OPERATING AND SUPPORT COSTING GUIDE

ARMY WEAPON SYSTEMS

DECEMBER 1974

DCA-R-6

DIRECTORATE OF COST ANALYSIS

OFFICE OF THE COMPTROLLER OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE COMPTROLLER OF THE ARMY
WASHINGTON, D.C. 20310

DACA-CAZ-B

23 December 1974

SUBJECT: Operating and Support Cost Guide

SEE DISTRIBUTION

The attached Operating and Support Cost Guide (O&SCG) for Army weapon systems is provided for use by Army cost analysts when preparing weapon system Independent Parametric Cost Estimates (IPCE) and developing cost inputs for Cost and Operational Effectiveness Analyses (COEA).

FOR THE COMPTROLLER OF THE ARMY:

WAYNE M. ALLEN
Director of Cost Analysis

1 Incl
as

DISTRIBUTION:

OFFICE, SECRETARY OF DEFENSE

Director of Defense Research and Engineering	2
Assistant Secretary of Defense (I&L)	2
Assistant Secretary of Defense (PA&E)	5
Assistant Secretary of Defense (Compt)	2
Assistant Secretary of Defense (ISA)	1

JOINT CHIEFS OF STAFF 5

HEADQUARTERS, DEPARTMENT OF ARMY

Deputy Under Secretary of the Army (Operations Research)	2
Assistant Secretary of the Army (FM)	6
Assistant Secretary of the Army (I&L)	2
Assistant Secretary of the Army (M&RA)	1

DACA-CAZ-B
SUBJECT: Operating and Support Cost Guide

DISTRIBUTION:

Chief of Staff (DACS-ZA)	1
Ballistic Missile Defense Program Manager (DACS-BMZ-A)	1
Director, Management Information Systems (DACS-DIZ-A)	1
Director, Program Analysis and Evaluation (DACS-DPZ-A)	5
Comptroller of the Army (DACA-ZA)	1
Deputy Comptroller of the Army (DACA-ZB)	1
Director of the Army Budget (DACA-BUZ-A)	2
Director of Operation and Maintenance (DACA-OMO)	2
Director of Cost Analysis (DACA-CA)	41
Deputy Chief of Staff for Operations and Plans (DAMO-ZXA)	1
Technical Advisor (DAMO-ZD)	2
Program and Budget Office	2
Director of Operations (DAMO-ODZ)	1
Director of Requirements (DAMO-RQZ)	2
Director of Force Programs and Structure (DAMO-FDZ)	1
Deputy Chief of Staff for Personnel	
Director of Plans, Programs and Budget (DAPE-PBB)	3
Director of Military Personnel Management (DAPE-MP)	1
Enlisted Division (DAPE-MPE)	1
Trainee Division (DAPE-MPT)	1
Deputy Chief of Staff for Logistics	
Assistant Deputy Chief of Staff for Logistics (DALO-ZB)	1
Director of Plans, Operations and Systems (DALO-PLZ-A)	1
Director of Transportation and Services (DALO-TSZ-A)	1
Director of Supply and Maintenance (DALO-SMZ-A)	1
Chief, Office of Support Management (DALO-MGZ-A)	1
Chief, Office of Aviation Logistics (DALO-AV)	1
Chief, National Guard Bureau (NGB-ZA)	1
Chief, Army Reserve (DAAR-ZA)	1
Chief of Engineers (DAEN-ZA)	1
Chief of Research, Development and Acquisition (DAMA-ZA)	1
The Surgeon General (DASG-ZA)	1
Professional Education Coordination Office (DASG-PTT)	1
Director of Resource Management	1
Assistant Chief of Staff for Intelligence (DAMI-ZA)	1
The Adjutant General (DAAG-ZA)	1
The Inspector and Auditor General, US Army Audit Agency	2

DACA-CAZ-B
SUBJECT: Operating and Support Cost Guide

DISTRIBUTION:

ARMY FIELD COMMANDS AND ACTIVITIES

Commander, US Army Forces Command (AFCO)	20
Commander, Training and Doctrine Command (DCS-ATRM)	20
Commander, US Army Materiel Command (AMCCP)	55
Commander, US Army Security Agency (DCSCOM)	1
Commander, US Army Health Services Command (Comptroller)	1
Commander, Eighth US Army (GCJ)	1
Commander, US Army Europe and Seventh Army (AEAGF)	1
Commander, First US Army	1
Commandant, US Army Logistics Management Center (Director Administration and Services)	2
Commander, US Army Management Systems Support Agency (DACS-AME)	1
Commander, US Army Concepts Analysis Agency (DMR)	6
Commander, Fifth US Army	1
Commander, TRI-TAC Office, Fort Monmouth, NJ	1
Commander, US Army Communications Command (Comptroller)	1
Commander, US Army Ballistic Missile Defense System Command	1
Commander, US Army Recruiting Command (USARCCM)	1
Commander, US Army Logistical Evaluation Agency	1
Commander, US Army Research, Development and Acquisition Information System Agency	1

SCHOOLS

Commandant, US Army Command and General Staff College	2
Commandant, US Army Infantry School	1
Commandant, Armed Forces Staff College	1
Commandant, The Army War College	6
Commandant, US Army Institute of Administration	1
Commandant, US Naval Postgraduate School	1
Commandant, US Air Force Institute of Technology	1
Commandant, US Army Southeastern Signal School	1
Commandant, US Army Missiles and Munitions School	1

DACA-CAZ-B
SUBJECT: Operating and Support Cost Guide

DISTRIBUTION

DEPARTMENT OF THE NAVY

Commandant, US Marine Corps (MC-CMC)	2
Comptroller of the Navy	
Director of Budget and Reports (NCD621)	1
Chief of Naval Operations	
Program Planning Office (NOP-605)	1

DEPARTMENT OF THE AIR FORCE

Assistant Chief of Staff, Studies and Analysis	1
Chief of Operations Analysis	1
Comptroller of the Air Force	1
Director of Budget	1
Air Force Systems Command	
Director of Cost Analysis, DCS Comptroller	1
Air Force Training Command, Director of Management	
Analysis ACMF, DCS Comptroller	1

MISCELLANEOUS

Central Intelligence Agency, DS-4A1AHS	1
Defense Communications Agency	1
General Accounting Office	1
Defense Documentation Center	1

OPERATING AND SUPPORT COSTING GUIDE

ARMY WEAPON SYSTEMS

December 1974

DCA-R-6

DIRECTORATE OF COST ANALYSIS

OFFICE OF THE COMPTROLLER OF THE ARMY

PREFACE

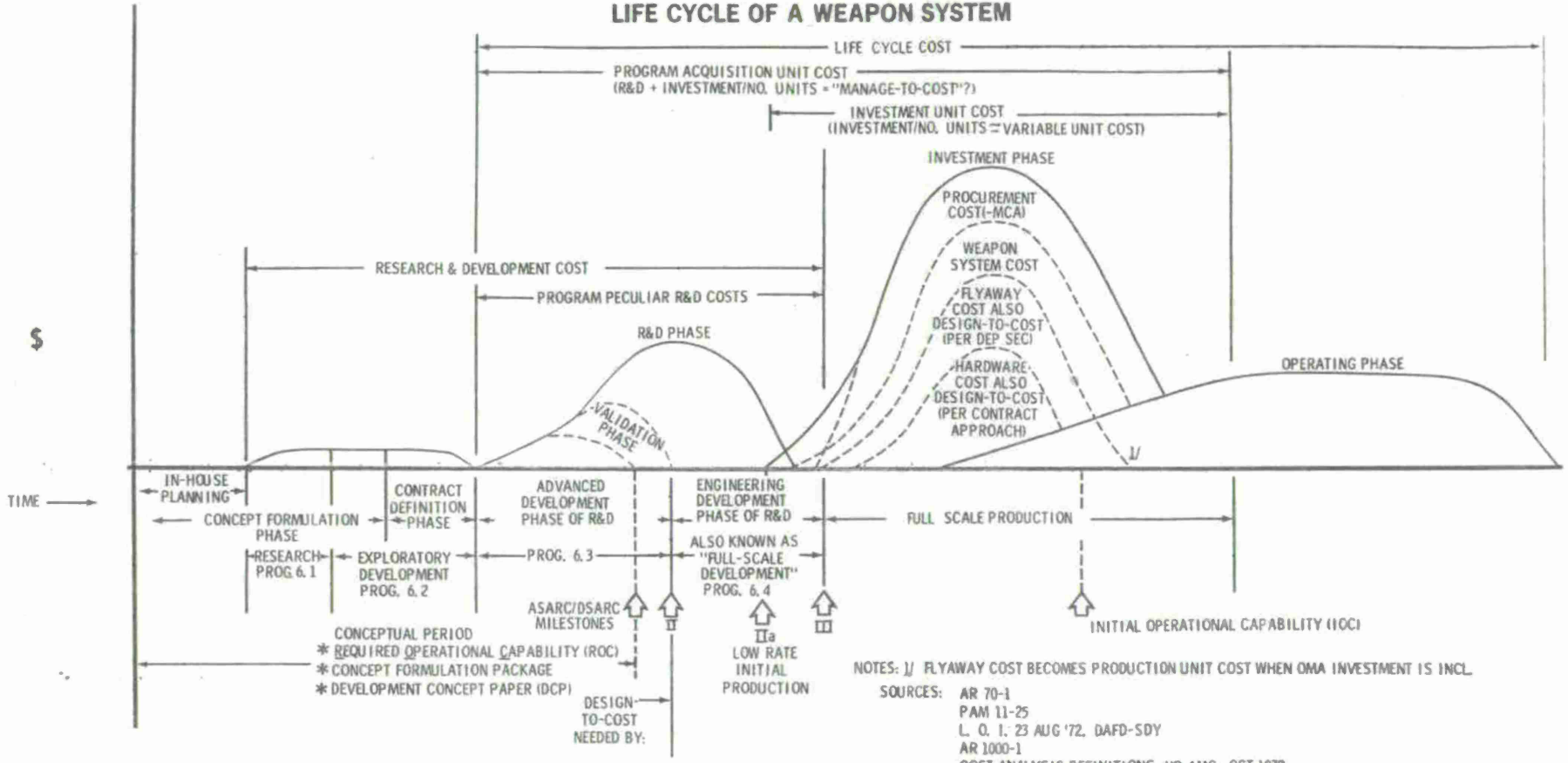
This guide was prepared by the Directorate of Cost Analysis, Office of the Comptroller of the Army, for use by Army cost analysis offices when preparing weapon system Independent Parametric Cost Estimates (IPCE) and developing cost inputs for Cost and Operational Effectiveness Analyses (COEA). It pertains to the Operating Phase in the context presented in Figure 1.

This guide is the first of three guides to be published. The other two guides, one on Investment costing and one on Research and Development costing, will be developed in the months ahead. The three guides, when completed, will be combined in a Weapon System Costing Guide planned for the spring of 1975.

The cost elements, methodologies and reporting formats reflect current parametric costing techniques. Specific questions concerning guide development and cost estimation procedures should be addressed to the System Estimates Division, ODCA, ATTN: Mr. Karl Seiler, OX 5-1104.

—Wayne M. Allen
Director of Cost Analysis

LIFE CYCLE OF A WEAPON SYSTEM



NOTES: 1/ FLYAWAY COST BECOMES PRODUCTION UNIT COST WHEN OMA INVESTMENT IS INCL.

SOURCES: AR 70-1
PAM 11-25
L. O. L. 23 AUG '72, DAFD-SDY
AR 1000-1
COST ANALYSIS DEFINITIONS, HQ AMC, OCT 1972

CONTENTS

Purpose of Guide

This guide provides an ASARC/DSARC/CAIG framework for review of major weapon system life cycle operating and support (O&S) cost estimates. It presents standard O&S cost elements, a standard approach to estimating O&S costs and a standard approach to documenting the cost estimates derived.

This guide formalizes the procedures for O&S costing throughout the Army cost analysis community. It reflects the cost elements and methodologies to be used by HQDA in analyzing weapon system O&S cost estimates prepared by subordinate commands. Because it is conceptually related to the CAIG O&S Guide*, this guide will be used as the basic O&S costing terms of reference before the CAIG.

Much interest has been exhibited in the visibility and management of weapon system O&S costs. The availability, i.e., supply, of O&S cost data is a topic receiving considerable investigation. This guide, by establishing O&S costing methods, surfaces data required, i.e., demand, for Army cost analysis purposes. Thus, an additional purpose of this guide is to make possible the explicit identification of O&S cost data shortfalls so that corrective action may be taken. This guide may also be useful in developing O&S costs for COEA. However, in many COEA's the systems being compared are deployed as part of a larger force; this guide does not explicitly address the force costing of such a larger force.

*See, "Operating and Support Cost Estimates—Cost Development Guide," ASD(PA&E), May 1974 (U).

I. INTRODUCTION

The Need for O&S Cost Estimates

The CAIG, in preparing its O&S Costing Guide, captured the essential reasons why the military services needed to improve their capability for quantifying and considering O&S cost impacts of new systems. These reasons are presented below.

- Force/Support Program Balance

In building the five-year defense program, one of the critical determinations that must be made is the balance between funding for equipment modernization and funding to operate and maintain current combat forces. On one hand, the Army must bring new equipment into the inventory to meet changing strategy demands or to counter changes in threat. On the other, sufficient operating funds need to be programmed to ensure that our existing forces are ready to perform their assigned missions under the President's National Security guidelines.

Over the last three to four years, the Army's flexibility to allocate resources between these competing demands has been reduced. The cost to operate and maintain ready combat forces has continued to rise and consume an increasingly larger percentage of the budget.

The important point is that it is costing more each year to provide the manpower and materiel the Army needs to support its combat forces. As these costs increase for a given equipment and manpower level, the resources available for other needs diminishes.

One of the critical places to examine these costs is in the System Acquisition Review process (ASARC/DSARC). Over the long term, equipment O&S costs are largely a function of the equipment buy decisions of the ASARC/DSARC. There are large outyear O&S cost impacts of each procurement decision. Thus, we must improve our examination of the O&S cost impact of each buy decision, and to ask the critical question, "How can we reduce these costs?" In addition, O&S costs are essential to the Extended Planning Annex (EPA), as the Army's analysis of long range program/budget questions.

- Weapon System Comparisons

Credible estimates of the O&S cost impacts of new systems will permit the Army to better discriminate between competing systems. In a scenaro in which two or more competing systems have comparable performance and unit production costs, it is conceivable that the systems could have significantly different maintenance costs. Although the Army's first priority is to ensure that the systems it buys can do the job, the Army needs to ensure that it gets that system at least total cost to the Nation. A knowledge and understanding of the O&S cost impact of each system will help accomplish that goal.

- Historical Cost Perspective

One of the best ways to gain an understanding of the relative cost impact on the Army of adding a new system to the force is to compare O&S cost estimates of the new system against actual O&S costs of current operating systems. Such a comparison permits the Army to:

(1) Measure and evaluate trends in equipment O&S costs;

(2) Identify shifting demands for support resources among comparable systems (for example, show changes in the requirements for DS/GS maintenance manpower of comparable systems over time);

(3) Focus management attention on critical resource demands of the new system (for example, the number of maintenance men required to service and maintain the system at DS/GS level).

These kinds of cost comparisons permit the Army to examine the resource demands of a new system from the perspective of limited defense resources and focus attention at the Army top management level on the critical question of future manpower and materiel support requirements of our forces.

- Design to Cost Implementation

An important reason for evaluating the O&S cost impacts of new systems is that the Design to Cost concept cannot be fully implemented until the Army integrates operating and support cost targeting and weapon system design. Although the Army establishes unit production cost targets for new systems, this procedure has been used almost exclusively in the acquisition area. That is, given a new system design, what is the unit production cost target that the constractor should aim at? Conceptually, the same principle applies to operating and support costs of the new system. For example, what is the operating

and support cost impact threshold within which the new system is judged affordable? This procedure has yet to be implemented in the O&S cost area.

One of the main reasons is that it is a hard job to establish reliable, useful, and understandable links between system design and the cost to operate and support that design. The link can only be established by a concerted effort to: (1) estimate O&S costs during the acquisition process, (2) record the costs of operating and maintaining our systems in the field, (3) learn what operating and structural characteristics about our systems drive the costs the Army pays out for operation and support, and (4) feeding back what the Army learns to the industrial community so they can improve designs from an operating and support cost impact veiwpoint. Once the Army understands the cause and effect relationship between design and cost, it can then improve the techniques for estimating these costs in the ASARC/DSARC process so that the principals can review total cost impacts of proposed new systems throughout the ASARC/DSARC process and direct attention to reducing the costs. In this way, O&S cost estimates can have a direct impact on system procurement decisions.

An Underlying Principle

The Army's task in estimating O&S costs differs rather substantially from that of its sister services. The Army is less major weapon system oriented and dependent than either the Navy or Air Force. In short, the Army is more labor intensive and less capital intensive than either Navy or Air Force. This reality causes frequent consternation in costing channels when analysts are faced with the decision of what should be included in Army major system O&S costs.

There is a principle that should guide us in making this determination. It is: If a given cost would not exist if the system did not exist, then that cost must be included in the system life cycle cost estimate (LCCE). The LCCE should capture all costs to the government of operating the system. Such estimates should include and clearly identify elements which represent sunk costs and/or inherited assets.

Converting principle to practice requires certain standardization of cost elements and is further assisted by prescription of algorithms for computing costs of those elements. In the final analysis considerable professional judgment must be exercised by the individual analyst in working in the spirit of this principle.

II. O&S COST ELEMENTS

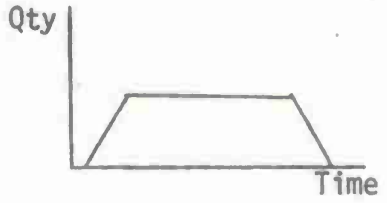
O&S Cost Definition

The term "operating and support cost" is defined in general to be the sum of all costs resulting from the operation, maintenance, and consumption of materials and supplies for a system after acceptance into the Army inventory. For the purposes of this guide, this definition is bounded by the following conditions:

* It includes the aggregate cost over the specified time period of operating and supporting the equipment inventory.

* O&S cost buildup begins when the first production equipment enters the active/reserve force structure either as operating unit equipment or combat crew training equipment.

* For each type of system, a specified life span (X years) is used for Army planning. The cost estimate should be based upon each item operating for X years. This will involve a phase-down period time phased similar to the build-up phase.



* These costs will normally be based on an assumed full trained strength with full TOE equipment in a peacetime environment.

O&S Baseline Definition

The cost estimates developed under the framework of this guide will normally be in constant budget year dollars of the fiscal year following the calendar year in which the cost estimate is made. For example, if the estimate is made in FY 74, constant FY 75 budget year dollars will be used. This is not to preclude development of current dollar cost streams but to define the baseline O&S costs as being in constant dollars.

Range vs. Point Estimate

Where appropriate, a range of costs should be provided. In addition, sensitivity to critical assumptions should be displayed.

O&S Cost Elements

Seven major O&S cost elements are identified in the cost element structure as follows.

COST ELEMENT STRUCTURE

Tactical Military Personnel

- Crew Pay and Allowances
- Maintenance Pay and Allowances
- Indirect Personnel Pay and Allowances
- PCS

Consumption

- Replenishment Spares
- POL

Transportation

Depot Maintenance

- Labor
- Materiel

Modifications

Other Direct Support Operations

Ammunition - Unit Training
Maintenance - Civilian Labor
Other Direct

Indirect Support Operations

Replacement Training
TPP (Transients, Patients, Prisoners)
Quarters Maintenance Utilities
Medical Support
Other Indirect

O&S Cost Element Definitions

* Tactical Military Personnel. This element captures all tactical unit personnel costs associated with operation of the system, including the total cost of operating those units (battalions and separate companies) which exist only because of the system being costed (e.g., Hawk Battalion). This element includes the pay and allowances for system personnel, but excludes replacement personnel while in training and the pro-rated share of instructor and overhead personnel at training centers and schools (see element Indirect Support Operations). Annual recurring PCS travel includes travel of replacement personnel from CONUS to overseas and of replaced personnel from overseas to CONUS. Annual recurring PCS travel within CONUS is not included (except for accession travel—see element Indirect Support Operations), because CONUS travel is not caused by operation and support of the weapon system.

* Consumption.

Replenishment Spares. This element includes the costs of procuring all parts, subassemblies, assemblies, components, special tools, and test sets consumed in repair/overhaul at each level of maintenance except depot. Costs of parts, subassemblies, etc., as a result of losses to the Army supply system caused by accidents, fair wear and tear, and deterioration reaching an uneconomical reparable status will also be included.

Petroleum, Oils and Lubricants (POL). The costs associated with the consumption of fuel and lubricants for the system are included in this element.

* Transportation. This element includes the cost of transporting all items to facilities for overhaul and return to operational units.

* Depot Maintenance. This element includes the labor and parts costs for the repair/overhaul of all items at the depot level.

* Modifications. This element includes the cost of procuring the materiel associated with any official alternation made to a system by accomplishing a modification work order (MWO), retrofit, conversion, remanufacture, or engineering change after acceptance by the Army.

* Other Direct Support Operations. Any direct operating costs not suitable for inclusion in previous elements will be included here. Examples are ammunition consumed during the annual service practice and other training, and below-depot labor cost for civilian employees.

* Indirect Support Operations. This element includes costs incurred in supporting the personnel, supplies, and services required to operate the system. Examples are:

Training of replacement personnel for crew, maintenance, and indirect personnel, who are assumed to attrit from the Army at the average Army rate or at the average rate for their MOS or career field. Included should be the pay and allowances of trainees and instructors plus an apportionment of the OMA cost associated with training.

Other indirect Support Operations. This includes the cost for other operations not specifically addressed above.

O&S Cost Exclusions

Cost specifically excluded from O&S cost estimates are:

* System costs incurred before acceptance into the Army inventory. This exclusion includes all R&D and investment cost elements and initial training associated with introduction of the system. These costs are included in the other two phases of the life cycle.

* O&S cost which cannot be directly related to the system itself or indirectly to support of the personnel, supplies, and services required to operate the system. Such costs (e.g., operating cost of HQ DA) are more appropriately considered as costs of operating the Army as a whole and thus not attributable to the system being costed.

* Operation of commodity commands, supply depots, NICPs.

* Certain elements of pay and allowances (such as enlistment bonuses, reenlistment bonuses, and proficiency pay). These elements are treated as total Army costs, rather than system-specific, because they vary with policy decisions not associated with weapon systems.

* Retirement pay.

III. COST ESTIMATING TECHNIQUES

General

The purpose of this section is to:

* Present generalized equations or algorithms used to estimate costs of each cost element identified and defined in Section II.

* Describe the methodologies/procedures associated with equation use.

For ease of presentation and understanding, the discussion in this section is keyed to the Resource Planning Map shown in Figure 2. The planning map is a simplified Army organization chart which:

* Identifies the Army activities that plan for and/or consume the O&S costs defined in Section II.

* Indicates, by number, the cost element in each block which will be developed in the discussion which follows. The equation for calculating that cost element is identified by the same number in the discussion. In the discussion to follow, the cost equations are in generalized form. That is, rather than showing the specific equations to be used to compute the cost of each cost element, the cost element equations show only the aggregate variables that lead to a particular cost estimate. This procedure is designed to focus attention on the kinds of data and factors needed to make O&S cost estimates.

RESOURCE PLANNING MAP

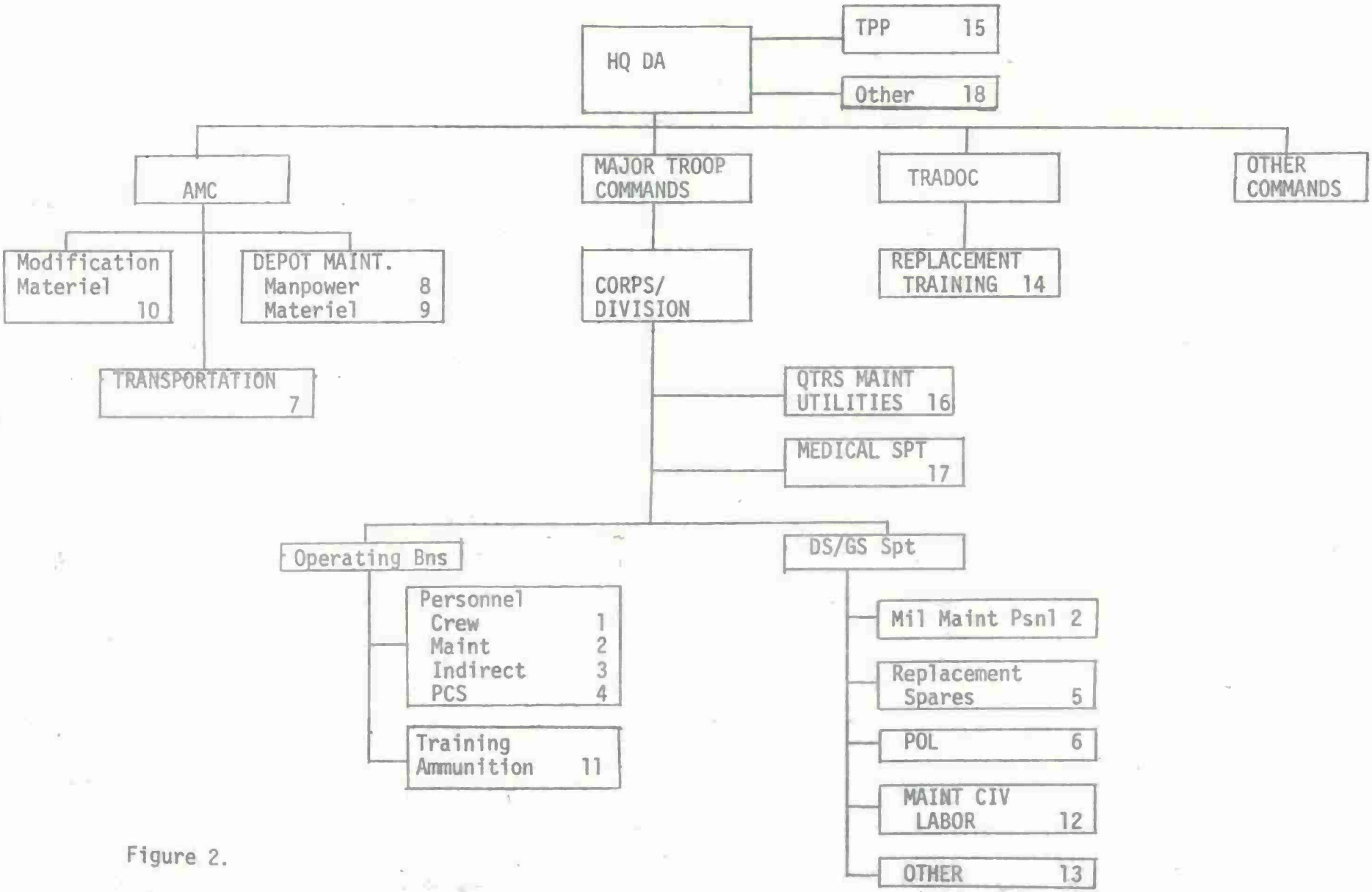


Figure 2.

Cost Estimating Equations

Eighteen generalized equations have been developed to create a framework for satisfying the O&S costing requirement. Each will be presented in turn.

Tactical Military Personnel

* Crew Pay and Allowances

EQ. 1. Crew Pay and Allowances = (number of operational equipments) x (number of crewmen per equipment) x (avg cost per crewman) x (number of operating yrs)

This equation is designed to capture the cost of personnel required to man the operational equipment. It includes all crew members including crew chiefs as appropriate. Included in average cost per crewman are:

- Actual weighted average pay based on grade and MOS assuming a weighted average length of service for each grade.

- Allowances for subsistence and housing (BAS and BAQ) based on grade structure and percent by grade receiving BAQ. These allowances represent the costs to feed the crew members, whether paid as an allowance (MPA) or in purchase of food (MPA). The cost of quarters maintenance/utilities (OMA) is included in indirect support operations.

- Flight pay based on grade. Because the Army maintains more aviators on flight status than there are cockpit seats, this amount must be increased by the multiplier (currently 1.7) which reflects the relationship between cockpit seats and authorized aviators on flight status.

* Maintenance Pay and Allowances

EQ.2. Maintenance Pay and Allowance = (number of maintenance personnel) x (avg cost per man) x (number of operating years)

This equation is designed to capture the cost of maintenance personnel categorized as organizational (org), direct support (DS), and general support (GS), depending upon the level of maintenance they perform. Each category is normally performed by personnel from different military units, who may also perform maintenance on other systems. Thus, their cost must, in some cases, be allocated to the various systems they maintain. Excluded are all costs incurred at depot level (see EQ 8, 9), and civilian labor below depot (see EQ 11).

The number of maintenance personnel may be computed in three ways (and the three techniques will frequently be applied at different echelons: org, DS, GS):

MOS. Where specific maintenance job positions are associated exclusively with the particular system being costed, these personnel should be charged to the system.

Allocation. Where a specific job position performs maintenance on the system being costed and on other equipments, the costs of that position must be allocated among those systems/equipments based upon equipment density or some other factor.

Workload. For example, the number of maintenance personnel required for aircraft may be computed on a per flying hour basis (maintenance manhours per flying hour) assuming a given number of flying hours per aircraft per year.

The average cost for maintenance personnel includes:

- Actual weighted average pay based on grade and MOS assuming a weighted average length of service for each grade.

- Allowances for subsistence and housing (BAS and BAQ) based on grade structure and percent by grade receiving BAQ. These allowances represent the costs to feed maintenance personnel, whether paid as allowances (MPA) or in purchase of food (MPA). The cost of quarters maintenance/utilities (OMA) is included in indirect support operations.

* Indirect Personnel Pay and Allowances

EQ. 3. Indirect Pay and Allowances = (number of indirect personnel) x (avg cost per man) x (number of operating years)

This equation is designed to capture the cost of personnel who, while not in crews or otherwise directly associated with the system, would not be required were it not for the system. For example, certain units (battalions or separate companies) exist only because of the weapon system being costed (e.g., a tank battalion, an assault helicopter battalion). The entire cost of operating such units should be charged to the weapon system. The same elements of pay and allowances included for maintenance personnel are also included here.

* Permanent Change of Station (PCS)

EQ.4. PCS = (total no. of crew, maint, and indirect personnel overseas) ÷ (average stay time for the theater) x (PCS cost per man) x (number of operating years)

This equation is designed to capture the cost of rotating crew, maintenance, and indirect personnel into and out of the units stationed overseas. The annual number of PCS moves should be estimated based on

the average stay time (not the tour length) in the applicable theater(s). Only the costs associated with the overseas movement should be considered. PCS moves within CONUS (other than replacement training) is not normally caused by operation and maintenance of the weapon system. Because such replacement involves a man coming and a man going, two-way PCS costs should be computed.

In summary, the cost of tactical military personnel is defined as the sum of equations one through four.

Consumption

* Replenishment Spares

EQ.5. Replenishment Spares = (number of operational equipments) x (activity rate) x (cost per activity rate) x (number of operating years)

This equation is designed to capture the cost of purchasing parts, components/subcomponents, assemblies/subassemblies, and common hardware items required for maintenance repair and replacement at all echelons below depot maintenance. These repair and replacement items should be costed for all subsystems. These costs should be based on expected reliability and historical experience on currently operating equipments with similar components. Computing a replenishment spare cost estimate normally involves developing an average replenishment spares cost per some activity rate (e.g., per mile for tanks or per flying hour for aircraft).

* POL

EQ.6. POL = (number of operational aircraft) x (activity rate) x (POL cost per activity rate) x (number of operating years)

This equation is designed to capture the cost of petroleum, oil, and lubricants necessary to support the annual activity rate (e.g., flying hours). This cost should be calculated on a per flying hour or per mile, etc., basis, based on experience on relevant existing systems.

In summary, the cost of consumables is defined as the sum of equations five and six.

Transportation

EQ.7. Transportation = (weight of opn equip overhauled per year) x (two times avg distance to depot) x (transportation cost per ton mile) x (number of operating yrs)

This equation is designed to capture the cost of transporting equipment from the using units to depot for overhaul/repair and back to the unit. This is a two-way cost, as equipment leaving a unit for depot is normally replaced by an incoming item at the same time.

Depot Maintenance

* Depot Maintenance Labor

EQ.8. Depot Maintenance Labor = (number of operating equipments overhauled per year) x (number of manhours per overhaul) x (avg cost per depot maintenance manhour) x (number of operating years)

This equation is designed to capture the cost of depot maintenance labor necessary to overhaul equipment at programmed intervals. Such costs should be estimated based on relevant historical experience for equipment which undergoes depot maintenance.

* Depot Maintenance Materiel

EQ.9. Depot Maintenance Materiel = (number of operating equipments overhauled per year) x (cost of materiel consumed per equipment) x (number of operating years)

This equation is designed to capture the cost of parts, assemblies/subassemblies, components/subcomponents, and common hardware items consumed in the depot overhaul/repair of the system. The consumption for such items should be calculated for all subsystems of the system.

In summary, the cost of depot maintenance is defined as the sum of equations eight and nine.

Modifications

EQ.10 Modification Materiel = (number of equipments) x (avg unit proc cost) x (annual mod. cost factor) x (number of operating years)

This equation is designed to capture the cost of materiel items purchased to modify equipment after it is in the Army inventory. Such modifications are made to make the equipment safe for continued operation, to enable it to perform mission essential tasks, and to improve reliability or reduce maintenance costs. Estimates for modification of proposed weapon systems should be based on a percentage of unit procurement cost using relevant historical experience to calculate the appropriate percentage. Because the labor necessary to install modifications may be acquired from any maintenance level, it should be excluded here to preclude double counting.

Other Direct Support Operations

* Ammunition - Unit Training

EQ. 11. Ammunition = (number of operational equipments) x (annual ammunition authorization for unit training) x (ammunition cost per round) x number of operating years)

This equation is designed to capture the cost of ammunition expended in annual service practice, training tests, and other unit training activities. The quantity of ammunition consumed each year should be calculated on a per equipment basis using estimates of the number of rounds authorized for annual training for similar systems.

* Civilian Maintenance - Labor

EQ. 12. Civilian Maintenance - Labor = (number of operational equipments) x (annual civilian manhours for DS/GS maintenance) x (cost per civilian manhour, DS/GS maintenance) x (number of operating years)

This equation is designed to capture the cost of civilian labor for DS/GS maintenance.

* Other Direct Support Operations - Miscellaneous (ODSO-Misc)

EQ. 13. ODSO-Misc = (number of equipments) x (annual cost per equipment) x (number of operating years)

This equation is designed to capture all other direct support costs not reasonably captured in equations 1 through 12. Cost analysts should use the ODSO-MISC as a "catch-all" to complete the 100% of direct O&S costs being sought in the cost estimate.

In summary, the cost of other direct support operations is defined as the sum of equations 11, 12, and 13.

Indirect Support Operations

* Replacement Training

EQ. 14. Replacement Training = (number of crew, maintenance, and indirect personnel) x (annual percentage attrition rate) x (cost per replacement for each MOS) x (number of operating years)

This equation is designed to capture the cost of training replacement personnel to maintain full TOE personnel strengths in units. Training costs are based on numbers of crew, maintenance, and indirect personnel requiring replacement annually. Thus, attrition rates must be established, normally on the assumption that personnel attrition will be the same as the attrition rate of the Army. If significantly different, separate rates can be used for commissioned officers, warrant officers, and enlisted men. Cost per man will include:

1. Recruiting Cost. The average cost per enlisted recruit.

2. Accession Cost. The cost of placing a man on active duty and outfitting him with equipment for further training. Enlistment and reenlistment bonuses should not be included. Precommissioning costs for officers should likewise be excluded.

3. Separation Cost. Each accession involves a separation.

4. Basic Training. The cost of basic combat training (BCT) for enlisted men, and branch basic course for officers.

5. Advanced Training. The cost of attending an MOS producing course beyond the basic training course for all officers (e.g, flight training) and enlisted men (AIT). For flight training, the multiplier for ground duty aviators must be applied.

6. Variable Training Cost. The above courses should be costed based on the variable cost of training one person. Pay and allowances for instructors and students should be included. Fixed costs that exist regardless of the level of students should be excluded from weapon system cost.

* Transients, Patients, Prisoners (TPP)

EQ. 15. TPP = (EQ 1 + EQ 2 + EQ 3) x TPP factor

This equation is designed to capture the pay and allowances of personnel added to the Army strength over and above the TOE/TDA spaces. Not all soldiers are in a unit, doing a job, at all times. On PCS between units, a soldier is accounted for as a transient. Similar accounting provides for long-term hospital cases and for prisoners committed to the Retraining Brigade or the Disciplinary Barracks. PCS students, including those attending MOS training, are carried in the student account. Trainees, during BCT and AIT, are accounted for in the trainee account. The size of the Army is increased above the total of the TOE/TDA spaces by the TTPPS (trainees, transients, patients, prisoners, students) account.

To the extent that the number of direct and indirect personnel associated with a weapon system increases the TTPPS, the pay and allowances of those TTPPS personnel should be included in the weapon system operating and support cost.

Pay and allowances of trainees are captured in the replacement training costs (Indirect Support Operations). The portion of the student account (MOS training) relevant to the weapon system is also captured in the replacement training costs.

The pay and allowances for TPP (transients, patients, and prisoners) in included in Indirect Support Operations as a percentage of pay and allowances for crew, maintenance personnel, and indirect personnel.

* Quarters Maintenance/Utilities

EQ. 16. Quarters Maintenance/Utilities = ([(number of crew, maint, and indirect personnel) x (% living in family housing) x (annual cost of family housing maintenance/utilities)] + [(number of crew, maint, and indirect personnel) x (% living in BOQ/BEQ) x (annual cost of BOQ/BEQ maintenance/utilities)] + [(number of crew, maint and indirect personnel) x (% living in barracks) x (annual cost of barracks maintenance/utilities)]) x (number of operating years)

This equation is designed to capture the cost of quarters maintenance and utilities provided personnel living in family quarters, BOQ/BEQ, and barracks.

* Medical Support

EQ. 17. Medical Support = (number of crew, maint, and indirect personnel) x (annual cost of medical support per soldier) x (number of operating years)

This equation is designed to capture the variable cost of medical and dental support rendered to military personnel. It does not include the cost of support rendered to cadets, retired personnel, or dependents, nor does it include the cost of medical research and other medical overhead activities.

* Other Indirect Support Operations (OISO)

EQ. 18. Other Indirect Support Operations = (number of equipments) x (annual cost per equipment) x (number of operating years)

This last equation is designed to capture any other indirect O&S cost necessary to complete 100% of the indirect cost picture. Such items will differ from system to system. This element will include the cost of general supplies to support those units which exist solely because of the system being costed. This element should also include any identifiable transportation cost (other than to/from depot), such as special transportation of tracked vehicles to training areas and transportation of repair parts and secondary items.

In summary, the cost of indirect support operations is defined as the sum of equations 14 through 18.

IV. COST DOCUMENTING TECHNIQUES

General

Eighteen generalized equations, also called cost data expressions, were presented in Section III. These equations were designed, by definition, to capture 100% of estimated O&S cost. The purpose of this section is to present an approach for communicating, in a highly visible way, the methodology, factors and sources employed by cost analysts to convert these generalized equations to specific working equations.

Approach

Each of the 18 cost data expressions is self-contained and mutually exclusive. Each is a cost building block. Cost building blocks are also called modules or "cells" when grouped in a cost model matrix. An attribute of this modularity is that documentation may be approached on a module basis.

* Documentation Module. To be complete a documentation module should cover the following points:

1. A recording of the cost data expression.

2. A listing of the inclusions and exclusions of the expression.

3. A recording of the expression as a mathematical notation.

4. A listing of the input variables associated with the notation.

---

5. A listing of the values assigned to input variables.

6. A discussion of how individual values were derived.

7. A recording of the source(s) leading to the choice of values.

* Documentation Formats. Experience suggests these seven points are best covered in two formats, a "Cost Data Sheet" and a "Variable Explanation Sheet." The first four points are covered in the data sheet and the last three in the explanation sheet. The documentation is split between these two formats to avoid unnecessary duplication. Certain variables are necessarily repeated in selected cost expressions.

* Examples. Using the first of the 18 cost data expressions, a Cost Data Sheet has been prepared and is presented in Figure 3. One of the variables in this cost data expression is average annual cost per crewman; a Variable Explanation Sheet has been prepared and is presented in Figure 4.

An O&S cost estimate is considered documented when a Cost Data Sheet has been prepared for each cost data expression and a Variable Explanation Sheet has been prepared for each different input variable. The cost estimator should append to the explanation sheet any evidence to support the choice of values, e.g., cost quantity curves or statistical material related to regression derivation.

O&S Data Demands

The 18 cost data expressions require certain operational and cost data to be collected and/or developed. This data has been summarized and is included in Table 1.

Figure 3

CELL NO: A(57,9)

DATE: _____

EXAMPLE

COST DATA SHEET

ITEM: Crew Pay and Allowance

COST DATA EXPRESSION:

Crew Pay and Allowance = (Number of Operational Equipments) x (Number of Crewmen per Equipment) x (Avg Cost per Crewman) x (Number of Operating Years) x (Constant Dollar Shift Factor - MPA)

INCLUDES:

1. Salaries of all crew members including crew chiefs where applicable.

2. Subsistence and housing.

3. Flight pay, if applicable.

EXCLUDES:

PCS Costs.

FINAL COST MODEL EXPRESSION (MATHEMATICAL NOTATION):

A(57,9) = XI(10) * XN(180) * AC(44) * YI(1) * SF(13)

VARIABLES ARE:

XI(10) = Number of operational equipments
XN(180) = Number of crewmen per equipment
AC(44) = Average annual cost per crewman
YI(1) = Number of operating years
SF(13) = Constant dollar shift factor, MPA[1/]

1/ All data is first normalized to FY72 $, shift factor permits expressing product of equation in any other year constant dollar terms, e.g., FY74 $.

EXAMPLE

Figure 4

VARIABLE NO: AC(44)

VARIABLE EXPLANATION SHEET

ITEM: AC(44) Average Annual Cost Per Crewman

CURRENT VALUE BEING USED: $6,123 (FY72 $)

DESCRIPTION OF HOW VALUE DERIVED:

1. Assume crew consists of:

   1 E5 Crew Chief
   1 E4 Door Gunner

2. Record pay scales[1/]:

   a. Include Europe Incremental

	FY72 $
E7	9,900
E6	8,216
E5	6,702
E4	5,543
E3	4,978
E2	3,902

3. Determine average:

   1 (E5) * 6702 + 1 (E4) * 5543 = 12,245 ÷ 2 = 6,123

SOURCE OF DATA:

1/ DCSPER, Comment to DF, Update of Data for Summary Cost Data Book for Army Managers (DACA-CAF).

COST CELLS IMPACTED:

TABLE 1

O&S COSTING DATA DEMANDS

Requirements Data	Cost Data
1. No. of operational equipments to be costed.	1. Average annual cost per crewmen - pay and allowance.
2. No. of crewmen per operational equipment.	2. Average annual cost per maintenance man - pay and allowance.
3. No. of years equipment is to be operated.	3. Average annual cost per indirect man - pay and allowance.
4. No. of military maintenance personnel per equipment.	4. Average PCS cost per man (to/from overseas).
5. No. of indirect personnel.	5. Replenishment spares cost per activity rate, e.g., flying hour.
6. Equipment activity rate, e.g., flying hours/year.	6. POL cost per activity rate.
7. Equipment transported per year, field-depot-field.	7. Transport cost per ton-mile.
8. Average distance field to depot.	8. Average cost per depot maintenance manhour.
9. Average no. of manhours per overhaul.	9. Average cost per DS/GS civilian manhour.
10. Annual ammo. authorization for unit tng.	10. Cost of materiel consumed per equip. during overhaul.
11. Annual personnel attrition rate.	11. Percent of equipment cost for modification.
12. No. of personnel overseas.	12. Ammo. cost per round.
13. Average stay-time overseas.	13. Cost of direct support operation not included elsewhere.
14. Average no. of civilian DS/GS maintenance.	14. Average cost per replacement personnel.
15. Factor for TPP (transients, patients, prisoners).	15. Annual cost per equipment for other indirect support operations.
16. Ratio of authorized aviators to cockpit seats.	16. Annual cost of maintenance/utilities for: Family Housing Units BOQ/BEQ per Occupant Barracks, per Occupant
17. Percentage of personnel living in: Family Housing BOQ/BEQ Barracks	17. Annual cost of medical support per soldier.

DISTRIBUTION

OFFICE, SECRETARY OF DEFENSE	
Director of Defense Research and Engineering	2
Assistant Secretary of Defense (I&L)	2
Assistant Secretary of Defense (PA&E)	5
Assistant Secretary of Defense (Compt)	2
Assistant Secretary of Defense (ISA)	1
JOINT CHIEFS OF STAFF	5
HEADQUARTERS, DEPARTMENT OF ARMY	
Deputy Under Secretary of the Army (Operations Research)	2
Assistant Secretary of the Army (FM)	6
Assistant Secretary of the Army (I&L)	2
Assistant Secretary of the Army (M&RA)	1
Chief of Staff (DACS-ZA)	1
Ballistic Missile Defense Program Manager (DACS-BMZ-A)	1
Director, Management Information Systems (DACS-DIZ-A)	1
Director, Program Analysis and Evaluation (DACS-DPZ-A)	5
Comptroller of the Army (DACA-ZA)	1
Deputy Comptroller of the Army (DACA-ZB)	1
Director of the Army Budget (DACA-BUZ-A)	2
Director of Operation and Maintenance (DACA-OMO)	2
Director of Cost Analysis (DACA-CA)	41
Deputy Chief of Staff for Operations and Plans (DAMO-ZXA)	1
Technical Advisor (DAMO-ZD)	2
Program and Budget Office	2
Director of Operations (DAMO-ODZ)	1
Director of Requirements (DAMO-RQZ)	2
Director of Force Programs and Structure (DAMO-FDZ)	1
Deputy Chief of Staff for Personnel	
Director of Plans, Programs and Budget (DAPE-PBB)	3
Director of Military Personnel Management (DAPE-MP)	1
Enlisted Division (DAPE-MPE)	1
Trainee Division (DAPE-MPT)	1
Deputy Chief of Staff for Logistics	
Assistant Deputy Chief of Staff for Logistics (DALO-ZB)	1
Director of Plans, Operations and Systems (DALO-PLZ-A)	1
Director of Transportation and Services (DALO-TSZ-A)	1
Director of Supply and Maintenance (DALO-SMZ-A)	1
Chief, Office of Support Management (DALO-MGZ-A)	1
Chief, Office of Aviation Logistics (DALO-AV)	1
Chief, National Guard Bureau (NGB-ZA)	1

DISTRIBUTION (Continuation)

Chief, Army Reserve (DAAR-ZA)	1
Chief of Engineers (DAEN-ZA)	1
Chief of Research, Development and Acquisition (DAMA-ZA)	1
The Surgeon General (DASG-ZA)	1
Professional Education Coordination Office (DASG-PTT)	1
Director of Resource Management	1
Assistant Chief of Staff for Intelligence (DAMI-ZA)	1
The Adjutant General (DAAG-ZA)	1
The Inspector and Auditor General, US Army Audit Agency	2

ARMY FIELD COMMANDS AND ACTIVITIES

Commander, US Army Forces Command (AFCO)	20
Commander, Training and Doctrine Command (DCS-ATRM)	20
Commander, US Army Materiel Command (AMCCP)	55
Commander, US Army Security Agency (DCSCOM)	1
Commander, US Army Health Services Command (Comptroller)	1
Commander, Eighth US Army (GCJ)	1
Commander, US Army Europe and Seventh Army (AEAGF)	1
Commander, First US Army	1
Commandant, US Army Logistics Management Center (Director, Administration and Services)	2
Commander, US Army Management Systems Support Agency (DACS-AME)	1
Commander, US Army Concepts Analysis Agency (DMR)	6
Commander, Fifth US Army	1
Commander, TRI-TAC Office, Fort Monmouth, NJ	1
Commander, US Army Communications Command (Comptroller)	1
Commander, US Army Ballistic Missile Defense System Command	1
Commander, US Army Recruiting Command (USARCCM)	1
Commander, US Army Logistical Evaluation Agency	1
Commander, US Army Research, Development and Acquisition Information System Agency	1

SCHOOLS

Commandant, US Army Command and General Staff College	2
Commandant, US Army Infantry School	1
Commandant, Armed Forces Staff College	1
Commandant, The Army War College	6
Commandant, US Army Institute of Administration	1
Commandant, US Naval Postgraduate School	1

DISTRIBUTION (Continuation)

Commandant, US Air Force Institute of Technology	1
Commandant, US Army Southeastern Signal School	1
Commandant, US Army Missiles and Munitions School	1
DEPARTMENT OF THE NAVY	
Commandant, US Marine Corps (MC-CMC)	2
Comptroller of the Navy	
Director of Budget and Reports (NCD621)	1
Chief of Naval Operations	
Program Planning Office (NOP-605)	1
DEPARTMENT OF THE AIR FORCE	
Assistant Chief of Staff, Studies and Analysis	1
Chief of Operations Analysis	1
Comptroller of the Air Force	1
Director of Budget	
Air Force Systems Command	
Director of Cost Analysis, DCS Comptroller	1
Air Force Training Command, Director of Management	
Analysis ACMF, DCS Comptroller	1
MISCELLANEOUS	
Central Intelligence Agency, DS-4A1AHS	1
Defense Communications Agency	1
General Accounting Office	1
Defense Documentation Center	1
RESERVE FOR ADDITIONAL REQUESTS	190
TOTAL	450