained in the active-only category were those for programs that should not be allocated to the reserve component (e.g., family housing, commissaries, and permanent change of station costs).

[b] Marine Corps medical support is provided by the Navy; the costs are allocated between the services on a pro rata basis.

[c] Less than $0.1 billion.

[d] Excludes flight crew training costs.

We can now combine the assumption of 50-percent variability with the service-unique infrastructure historical data partitioned by component applicability to estimate the amount of infrastructure spending associated with each increment of mission O&S funding. The second to last line of Table 25 shows the result of combining active-only, medical, and joint-support variable costs to form a total active infrastructure cost factor. The reserve total factor is obtained by adding the reserve-only and joint-support variable costs.

**Table 25. Variable Portion of Infrastructure Spending in the 1980s**

| | Billions of FY 1990 Dollars | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Marine Corps | Air Force | DoD |
| Infrastructure Spending | | | | | |
| Active-Only | 11.4 | 3.2 | 2.2 | 12.7 | 29.0 |
| Reserve-Only | 1.3 | NA | 0.1 | 0.8 | 3.3 |
| Joint Support | 19.1 | 20.6 | 2.2 | 15.1 | 56.6 |
| Total | 31.7 | 25.1 | 4.4 | 29.7 | 91.0 |
| Central Medical Support | 4.1 | 3.0 | NA | 3.6 | 10.7 |
| Average Mission O&S | | | | | |
| Active Forces | 19.0 | 23.1 | 4.2 | 17.4 | 63.7 |
| Reserve Forces | 5.2 | 1.2 | 0.4 | 3.5 | 10.3 |
| Total | 24.2 | 24.3 | 4.6 | 20.9 | 74.0 |
| Average Infrastructure Spending per $1 of Mission O&S | | | | | |
| Active-Only | 0.60 | 0.13 | 0.53 | 0.74 | 0.46 |
| Reserve-Only | 0.24 | 0.00 | 0.07 | 0.21 | 0.20 |
| Joint Support | 0.79 | 0.91 | 0.47 | 0.77 | 0.80 |
| Medical[a] | 0.11 | 0.05 | 0.05 | 0.10 | 0.08 |
| Variable Portion of Infrastructure per $1 of Mission O&S, 50% variable | | | | | |
| Active Total[b] | 0.75 | 0.55 | 0.53 | 0.80 | 0.68 |
| Reserve Total[c] | 0.52 | 0.45 | 0.27 | 0.49 | 0.50 |

Note: Totals may not add due to rounding.

[a] Allows for 50% CHAMPUS and Regional Hospital funding for retirees.

[b] 50% of (Active-Only + Medical + Joint Support).

[c] 50% of (Reserve-Only + Joint Support).

These figures show that active forces incur roughly one-third higher infrastructure costs per dollar of O&S spending than do the reserve counterparts. This occurs because active-duty personnel receive some support services not provided to part-time reservists. When this difference is combined with the fact that reserve unit annual O&S costs run from 30 to 75 percent of a comparably equipped and manned (but not necessarily comparably trained or ready) active unit, the infrastructure savings account for a significant part of the total difference in the cost of active and reserve units.

## D. AVIATION TRAINING COSTS

Aviation training is a central training activity but has been excluded from the general treatment of infrastructure discussed in the previous section. Because of the relatively high cost of aviation training and the fact that this cost is only relevant to decisions involving flying units, special treatment is given to flight training in infrastructure calculations. Aviation crew training is a centrally-provided training program and is not funded by or tied

directly to units. Even though crew training costs for aviation units are estimated on the basis of unit pilot/navigation manning, the impact of large force structure changes on such training can be assessed accurately only at the service level, where the impact of all prospective force changes can be considered.

Cost impacts on flight crew training are based on several interrelated factors, including the effect that prospective changes in the active-reserve mix will have on the total number of crews that must be trained. Historically, a large number of reserve component flight crews have entered reserve service already flight-qualified. Valuable training that would have been lost to the total force as a result of crew members' leaving active duty has thus been retained, and the services have not needed to train as many new pilots. As long as the number of pilots joining reserve units upon leaving active duty exceeds the number needed to fill reserve component pilot billets, the number of pilots trained specifically for the reserves is not affected by the active-reserve mix (i.e., the supply exceeds the demand). As the relative size of reserve forces increases, however, there is a point where not enough prior-service personnel are available to fill reserve flying billets. The point at which the demand cannot be met by active separations is affected by the active-reserve mix, retention rates in both components, and the rate at which prior-service personnel join reserve component units. Each of these factors changes over time, and the cost effects are best estimated on a total force basis using current retention data. Each service maintains estimates of pilot training costs and these can be used to estimate additional costs or savings that will occur when the requirements for rated crews are affected by force changes.

Table 26 illustrates the impact of pilot training costs on active and reserve units. The data assume a change to only a single squadron, and reflect the current Air Force active-reserve fighter force mix and current crew turnover rates. The assumption that there are enough pilots separating from active units to fill vacancies in reserve component units is critical to this comparison.

**Table 26. Comparison of Pilot Training Costs**

| | Active | Air National Guard | Air Force Reserve |
|---|---|---|---|
| Pilot Turnover | 8% | 6% | 8% |
| Non-Prior Service | 100% | 36% | 10% |
| Total Training Costs | $4.42 million | $1.19 million | $0.44 million |

Note: Number of aircraft = 24, crew ratio = 1.25, and pilot training cost = 1.84 million per pilot. Total Training Cost = (Number of Aircraft) × (Crew Ratio) × (Pilot Training Cost) × (Pilot Turnover) × (Non-Prior-Service Fraction).

The data in Table 26 show that, on average, converting one active F-16 squadron to an Air National Guard unit will save $3.23 million annually in training costs, in addition to the savings in direct unit costs and other infrastructure-related expenditures. Savings from conversions to the Air Force Reserve would average almost $4 million per year. These results, while valid for small adjustments in force mix, cannot necessarily be extended to larger changes. Increasing the proportion of aviation forces in the reserves past a critical point would require that pilots and crews be trained directly for reserve units, thus increasing the percentage of non-prior-service personnel.

Infrastructure costs related to force structure changes range from 27 to 75 percent of the impact of direct unit O&S costs, as shown in Table 25. The specific impact also varies between active and reserve units. These factors significantly affect total force cost estimates and should be included in those analyses.

# VI. TRANSITION COSTS

## A. INTRODUCTION

Changes in force structure almost always require expenditures for one-time activities. These transition costs can be very substantial. Unit activations, inactivations, and transfers between active and reserve forces can cost hundreds of millions of dollars, potentially overshadowing the recurring savings. For example, DoD's base closure report estimates that one-time costs for closing or realigning 71 bases will be $5.7 billion, offsetting a large fraction of the anticipated savings.[4]

There are no general techniques for estimating transition costs, other than ensuring that the full spectrum of potential costs is examined. Each situation is unique and must be assessed individually to determine the specific one-time effects a force change will have on funding requirements. There are often alternative ways of implementing a force structure change that can have significantly different costs. Three categories of transition costs must be considered: base and facilities costs, equipment costs, and personnel costs.

## B. BASE AND FACILITIES COSTS

When bases or facilities are opened, closed, or modified there are both recurring and non-recurring cost implications. Recurring cost changes having to do with bases and facilities, such as the cost of base operations, are treated as part of infrastructure costs. On the other hand, the non-recurring costs, which result from changes in force posture, must be addressed explicitly as transition costs. When units are formed or expanded, it may be possible to take advantage of existing underused facilities. Otherwise new facilities must be leased (permanently or temporarily) or built. Existing facilities sometimes require extensive modification and renovation. Conversely, when facilities are closed, there are shutdown costs.

The cost of opening and closing bases and facilities includes the cost of planning and administering the changes. This is also true of all transition costs where planning and

---

[4] Department of Defense, "Base Closure and Realignment Report," April 1991, p. 1.

administration are best considered in the context of what is being planned and administered, rather than as a separate category of costs. Bases gaining new forces may require environmental studies, while those losing forces may require both environmental studies and cleanup. It can be very expensive, for example, to insure that no unexploded munitions remain on firing ranges.[5] Both gaining and losing facilities may involve a variety of legal challenges. In some cases it might be so expensive to do the environmental cleanup necessary to prepare a base for sale that facilities are kept in caretaker status to avoid the cleanup costs.

To illustrate the potential magnitude of facilities costs, a new C-5 Air National Guard unit slated for operation at Memphis Naval Air Station was estimated to need $142 million for runways, operations and logistics facilities, and aircraft hangars.[6] This cost is more than ten times the estimated recurring savings that could be gained by moving the aircraft from the active to reserve component. Facilities preparation costs depend critically on the basing alternative chosen. If the C-5 Guard unit were to be located at a base that already supports C-5s and can handle the additional aircraft, the facilities costs could be reduced to the range of $20 million. Clearly, transition costs related to facilities can vary greatly and are dependent on specific circumstances of each unit transition.

The sale of base property when activities are reduced or terminated may provide an important offset to the costs of transition, though the time and expense it takes to get property ready for sale may be considerable. The proceeds from property sales go straight to the federal treasury, so the Department of Defense and the services cannot use them to offset their costs, but they should be considered in determining the proper course of action for the government.

---

5 The "Base Closure and Realignment Report" makes the point that environmental restoration costs should not be treated in transition cost calculations because DoD has a legal obligation for environmental restoration, regardless of whether a base is closed or realigned. It seems likely, however, that base closure may sometimes cause environmental restoration to take place much sooner than it otherwise would have. When proper discounting procedures are used, costs delayed are costs reduced. Thus, it may often be appropriate to consider environmental restoration costs as an element of transition cost.

6 Schank, John F., et al., *Cost Analysis for Reserve Force Change*, The Rand Corporation, R-3492-RA, 1987.

## C. EQUIPMENT COSTS

Repositioning unit equipment can engender many different kinds of costs when force structure changes are made. Sometimes equipment needs preparation for storage, movement, decommissioning, or disposal. The transfer of forces into the reserves can require the procurement of additional support equipment when a single active unit is geographically dispersed. For example, the transfer of four FF-1052s to reserve units based in San Francisco required procurement of about $7 million in new support equipment at the shore-based intermediate maintenance facility. Similarly, the introduction of the AH-64 into the Army National Guard required about $8 million of additional electronic support equipment at a higher-level maintenance facility.[7]

M-1 tanks from deactivated European armored units would normally be redistributed to replace older tanks in other units or given to allies. First, however, the tanks would have to be brought to a standard configuration to conform to transfer standards. The Army Cost and Economic Analysis Center estimates equipment preparation costs for an armored division at $36 million. The cost of transporting the division back to CONUS is estimated at $45 million. These preparation and movement costs would be incurred regardless of the disposition of the equipment on its return to CONUS, as long as the equipment was to be used in a unit.

A major equipment-related transition cost for the Navy is the expense associated with decommissioning ships. The costs can run as high as $30 million for nuclear-powered ships such as attack submarines, and mothballing a battleship costs at least $40 million.

The sale to foreign governments of equipment rendered surplus by a force structure reduction offers potential offsets to transitional cost.

## D. PERSONNEL COSTS

Large reductions in personnel can require one-time separation costs and funding for changes of station above the level normally budgeted for routine transfers. Increases in end-strength in a reserve component may entail higher recruiting and training expenses, even when there are comparable reductions in the active component of the same service.

---

[7] These examples of the magnitude of transitional support equipment costs are drawn from a forthcoming paper: Michael G. Shanley, *Guidelines for Planning the Cost Analysis of Force Structure Change*, WD-5055-PAE/FMP, The Rand Corporation, August 1990.

Several severance pay plans are being weighed for the force structure reductions being contemplated. One that has been reported in the press would offer enlisted personnel 15 years of service with total payments of roughly $250,000 over 35 years.[8]

Separation costs affect civilian employees as well as military personnel. Some civilians may receive early retirement payments while others may receive separation pay. It can be even more expensive to reduce foreign civilian personnel, depending on the status of forces agreement between the U.S. and the host country. In addition, the services and defense agencies annually budget unemployment contributions to the Federal Employees Compensation Account for DoD civilian and military employees. Contributions attributable to force structure changes and base closures or realignments should be included in transition cost calculations.

Permanent change of station (PCS) costs can be a significant part of transition costs. Even though PCS costs are part of the recurring infrastructure costs, personnel moves resulting from activations, deactivations, and conversions that exceed the normal turnover cause one-time increases in these costs. Current Air Force factors used in the COBRA (Cost of Base Realignment Action) model imply transitional PCS costs of $16 million to $25 million per fighter wing. PCS costs include moving costs (per diem allowances, house hunting costs and house sales allowances), transportation costs (air fares and automobile mileage allowances) and freight costs for household goods.

Recruiting and training expenses are recurring infrastructure costs incurred in a steady-state force structure. A shift from the active to the reserve components may, however, require recruiting and training expenditures in the gaining component that are above the steady-state level for the new force structure. These are properly viewed as transition costs. They can be very case-specific. For example, it may be difficult to find personnel for a new Marine Corps Reserve battalion. Experienced people must be recruited from a limited geographic area, and as the smallest service, the Marines may not have large concentrations of prior service personnel to draw on. Bonus packages may be needed to attract the required personnel. Similar problems can arise in any service as functions requiring specialized skills are transferred to the reserves. Transitional training costs are affected by the number of recruits in the new reserve unit who have not already been trained in the specialties of the new unit.

---

[8] Grant Willis, "Pentagon weighs early out incentives," *The Army Times*, April 1991.

## E. ADDITIONAL ISSUES

### 1. Identifying Transition Costs

Sometimes it can be difficult to determine whether a particular expenditure is best categorized as a transition cost, an infrastructure cost, or a unit cost. Two examples may serve to illustrate this point. Suppose an active unit is being removed from the force structure and being replaced by a reserve unit, but there is a one-year period when both units will be operating. During that year, personnel and other operating costs will exceed their normal recurring level. Is this extra cost properly considered a transition cost? Alternatively, suppose that a unit is being removed from the force structure, its base is being closed, and other activities at the base are either being terminated or transferred elsewhere. Suppose that a hospital is among these other activities and that it is being closed. This means that more people will have to receive medical treatment via CHAMPUS (Civilian Health and Medical Program of the Uniformed Services). Is the continuing stream of increased CHAMPUS expenditures an element of transition costs?

Even though these are legitimate cost considerations, the answer to both questions is no, in the context of the framework described in this study. In the first case, the higher operating costs reflect the fact that both units are in the force structure for one year. The costs of operating both units for that year are captured as unit costs. Both an active and reserve unit are costed, and the overlap of their operating periods will capture the additional costs during the phase-in period.

In the case of the medical costs, medical care is a component of infrastructure costs. The increase in CHAMPUS usage causes a recurring change in infrastructure costs, not a short-term transition cost. As discussed in Section V, infrastructure cost changes are usually estimated as functions of the general characteristics of force structure changes, rather than on the basis of detailed information about how infrastructure will be affected. Thus, the fact that a hospital is being closed would not enter directly into the calculation of recurring medical cost changes. Estimates of decreased medical costs would result because a smaller active force structure is being supported.

### 2. Using Cost Factors

Transition costs must be estimated on a case-by-case basis, but cost factors have been developed to facilitate some parts of the costing. For example, factors for PCS costs and the cost of preparing and shipping equipment are currently being used by analysts in

the Office of the Secretary of Defense. PCS costs are estimated as $11,271 per officer or civilian and $2,763 per enlisted person for movement between Europe and CONUS. The cost of preparing and shipping a ton of equipment depends on the location and destination of the equipment.

The COBRA model, which was built for the Secretary of Defense's Commission on Base Realignment and Closure, is the most complete attempt to develop a set of factors to use in transition costing. Of course, COBRA is tied to base closings rather than force structure changes, but many of the issues and their associated costs are very similar.

COBRA deals with administrative planning and support costs, personnel actions costs, moving costs, transportation costs, freight costs, environmental costs, new construction costs, shutdown costs, procurement and construction costs avoided, and the sale of real property. To use COBRA, a scenario must be defined in considerable detail. The information that must be provided includes the distances from the losing base to all gaining bases, the weight of equipment (other than vehicles) being transferred, the numbers of vehicles in several categories that must be driven or transported, the square footage of property no longer used after the move, real property purchases, environmental mitigation requirements, housing units vacant at gaining facilities, and many other factors.[9]

## F. SUMMARY

Table 27 presents a cost element structure that summarizes the kinds of transition costs that must be considered when force structure changes are made.

This listing of cost sub-elements illustrates the diverse nature of transition costs. No force structure change is likely to involve costs in all of the categories, but every one is likely to involve costs in some of the categories. There are a few cases where cost factors are available to facilitate costing: Air Force PCS moves and decommissioning a class of ships, for example. Most of the time, however, good transition costing requires careful specification of the nature of the change being undertaken.

Transition costs can make force structure changes less fiscally attractive than they initially appear to be or even undesirable. Changes that look cost-effective when transition costs are omitted may not be when they are included. Just as important, failure to estimate transition costs may lead to failure to plan and budget for them. Inadequate funding for the

---

[9] More complete information about COBRA is available in a paper by Douglas M. Brown, *COBRA: The Base Closure Model*, The Logistics Management Institute, Report PL908R1, May 1989.

transition period may lead to reductions elsewhere to free up the necessary money, and readiness may suffer as a result.

**Table 27. Elements of Transition Costs**

| |
|---|
| Base and facilities costs |
| Leasing |
| Construction |
| Land acquisition |
| Environmental studies |
| Cleanup |
| Legal |
| Sale of property (revenue) |
| Equipment Costs |
| Preparation |
| Storage |
| Movement |
| Decommissioning |
| Disposal/Sale |
| Procurement |
| Personnel costs |
| Separation |
| Permanent change of station |
| Recruiting |
| Training |

# VII. SUMMARY AND RECOMMENDATIONS

## A. SUMMARY

The purposes of this research were to develop a cost-estimating framework to support Total Force policy analyses and to apply the framework to illustrate the cost differences of alternative force postures. The study was especially cognizant of cost differences in active and reserve forces and the underlying characteristics that cause these costs to differ.

The development of the framework was influenced by the nature of the questions raised most often during Total Force policy analyses, the types of alternatives considered, and the objectives of these deliberations. This study assumes that the principal variables in Total Force policy analyses are force size and the mix of active and reserve forces. A typical policy-level analysis might evaluate and compare a force of 20 units, 15 active and 5 reserve, or a 22-unit force composed of 14 active and 8 reserve units. From a cost-estimating perspective, this raises a quite different problem than an analysis of two forces of equal size but different active-reserve mixes. The total costs of owning and operating forces of two different sizes, requires the consideration of more elements of defense spending than if one were just considering the relative costs of a specific unit in different components. The range of the relevant costs is broader because more aspects of defense spending are affected by the total size of the force than by its mix of active and reserve units.

Table 1 shows that the pay and operating costs of units constitute only about one quarter of defense spending. On average, the DoD spends as much as that or more on procuring the equipment used by these forces and an even larger portion is spent on infrastructure activities. Based on this understanding of the composition of the defense budget, this study recommends that the framework used to estimate the cost effects in Total Force policy analyses go beyond the traditional focus on direct unit operating costs. Force cost estimates should recognize that equipment procurement is affected by the size of the total force (active plus reserve components) and that a significant portion of the defense infrastructure varies as force size (and to some degree the mix of components) changes.

Even though it is more difficult to estimate, force cost analyses should be aware that there are secondary effects on non-centrally funded support programs that arise because of changes in the primary forces and that force structure changes often require funding for one-time transition expenses.

The recommended estimating framework consists of four major categories:

- Direct Unit Cost
  - Manpower costs
  - Operating costs
  - Equipment-related costs
- Direct Support Costs
  - Non-centralized training
  - War reserve material
  - Other deployable direct direct support activities
- Infrastructure Costs
  - Installation support
  - Central logistics
  - Central training
  - Force management and administration
  - Central medical
  - Central communications
  - Central personnel
  - Aviation training
- Transition Costs
  - Base and facilities costs
  - Equipment costs
  - Personnel costs.

Table 28 summarizes the cost calculations shown in Sections II and V for direct unit costs (operating and equipment costs) and infrastructure costs. The table shows the costs of a variety of primary defense forces displayed by unit pay, operations, and equipment costs along with an estimate of the portion of the defense infrastructure that is affected by type of unit. Estimates of direct support costs and transition costs are omitted from this table because there are no typical, average effects that can be estimated without knowing more of the circumstances of the total force change being considered. The degree to which active units are broken into geographically separated sub-units, can have a major impact on active-reserve comparisons, and this is highlighted in the case of KC-135R units.

## Table 28. Force Cost Summary

| Unit Characteristics | | | | Direct Unit Costs | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Service/Unit Type | Table | Unit Type | Service Component | Personnel Cost | Operating Cost | Unit Annual Cost | Avg. Annual Equip. Cost | Long-Term Annual Cost | Infrastructure Costs | Long-Term Cost |
| **Army** | | | | | | | | | | |
| Armored Division | 5 | European | Active | 617 | 184 | 801 | 175 | 976 | 577 | 1553 |
| | 7 | C1/ALO1 | ARNG | 145 | 66 | 211 | 175 | 386 | 146 | 532 |
| Light Infantry Division | 5 | CONUS | Active | 371 | 29 | 400 | 31 | 431 | 288 | 719 |
| | 7 | C1/ALO1 | ARNG | 92 | 11 | 103 | 31 | 134 | 71 | 205 |
| | 9 | | USAR | 83 | 8 | 91 | 31 | 122 | 63 | 185 |
| NDCI | 5 | CONUS | Active | 197 | 15 | 212 | 13 | 225 | 153 | 378 |
| | 7 | C1/ALO1 | ARNG | 49 | 5 | 54 | 13 | 67 | 37 | 104 |
| | 9 | | USAR | 44 | 4 | 48 | 13 | 61 | 33 | 94 |
| TSI | 5 | CONUS | Active | 266 | 17 | 283 | 10 | 293 | 204 | 497 |
| (Supporting Light | 7 | C1/ALO1 | ARNG | 66 | 6 | 72 | 10 | 82 | 50 | 132 |
| Infantry Division) | 9 | | USAR | 60 | 5 | 65 | 10 | 75 | 45 | 120 |
| **Navy** | | | | | | | | | | |
| FFG-7 | 13 | 65% Full | USN | 6.8 | 5.4 | 12.2 | 12.4 | 24.6 | 6.0 | 30.6 |
| | 13 | Time | USNR | 5.0 | 4.1 | 9.1 | 12.4 | 21.5 | 4.0 | 25.5 |
| F-14 Squadron | 14 | 4018 Fhr | USN | 9.1 | 10.7 | 19.8 | 40.0 | 59.8 | 10.0 | 69.8 |
| | 14 | 2203 Fhr | USNR | 5.4 | 6.3 | 11.7 | 35.3 | 47.0 | 5.0 | 52.0 |
| **USMC** | | | | | | | | | | |
| Infantry Battalion | 15 | | USMC | 24.9 | 8.9 | 33.8 | 0.6 | 34.4 | 18.0 | 52.4 |
| | 15 | | USMCR | 4.5 | 5.3 | 9.8 | 0.6 | 10.4 | 4.0 | 14.4 |
| Tank Battalion | 16 | | USMC | 26.4 | 7.7 | 34.1 | 7.2 | 41.3 | 18.0 | 59.3 |
| | 16 | | USMCR | 5.2 | 5.7 | 10.9 | 7.2 | 18.1 | 5.0 | 23.1 |
| CH-46 Squadron | 17 | 4056 Fhr | USMC | 6.7 | 5.3 | 12.0 | 14.4 | 26.4 | 6.0 | 32.4 |
| | 17 | 2041 Fhr | USMCR | 4.1 | 2.1 | 6.2 | 12.8 | 19.0 | 3.0 | 22.0 |
| **USAF** | | | | | | | | | | |
| F-16 Squadron | 18 | 8134 Fhr | USAF | 20.2 | 13.8 | 34.0 | 30.7 | 64.7 | 27.0 | 91.7 |
| (24 aircraft) | 18 | 4682 Fhr | AFR | 14.6 | 8.3 | 22.9 | 28.5 | 51.4 | 11.0 | 62.4 |
| | 18 | 5064 Fhr | ANG | 11.1 | 8.9 | 20.0 | 28.7 | 48.7 | 10.0 | 58.7 |
| KC-135 Squadron | 19 | 2840 Fhr | USAF | 7.4 | 6.1 | 13.5 | 23.0 | 36.5 | 11.0 | 47.5 |
| (10 aircraft) | 19 | 3801 Fhr | AFR | 12.8 | 8.0 | 20.8 | 23.4 | 44.2 | 10.0 | 54.2 |
| | 19 | 3500 Fhr | ANG | 11.5 | 7.3 | 18.8 | 23.3 | 42.1 | 9.0 | 51.1 |

Note: Costs are in millions of FY 1992 dollars.

When the direct unit operating costs of active and reserve units shown in Table 28 are compared, there are two distinct groupings of relative savings. Some units' long-term average costs have only a modest proportion for equipment, while others have a significant portion of these costs in equipment. Land forces are relatively less capital-intensive than units organized around major weapon systems such as aviation units and ships. The relative savings that can be realized from operating reserve rather than active units is directly related to the difference of a unit's capital intensity. Capital intensity seems to be associated with levels of training and maintenance. These factors are larger for units with high capital investments and have a major impact on the magnitude of the savings that are achieved.

Units with high capital investment (relative to their operating costs) generally save a smaller percentage of their costs than do other units. Considering just the recurring O&S costs of the units, labor-intensive units save from 68 to 77 percent of annual O&S costs, while capital-intensive units save from 25 to 48 percent[10] (see Figure 5). This occurs because the training requirements of the non-capital intensive-units allows these units to operate only a small fraction of the time of their active counterparts while maintaining an acceptable level of readiness. Lower training levels permit the use of a high fraction of part-time personnel and thereby have much lower operating costs in peacetime.

A more complete perspective can be obtained by examining the relative costs when all long-term and indirect support costs are included. Again, labor-intensive units provide the greatest opportunity for savings but not quite the same relative magnitude as when only recurring O&S costs are compared. Figure 6 shows the same relationship as Figure 5 for total ownership costs (i.e., operations, investment, and infrastructure). The relative savings in this comparison are even more significant because investment costs represent a larger proportion of the ownership costs of capital-intensive forces. When all long-term costs are included, labor-intensive forces save 61 to 76 percent compared to their active counterparts. Aviation and ship units save 17 to 36 percent.

---

10 The KC-135R example is excluded from these comparisons because it is an atypical case.

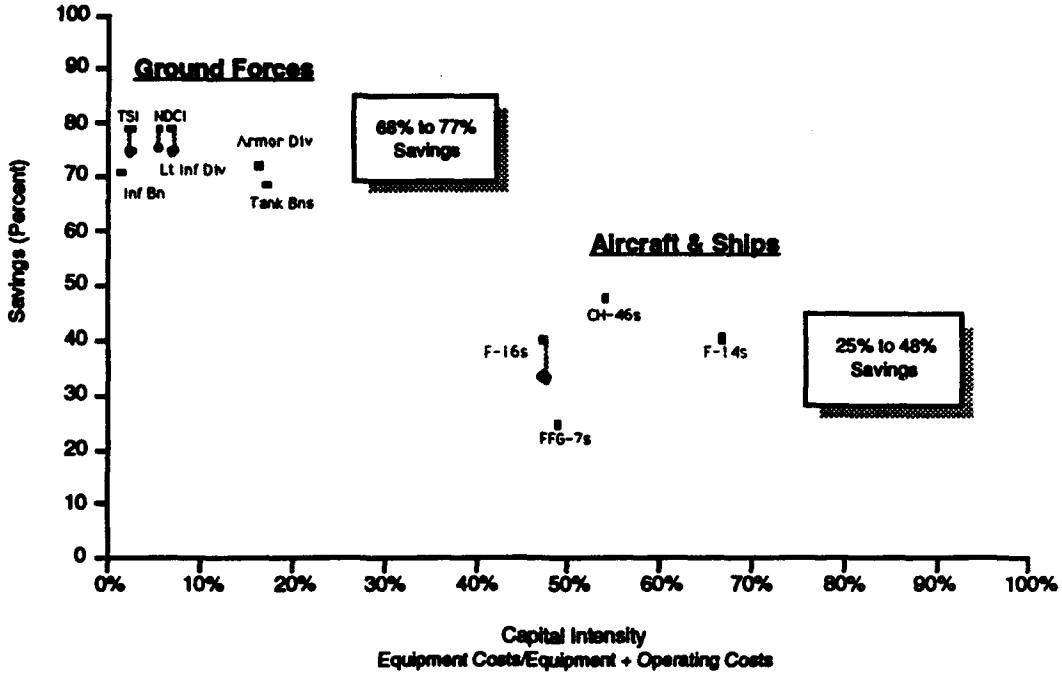


**Figure 5. Unit O&S Cost Savings**

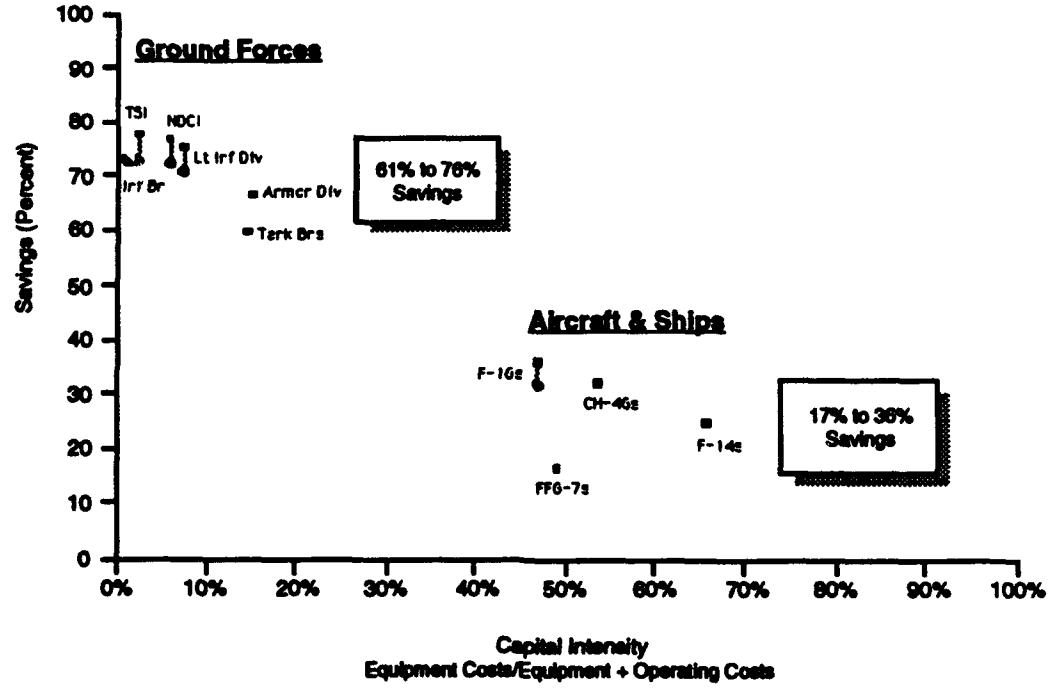


**Figure 6. Total Ownership Cost Savings (O&S, Equipment, and Infrastructure)**

## B. RECOMMENDATIONS

Based on our review of the cost-estimating methods and data currently in use, we believe improvements in total force cost estimates will be obtained by using a framework like the one described in this study. Standardization of the elements of unit operating costs will help make comparisons of active and reserve units more equitable and comparable. Increased standardization will also facilitate comparisons of units from one service with similar units in others. The cost element structure of Table 2 should be used as a guideline to build better and more consistent unit cost databases for both active and reserve units.

Recognition that O&S costs are only a fraction of the total cost of owning and operating an element of force structure is an essential part of total force costing. Force cost analyses should recognize that equipment investment costs and infrastructure costs are affected by Total Force policy decisions, especially those involving changes in total force size. Ignoring these costs will give policy makers an incomplete understanding of the long-term affordability of force posture decisions.

Finally, this study has highlighted the need for some additional research to better achieve the goals of total force costing. More work is needed to improve cost estimators' insights into secondary effects on direct support programs. Estimating the effects on these programs will always require a degree of adaptation to current program contents, but the existing methods do not provide a sufficiently systematic process for considering the major relationships. Similarly, a considerable amount of additional research is required on the relationship between infrastructure program funding and its cost drivers. This work is underway at IDA and will provide a more complete approach to infrastructure estimating than we were able to present in this paper. More research is also required on identifying and estimating equipment-related costs, especially for all types of land forces. Better unit operating cost databases and historical data on unit operating tempos would contribute to force cost analyses. Data on Marine Corps unit operating costs and the operating costs of reserve units need to be improved.

# ABBREVIATIONS

# ABBREVIATIONS

| | |
|---|---|
| ADCOM | Air Defense Command |
| AFR | Air Force Reserve |
| AGR | Active Guard Reserve |
| ALO | Authorized Levels of Organization |
| ANG | Air National Guard |
| ARNG | Army National Guard |
| BLTM | battalion-level training models |
| CHAMPUS | Civilian Health and Medical Program of the Uniformed Services |
| COBRA | Cost of Base Realignment Action |
| CONUS | continental United States |
| DLR | depot-level repairable |
| DoD | Department of Defense |
| FSSG | Force Service Support Group |
| FYDP | Future-Years Defense Program |
| MAGTF | Marine Air Ground Task Force |
| MDEP | Management Decision Package |
| MEB | Marine Expeditionary Brigade |
| MEF | Marine Expeditionary Force |
| MEU | Marine Expeditionary Unit |
| MFP | major force program |
| MPA | military pay and allowance |
| NDCI | non-divisional combat increment |
| O&M | operations and maintenance |
| O&S | operating and support |
| PAA | primary authorized aircraft |
| PCS | permanent change of station |
| POL | petroleum, oil, and lubricants |
| RDT&E | research, development, test, and evaluation |
| SABLE | Systematic Approach to Better Long-Range Estimating |
| SIMA | shore-based intermediate maintenance activity |
| SORTS | Status of Resources and Training System |

| | |
|---|---|
| TAFCS | The Army Force Cost System |
| TAR | Training and Administration of the Naval Reserves |
| TRM | Training Resources Model |
| TSI | tactical support increment |
| USAR | U.S. Army Reserve |
| VAMOSC | Visibility and Management of Operating and Support Costs |
| WRM | war reserve materiel |