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Technical Report

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DEPARTMENT OF DEFENSE

Materiel Distribution System Study

Volume II.
Technical report.

PREPARED FOR THE

JOINT LOGISTICS COMMANDERS

WORK PAPERS ONLY, LIMITED DISTRIBUTION, NOT APPROVED OR COORDINATED STAFF POSITIONS OF THE JOINT DARCOM/NMC/AFLC/AFSC COMMANDERS

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VOLUME II
TECHNICAL REPORT

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FOREWORD

A. REPORT ORGANIZATION

The Final Report of the Department of Defense Materiel Distribution System Study consists of three principal parts.

The Executive Summary, Volume I, is intended for the decision maker who must know the essential elements and findings of the study. It contains five chapters: (1) The Foundation of the Study; (2) The DOD Materiel Distribution System Defined; (3) Tools for Analysis; (4) Analysis and Findings; and (5) Implementation Planning.

The Technical Report, Volume II, is the technical description of the study. It is intended primarily for staff elements required to review the report and those persons who will have implementation or follow-on responsibilities. It consists of eight chapters:

Chapters One and Two -- "Introduction" and "System Requirements" -- establish the reasons for the study, the objectives, the study organization, the Service requirements, and planning factors for the study.

Chapter Three -- "The Baseline System" -- describes the baseline DOD Materiel Distribution System, in a total system context, used in conducting the DODMDS study.

Chapter Four -- "Methodology" -- is a description of the analytical tools and techniques used to study the system (the methodology).

Chapter Five -- "Analysis" -- provides a narrative account of how the analysis was conducted and how the proposed system structure evolved.

Chapter Six -- "Options" -- provides the options available to the decision maker within the framework of the system structure evolved in Chapter 5.

Chapters Seven and Eight -- "Findings, Conclusions, and Recommendations" and "Implementation Considerations" -- present: (a) the conclusions drawn from the study, (b) recommended structure, and (c) an overview of the implementation process.

Volume III, contains the Appendices which provide supporting detail for the Technical Report. It has reference documents, tables, descriptions and other source data for statements made in the Technical Report.

Final Report contents and structure are shown in table format on page ix.

B. LIMITATIONS AND ADVANTAGES OF THIS REPORT

1. LIMITATIONS

a. Exclusions. The greatest problem faced by the study group stemmed from the size and structure of the wholesale distribution system in the Department of Defense. It was necessary to develop exclusions to bound the distribution problem. Excluded were these major commodities: ammunition, bulk fuel, perishable subsistence and classified materiel. The functions of maintenance and inventory management were also excluded.

b. Aggregations. It was also necessary to aggregate such immense variables as 3 1/2 million stock numbers and 50 thousand customer locations worldwide. Large scale studies such as this are always open to the charge that problems are aggregated out of existence, or that results are biased by the aggregations which have been made. To forestall and rebut criticisms of this type the study group sought to retain the essence of the real world within the aggregations. All major military installations in CONUS were retained as discrete customers of the wholesale system in a way which retained their essential characteristics. But perhaps most important, the aggregation strategies permitted sufficient flexibility for the consideration of specific items and customers where necessary. The techniques used for these aggregations are described in considerable detail in Book 4, Appendix D-2.

c. Age of Data Base. The data represent actual customer transactions which existed in 1975-1976. Are they still valid? First of all, the customer demand patterns in DOD change relatively little. Support systems, like Direct Supply Support (DSS), Air Lines of Communication (ALOC) and the like can vary but the essential characteristic which drives the system - the customer - does not shift dramatically from year to year. Secondly, there is a capability to evaluate the impact of major hypothetical customer and supplier shifts for mobilization or other scenarios. These two factors - relative stability of customer demand and capability to evaluate major changes on a "what if" basis - combine to make the 1975-1976 data quite useful for many years to come.

d. Depot Cost. In terms of depot cost analysis, that most sensitive of all concerns, the study group was limited by the DOD cost accounting structure for distribution facilities. The cost accounting structure required the development of complex data analysis techniques to reflect the variety of depots, missions, and commodity mixes in the DODMDS. Even though the data analysis techniques have some limitations in delineating detailed internal depot operating costs, the system sensitivity to these limitations under several conditions was tested. The baseline depot cost data base is the culmination of extensive and exhaustive research at the depot level to ensure that the numbers represent maximum reality.

e. Difficulty Factors. In joining historical depot workload and depot costs, it was impossible to use a single criterion, like line items issued, or weight issued, to develop depot cost rates. Therefore, difficulty factors were developed which have the advantage of using more than a unitary measure, but the disadvantage of being an average value applicable to a commodity group. Yet, it was clear that the cost and difficulty of issuing a pound of electronic parts was different than that for issuing a pound of canned food. Difficulty factors were a necessity.

f. Transportation Rates. Transportation costs required aggregation from literally trillions of possible rate combinations to a more manageable number of representative rates. The verification of transportation homogeneity through use of Transportation Cost Indices, and the use of weighted average transportation rates provided a very constructive and successful way to deal with this problem.

g. Facility Investment. In general, it was found that the storage facilities were relatively old but serviceable, and the processing capacities satisfactory, particularly with several new facilities having been constructed during the past few years. The study, then, has the limitation, if it could be called that, of proposing relatively limited new investment. Rather, it recommends greater volume through existing facilities. This is not meant to be a case against new construction or modernization. The intent is that DOD make better use of its existing facilities and at the same time evaluate investment proposals on a location-by-location basis, given the workloads implicit in the DODMDS study recommendations. The capacity for technological adaptivity at many existing sites should lead to high potential labor savings without intensive investment in new construction.

h. Models. Other limitations relate to the use of modeling -- both dynamic (simulation) and static (optimization). It is difficult to say that a computer program can somehow replicate the ebb and flow of talented people working in DOD facilities and represent a "best" system which would ultimately affect the livelihood of large numbers of people. Models were used only as a tool in the analysis, but a very powerful and versatile tool. The dominant analysis technique has been people - personnel of the study group, logistical commands and DLA - using models as an aid.

i. Economic Analysis. Another limitation is detailed economic analysis. While conclusions are very specific and relate to real savings in personnel, transportation, and facility costs, it will still be necessary to review in a more detailed way the savings which are proposed. For example, one-time costs associated with personnel dislocations are estimates, based on anticipation of conditions several years hence.

j. Quality of Data. As the report shows, the data furnished by the Services and DLA were far from perfect. The data contained many omissions, inaccuracies and other flaws. Steps were taken (and documented) to make the data better - not perfect - but better. In many cases it was necessary to use "plugs", or samples, to represent the class or commodity involved. These plugs and the rationale for them are described in Book 3, Appendix D-1. The quality of the data used in this report was, then, subject to the problems of the Services'/DLA capacity to report their transactions correctly and accurately and the difficulties of aggregating that data for study purposes. Some original source data errors are undoubtedly still in the data base. On balance however, the study group felt that the corrected data base was representative of the total system.

2. ADVANTAGES

a. Large Potential Savings. Given the limitations just discussed, a very specific blueprint for the future is recommended. It is a plan which makes sense intuitively. In general, the potential savings are more than enough to justify the cost of the study whether the entire blueprint or only a portion of it is ever implemented. Very specific time phased steps to attain savings are suggested.

b. Spin Offs. Many agencies have already used elements of the DODMDS data base with success. The availability of this kind of data to the DOD is a mixed blessing - it can generate more questions than it answers. Yet, this is the very type of analysis which could be most valuable - the review of concepts which had not previously been possible to consider and decision options which show, at a minimum, the opportunity costs for decisions under evaluation.

c. Trained Personnel. A joint study can lead to the strength of shared knowledge - which this study has - and also occasionally to the difficulties of misunderstood goals and hopes - which has also occurred. Yet for those members of the DODMDS study group, there has been an opportunity to prepare for broader challenges in the field of logistics.

3. SUMMARY

On balance, this report and its methodology can be criticized as being too aggregated, too complicated, too dependent on models, or insensitive to unique needs. Yet the pages which follow describe an immense task, accomplished by personnel who were very sensitive to both the general and specific needs of the Services/DLA, using techniques which have broken new ground - yet which also have generated solutions which are practical, implementable and future-oriented.

DODMDS Final Report Structure

DEPARTMENT OF DEFENSE
MATERIEL DISTRIBUTION SYSTEM STUDY
(DODMDS)

VOLUME II

TECHNICAL REPORT

CONTENTS

CHAPTER 6 - OPTIONS

CHAPTER 7 - FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

A. THE DOD MATERIEL DISTRIBUTION SYSTEM IN PERSPECTIVE

Military logistics has been defined as "the creation and sustained support of weapons and forces to be tactically employed to attain strategic objectives."[1] It encompasses the planning and carrying out of the movement, maintenance and necessary support of the armed forces, their weapons systems and equipment. The materiel distribution function within logistics includes those processes and facilities necessary to receive, store, package and preserve, issue, transport and control military materiel from the point of materiel origin at the supply sources through the distribution facilities to the using activities.[2] It is within this context that the Department of Defense Materiel Distribution System (DODMDS) was examined in this study.

The DOD budget of $110.2 billion for Fiscal Year 1977 included, of course, the complete U.S. arsenal of weapons, manpower, and logistic support, for both strategic and tactical purposes -- on the land, on and under the sea, and in the air. Although logistics is one of the largest claimants of the defense dollar (one source says it accounts for as much as 50 percent

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[1] Henry E. Eccles, RADM (Ret), Military Concepts and Philosophy, (New Brunswick, N.Y.: Rutgers University Press, 1965).

[2] Adapted from Department of Defense Dictionary of Military and Associated Terms, Joint Chiefs of Staff, JCS Pub. 1, 3 September 1974.

of the DOD budget[1]), its precise cost is difficult to determine due to the many functional areas and echelons which incur logistics related costs.

Logistics activities involve military units at all levels -- in combat units, at intermediate levels, and at centralized facilities -- throughout the defense establishment in every part of the world where U.S. forces are located. The most visible, perhaps, are the centralized activities of supply and maintenance. In FY 1977, it was estimated that these centralized activities accounted for approximately 35 percent of all logistics functions, or $10.2 billion.[2]

The DOD Materiel Distribution System (DODMDS) is a portion of this vast logistics activity. This "system" consists of five semiautonomous subsystems -- Army, Navy, Air Force, Marine Corps and Defense Logistics Agency (DLA) -- with policy guidance, coordination and directives provided by the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). The DOD Materiel Distribution System, in a simplified form, is illustrated in Figure 1-1.

The study concentrates on the wholesale distribution system which moves millions of items of subsistence, parts and supplies used by all of the Services and DLA.[3] The latest techniques in physical distribution analysis were used. By analyzing the total system in this manner, an analysis of the trade-offs between system cost and levels of service could be made. This particular approach to DOD wholesale

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[1] Thomas R. Weschler, "Decade of Logistics," Army Logistician, Vol. 7, No. 1 (January - February 1975), pp. 3, 5.

[2] Annual Defense Department Report, FY 77. 27 Jan 76 (Washington, D. C.).

[3] For a recent study of the retail activities, see "DOD Retail Inventory Management and Stockage Policy (RIMSTOP)" Office of the Assistant Secretary of Defense - Installations and Logistics, Working Group Report (September 1976).

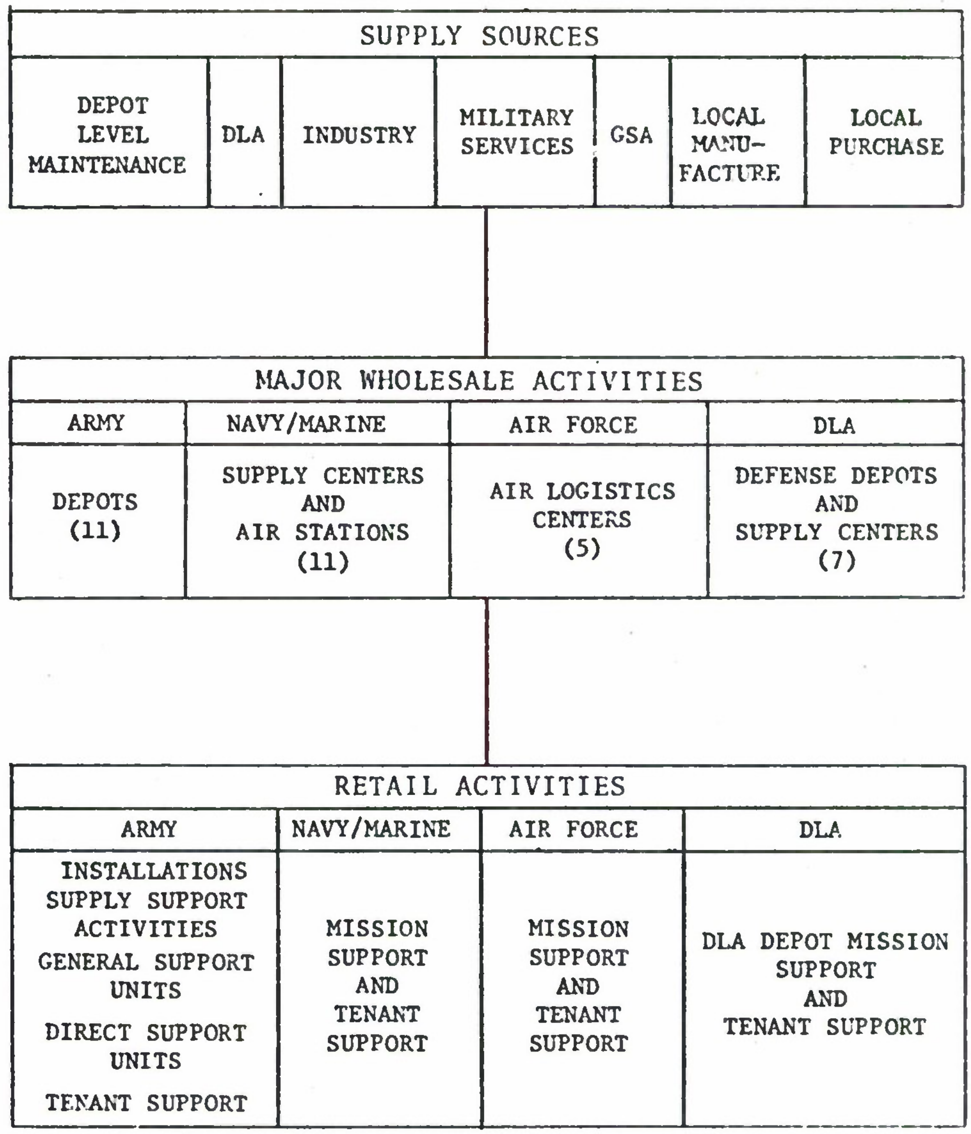

FIGURE 1-1

DOD MATERIEL DISTRIBUTION SYSTEM

distribution, as a total system, is a concept that had never before been attempted in depth.

B. REASON FOR THIS STUDY

Improvements to logistical support which provide quicker response times to the combat units, at reduced cost, is a goal continually sought by logisticians and others concerned with U.S. military readiness and capabilities. At the 1975 DOD Logistics Symposium,[1] composed of top DOD military and civilian logisticians, a number of alternatives were examined for achieving greater efficiency in the distribution of materiel within the DOD. An understanding was reached that the Joint Logistics Commanders (JLC) would

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[1]Held 20-22 January, 1975 at Airlie House, Warrenton, Virginia. Participants included the Logistics Systems Policy Committee (LSPC), the Military Logistics Council (MLC), the Joint Logistics Commanders (JLC), and top supporting staffs. The LSPC included: the Assistant Secretary of Defense (Installations and Logistics), the Assistant Secretary of Defense (Comptroller), and the Assistant Secretaries of the Army, Navy and Air Force, respectively, for Installations and Logistics; their military counterparts: - the Director of Logistics of the Joint Chiefs of Staff, the Deputy Chiefs of Staff for Logistics of the Army, Navy and Air Force, respectively; the Marine Corps Deputy Chief of Staff for Installations and Logistics; and the Director of the Defense Logistics Agency. The MLC is made up of: the Director of the Defense Logistics Agency, JCS (J-4), the Army Deputy Chief of Staff for Logistics, the Air Force Deputy Chief of Staff for Systems and Logistics, the Navy Deputy Chief of Naval Operations (Logistics), and the Marine Corps Deputy Chief of Staff for Installations and Logistics. The JLC consists of the Commanders of the Army Materiel Development and Readiness Command, the Naval Material Command and the Commanders of the Air Force Logistics and Systems Commands, respectively.

conduct a study of the wholesale DOD Materiel Distribution System with the objective of recommending specific actions, time frames, and resources required to improve the system.[1]

This understanding culminated a series of events which can be traced to the late 1960's. In 1967, the Congress trimmed the Defense budget "to encourage integration of logistics support."[2] In 1969, the President appointed a Blue Ribbon Defense Panel composed of leading citizens from industry, academic institutions, law, and finance, and charged them with examining the organization and management of the Department of Defense, including its logistical support functions. The panel found, among other things, that "the logistics system of the Department of Defense is decentralized and fragmented in functional assignments." It noted that in some activities, efforts of the Congress and the Office of the Secretary of Defense (OSD) to improve efficiency and effectiveness through standardization of procedures "achieved very limited improvements." The report stated:

> "the current inventory management, distribution, maintenance, and transportation systems are needlessly inefficient and wasteful, and even more important, fall far short of the potential for effectiveness of support of combatant commanders".[3]

In January 1970, the Logistics System Policy Committee (LSPC) was created "to direct the development, maintenance and coordination of the LOGPLAN" (DOD Directive 5126.43). The LOGPLAN in turn

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[1] "Summary Report of DOD Logistics Symposium", Airlie House, January 1975, p. 9.

[2] Report to the President and the Secretary of Defense on the Department of Defense by the Blue Ribbon Defense Panel", 1 July 1970, p. 98.

[3] Ibid., p. 106.

was intended to be a "DOD-wide long-range improvement plan for logistics system development, complementing the Five Year Defense Program."[1]

The Assistant Secretary of Defense (I&L), noted at the DOD Logistics Symposium in 1975 that the "LOGPLAN has not yet become an action plan" and that "the LSPC has not become a body which facilitates action."[2] To remedy this situation, he called for increased emphasis, greater cooperation and new approaches toward improving the DOD Materiel Distribution System."[3]

The Military Logistics Council offered a plan for study of the DOD Materiel Distribution System under the auspices of the LSPC.[4] The proposal for the study was adopted but it was agreed that it would be conducted by the JLC. In addition, the LSPC subsequently agreed that the recommendations and some personnel from the LSPC Task Group 5-70, Depot Storage Facility Modernization, should be incorporated into the DODMDS effort, as appropriate. See Appendix A Section 1, for background on LSPC Task Group 5-70.

C. <u>OBJECTIVES</u>

The objectives of the DODMDS study were to:

a. Review and analyze the current DOD Materiel Distribution System processes;

b. Identify future peacetime and mobilization Service support requirements worldwide;

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[1] Logistics Systems Policy Committee, "Department of Defense LOGPLAN FY 1975 - FY 1981", May 1972, p.1-4.

[2] The Logistics Systems Policy Committee (LSPC) is defunct. DOD Directive 5126.43, "DOD Logistics Systems Planning," establishing the LSPC expired without renewal 30 June 1976.

[3] "Summary Report of DOD Logistics Symposium", January 1975, P. 1.

[4] See LOGPLAN Logistics Doctrine Objective DO-2 and Implementing Action DO-2a (Change 4).

c. Examine and recommend alternatives to optimally integrate, consolidate and/or standardize Service/Agency distribution system functions and facilities within the 50 states where it is clearly beneficial in terms of cost and response.[1] (Appendix A Section 2, Charter, Section II - Mission)

These ojectives are elaborated in the DODMDS Study Plan, which stipulates that the study develop alternatives which reduce total materiel requirements -- both retail and wholesale -- "by such means as modes of transportation and positioning of stocks to optimize total DOD inventory and distribution costs within prescribed response times." (Appendix A, Section 3, DODMDS Study Plan)

In short, the objective of the study was to develop system alternatives in terms of number and location of facilities, transportation arrangements, and stock positioning, to meet the Services and DLA requirements at the minimum total cost.

D. SCOPE

The "wholesale" distribution system on which this study concentrated includes the distribution processes involved at the major wholesale activities (depots, supply centers and logistic centers) presently operated by the Army, Navy/Marines, Air Force and Defense Logistics Agency. More specifically, it included (1) the sources and ownership of materiel delivered to the depot system; (2) the location, ownership, management and operation of the depot facilities; (3) the customers served by the system; and (4) the transportation links, both commercial and government, that connect the sources of supply, the depots and the customers, including overseas customers.

The study was also expected to produce results which could be implemented within the time frame of the Five Year Defense Program. Any previous or ongoing studies

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[1] Appendix A, Section 3, pages 3.11 through 3.14, depict the facilities that were included in the study.

affecting the DOD Materiel Distribution System were to be taken into account, particularly any relevant conclusions and recommendations from such studies. Further guidance which elaborates on the scope of the study is contained in Appendix A, Section 3, DODMDS Study Plan and Appendix A, Section 4, Assumptions and Policy Guidance For Use In The DODMDS Study.

E. ORGANIZATION AND COMPOSITION

The study effort was accomplished in three phases, as follows:

Phase I - Administrative
(February 1975 - May 1975)

Phase II - Development of Methodology
(June 1975 - December 1975)

Phase III - Full Study Group Effort
(January 1976 - March 1978)

The Charter was adopted 25 March 1975 and the study was targeted for completion by 31 March 1977. However, the data acquisition, validation, data processing and aggregation tasks proved formidable and necessitated additional time for completion.

The structure of the DOD Materiel Distribution System study group was designed to assure the broadest representation of interests in its composition, a very high level of competence of those participating, and an administrative organization which assured both adequate representation of viewpoints and controls, as well as a functionally sound mechanism.

1. Organization

The organizational structure consisted of three principal elements -- the Joint Logistics Commanders (JLC), the JLC Control Panel, and a working group.

The Joint Logistics Commanders are the senior commanders within the armed forces responsible for logistics support of their respective Services. They include:

The Commanding General
U.S. Army Materiel Development and
Readiness Command (DARCOM)

The Chief of Naval Material
Naval Material Command (NMC)

The Commander
Air Force Logistics Command (AFLC)

The Commander
Air Force Systems Command (AFSC)

The Joint Logistics Commanders designated a control panel to provide centralized direction, guidance and coordination for accomplishing the study. The panel, in turn, appointed a working group to operate under their control. The working group was organized into task groups in functional categories such as transportation, system cost, performance analysis and integration, and modeling and data processing. A coordination and control group also was provided. The DODMDS study organization is shown in Figure 1-2.

2. Composition

To insure an appropriate balance of viewpoints and experience, participants were carefully screened and selected from the interested and responsible elements of the defense establishment. The composition of this team may be summarized as follows:

a. JLC Control Panel. This panel consisted of senior officers representing DARCOM, NMC, AFLC, and AFSC, respectively. Also participating in control panel deliberations were senior representatives of the Marine Corps, the Defense Logistics Agency, the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) and the Office of the Assistant Secretary of Defense (Comptroller).

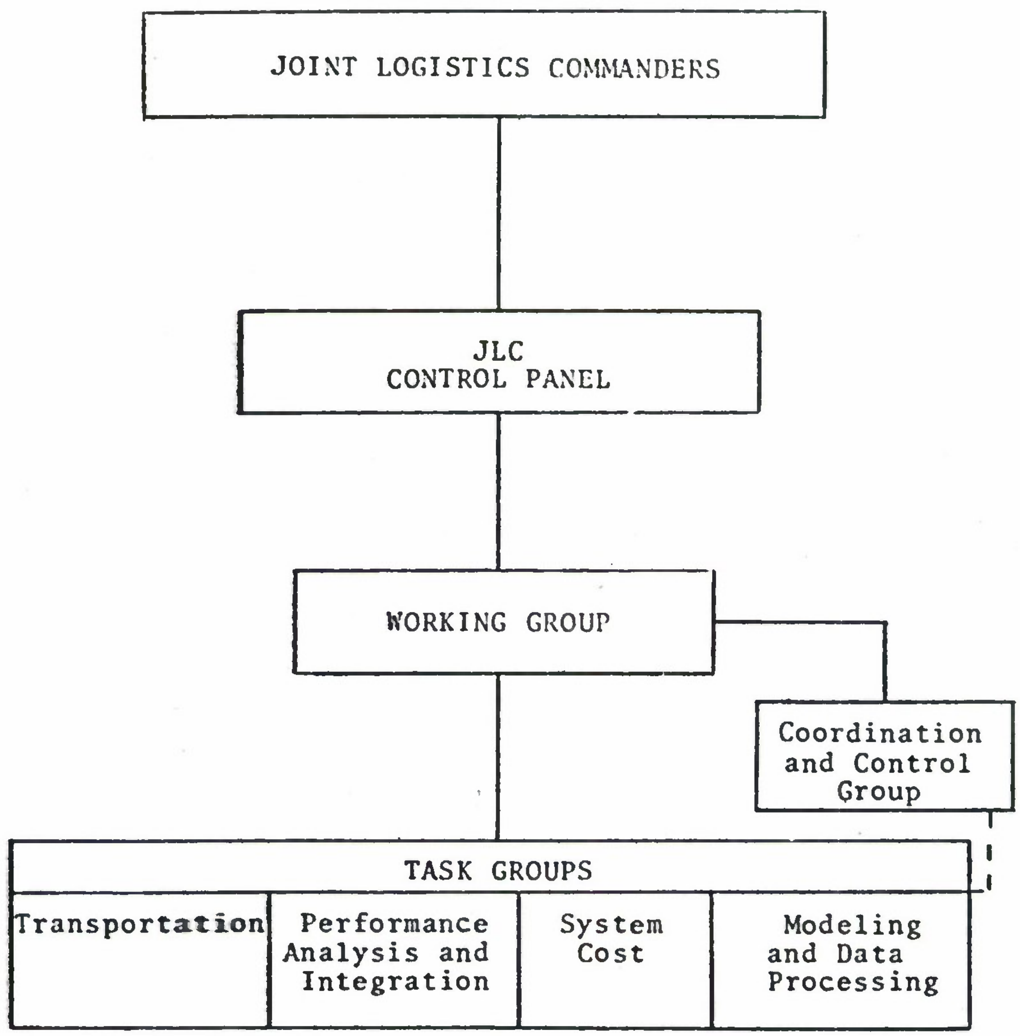

Figure 1-2

DODMDS STUDY ORGANIZATION

The Air Force was designated the lead service and the Air Force Logistics Command provided both the chairman of the JLC Control Panel and the lead secretariat.

This panel approved the DODMDS Study Plan on 16 May 1975 and met frequently to provide the necessary coordination, guidance, and approval of results.

b. Working Group. The working group comprised five senior Service members (O-6 Level) appointed by the control panel members representing the Army, Navy, Air Force, Marine Corps and the Defense Logistics Agency, respectively. They were full-time representatives of their respective Services, and also served as monitors of the task groups. The Navy representative served as chairman to the group. They were assisted by the full-time chairmen of four task groups and the director of the coordination and control group.

c. Task Groups. The task group members -- both full-time and part-time -- represented a cross-section of experts from the Army, Navy, Air Force, Marine Corps and Defense Logistics Agency. The task group chairmen were selected by the senior Service representatives.

In all, the working group, task groups and clerical support consisted of approximately 37 full-time members and 34 part-time representatives, including those from the Military Traffic Management Command, the Military Sealift Command, and the Military Airlift Command. The Naval Postgraduate School and the Air Force Institute of Technology also made contributions.

Technical support and advice to the working group and the task groups were furnished by individuals from the civil sector with expertise in business logistics, distribution systems, distribution management and the application of computer models to distribution systems. Such support also was provided by contractors with special expertise in models, data aggregation and handling, and in transportation and warehousing requirements and operations.

The complete list of those who participated in the DODMDS study is included in Appendix A, Section 5.

CHAPTER 2
SYSTEM REQUIREMENTS

A. INTRODUCTION

The DOD Materiel Distribution System is the interaction of all required elements which allow materiel needed by the various DOD elements to be delivered on time to all customers throughout the DOD. Distribution, in general, is not directly oriented toward the definition of requirements. It begins when a product is purchased and available at a vendor's location and ends when the product is made available to the customer. At this point, a distinction should be made between wholesale and retail distribution. Wholesale distribution is defined as "the receipt, storage and issue of materiel by any facility whose primary mission is to receive, store and issue materiel to any activity other than itself or its tenants, and over which the Inventory Control Point (ICP) has asset knowledge and simultaneously exercises asset control, without restrictions, to meet worldwide inventory management responsibilities, regardless of funding source."

Intermediate and consumer levels, while important as a subset of the total distribution system, were outside the scope of this study.[1]

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[1] For a more complete description of the retail distribution system, see DOD Retail Inventory Management and Stockage Policy (RIMSTOP), Office of the Assistant Secretary of Defense Installations and Logistics Working Group Report, September 1976.

The Services/Agency wholesale distribution systems consist of a complex series of levels of supply which extend through a depot system, subordinate storage system and ultimately to the consumer, be it a ship, a unit in the field, or a mechanic on the flightline. Among many other requirements, a distribution system must satisfy the following:

- It must be responsive to the customer, regardless of location.

- It must have the capacity to expand significantly and rapidly in times of national emergency.

- It must be relatively easy to operate, both within the context of the Service itself and in consideration of shared or joint use of facilities. This implies that it must have flexible, relatively common elements.

- It must be sufficiently resistant to disruption by potential aggressors, civil disorders or other external factors.

The Services and DLA have developed supply systems of their own, which seek to meet these objectives. Their distribution systems perform many functions that are common to any distribution system; however, the particular structure of each distribution system is tailored to satisfy the unique mission requirements and management philosophy of each of the Services. The Army, Navy, Air Force and Marine Corps are primarily interested in satisfying the operating requirements of their basic combat units, which vary greatly in size as well as mission. Several other factors influence the methods and structure of the Services' distribution systems: the degree to which a unit may be dependent on outside support (external to command jurisdiction), the proximity of support bases to areas of operations, the permanence of support bases, the relationship of personnel to their equipment, the mobility of the forces being supported and the value of inventory. A significant difference between the distribution system of the Defense Logistics Agency and the systems of the Services is that the Defense Logistics Agency has the mission to provide support principally at the wholesale level while the Services have the mission to provide both retail and wholesale support.

B. SPECIAL/UNIQUE SERVICE/AGENCY WHOLESALE MATERIEL DISTRIBUTION SYSTEM REQUIREMENTS

Each of the Services has responsibility for providing logistics support, including materiel distribution, for its forces. This logistics support is tailored to each Service's own mission requirements/responsibilities. "The problems and complexity in providing responsive and adequate logistics support vary by the type mission assigned to a military organization. In some cases, the logistics thrust is to equip personnel for the principal mission, e.g., large ground forces, in other cases, the thrust is toward manning equipment, e.g., sophisticated weapons systems, such as missile submarines, supersonic fighter aircraft, etc. The rapid growth in technology has added to the complexity and cost of providing needed logistics to the armed forces."[1] In conducting a study of the DOD Materiel Distribution System, it is immediately apparent that we are using the term "system" in a very general context. The DODMDS, in reality, is not one but five separate sub-systems, operated and managed by each of the respective Services and DLA. Hence, each Service and DLA operating under the general policy and guidelines of DOD, has developed its own distribution system to be responsive to satisfying the individual Service's own unique mission requirements. Furthermore, each system is supported by its own unique computerized materiel management and information systems. (See Appendix B-1, Unique Service/Agency Needs.) It is recognized that some functions are common to two or more Services, but are performed by differing organizational elements. These differences are the result of Service prerogatives resulting from varying roles and missions.

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[1]Lt Gen Walter J. Woolwine, USA, "Logistics: A Second Look," Perspectives in Defense Management, ICAF 1974, p. 45.

1. Army

a. Mission

Inherent in the Army mission is the necessity to seize, occupy and defend land areas.[1] To accomplish its mission, the Army must stay "on the ground" and "up front." In this environment, the distribution system is required to place stocks as close as possible to the using units. This frequently involves the large volume movement of supplies and equipment tailored to a unit's particular mission. Historically, the Army has relied heavily on dependable and responsive surface transportation modes. To insure appropriate management and control in support of the variety of missions assigned to all units, the Army has assigned management control over the different categories of materiel and equipment to commodity commands within U.S. Army Materiel Development and Readiness Command (DARCOM). These commands and depots, and the materiel which they manage, are outlined below along with certain other specialized requirements. In support of the Army mission, several distribution system features/requirements peculiar to the Army have been taken into consideration and are summarized below. (See Appendix B-1 for detailed description of Army Unique Needs).

b. Unique Features/Requirements

(1) The Direct Support System (DSS). This system provides for direct delivery from a CONUS depot to a CONUS/overseas supply support activity bypassing overseas depots and break bulk points. Materiel is routed through consolidation/containerization points (CCP's) at New Cumberland, Red River and Sharpe AD's (storage requirements were provided).[2]

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[1] JCS Pub 2, Unified Action Armed Forces, Joint Chiefs of Staff, Washington, D.C., October 1974, p. 17.

[2] DARCOM letter, DODMDS Study, Unique Service/Agency Requirements (DRCMM), 18 June 1976.

Emphasis on DSS causes some changes to UMMIPS, resulting in shorter elapsed time through the wholesale system than called for by UMMIPS.[1]

DODMDS Study Position: DSS transportation links were considered in DODMDS modeling efforts. Alternatives to DSS were also considered.

(2) Missile Systems. Due to configuration, size and structural characteristics of Army managed missiles and oriented systems, special requirements exist for utilization, transportation, and storage. Specific storage requirements have been identified and are accounted for in Appendix B-1. A dedicated distribution system exists in Korea.[2]

DODMDS Study Position: The modeling effort was not restricted to the nine specified Army depots having this mission, since alternates designated in the solution may prove to be more desirable. Alternate solutions, in order to be viable, must provide adequate physical handling, storage, and security capability, or capital investments for this purpose must be cost effective. Providing necessary secure transportation capability required for missile movements is a MTMC responsibility and is available from any depot. Although accessorial charges were not used in DODMDS transportation costs, the essence of the increased costs for transporting missiles was captured through the use of weighted average class rates which reflect the high class rates for the mix of NSN's within this commodity (missiles).

(3) Troop Support and Aviation Materiel Readiness Command (TSARCOM) Items.

(a) TSARCOM managed shop sets and tools, in support of Army aircraft, are considered unique since they are oriented to specific systems and aircraft.[3]

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[1] DARCOM letter dated 29 January 1976, Subject: Revision of UMMIPS Standards Based on DSS Performance.

[2,3] DARCOM letter dated 18 June 1976, op. cit.

DODMDS Study Position: The costs of shop set assembly were included within the costs of supply operations for affected depots. Surveillance, inspection and replacement of aerial delivery equipment also falls within the scope of depot costs and were treated accordingly in the study. Packaging and preservation of aerial delivery equipment falls within the purview of depot supply operations costs. Special handling during shipment is not within the scope of the study.

(b) TSARCOM manages three unique rail equipment systems in FSC's 2210, 2220, 2240 and FSC 2250. Depot level support is provided at the only DOD-operated facility, located at Hill AFB, UT.[1]

DODMDS Study Position: This is a maintenance operation and outside the scope of the study.

(4) Electronics Command (ECOM) Items. ECOM is single service manager for dry batteries, which require refrigerated storage. Tobyhanna Army Depot, Lexington-Blue Grass Army Depot, and Sacramento Army Depot have this specialized refrigeration. ECOM also stores and issues cryptographic materiel, which is not governed by MILSTRIP procredures.[2]

DODMDS Study Position: Stated storage requirements were taken into consideration in the overall analysis. COMSEC (CRYPTO) materiel was excluded from the study. Dry battery storage is a requirement that received special review.

(5) Tank-Automative Materiel Readiness Command (TARCOM). TARCOM is the single manager for wheeled vehicle tires (FSC 2610) and parts peculiar for combat/tactical vehicles.[3]

DODMDS Study Position: No impact on DODMDS study objectives.

1,2,3, Ibid.

(6) Armament Materiel Readiness Command (ARRCOM) Items. ARRCOM is the DOD agent for management of the Weapons Management Improvement Program (WMIP); stores secondary items in support of special weapons at Seneca and Sierra AD's; and, single manager of ammunition, with the exception of a few Navy peculiar items.[1]

DODMDS Study Position: Ammunition was excluded from study. The study group considered the economic aspects of curtailing a depot's mission to that of pure ammunition.

(7) Tobyhanna Army Depot. Tobyhanna AD has Army overhaul mission for AN/TPN-18 and AN/FPN-40 radar systems. This depot also provides this support to the Navy.[2]

DODMDS Study Position: Depot level maintenance facilities were considered as both customers and suppliers of the DOD distribution system. The necessity to support depot maintenance functions and contingency plans also bear on facility location decisions.

(8) Sacramento Army Depot. Sacramento AD provides communications network support to the Armed Forces.[3]

DODMDS Study Position: The DODMDS effort was not restricted to specified depots since alternates specified in the solution may prove to be more desirable.

(9) Lexington-Blue Grass Depot Activity. Lexington-Blue Grass DA has distribution/maintenance mission for COMSEC materiel on a world-wide basis. This depot also hosts a communication command detachment to support operating communications facilities within the area.[4]

DODMDS Study Position: COMSEC equipment was excluded from the study. DODMDS has pertinent

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[1,2,3,4] Ibid.

facilities and resources data pertaining to tenant activities at each of the 34 depots in the study. These data were cited in cases where depots with tenants are recommended for closure or reduction of mission.

(10) Materiel Readiness Commands. Readiness commands have assigned special maintenance and storage missions to depots in addition to their distribution mission. The requirement to use them in this capacity should be recognized in any consolidation effort.[1]

DODMDS Study Position: Service management concepts and policies were not considered as constraints in the study. Stock ownership and depot ownership at a given facility do not have to be of the same Service/Agency.

(11) Training. Current depot operations should be used as a training base for military personnel.[2]

DODMDS Study Position: Total training requirement (294 officers, 13 W/O, 367 EM) was recognized. Allocations of these positions is at the discretion of HQ DARCOM.

(12) Depot Systems Command (DESCOM). This agency provides managerial assistance and coordinates operational support planning and programming for all depot operations.[3]

DODMDS Study Position: The described management functions of DESCOM are generally provided by the other Services with varying degrees of centralization. Should the study indicate the need to combine depots of different Services/Agencies, management/ownership of stocks and facilities must be addressed.

(13) Contingency Materiel. The Army has a requirement to maintain materiel in storage to support contingency operations in CONUS and overseas.[4]

[1,2,3,4] Ibid.

DODMDS Study Position: Only that portion of contingency stocks which are segregated and/or packed for quick reaction will require storage at dedicated service depots (see confidential letter, DRCMM-SP, 22 Feb 1977). Only a small portion of PWRS is segregated and packed for quick reaction.

2. Navy

a. Mission

The primary Navy mission is to seek out and destroy enemy naval forces and to suppress enemy sea commerce, to gain and maintain naval supremacy, to control vital sea areas, and to protect vital sea lines of communication and to establish and maintain local superiority (including air) in an area of naval operations.[1] The diverse mission of the Navy requires that the operational forces be composed of air, surface, and sub-surface weapons platforms.

b. Navy Tidewater Logistics Complexes

In order to accomplish its mission the Navy has developed a two stage logistic system composed of mobile support forces which replenish Naval units at sea and in forward operating areas and shore based logistics support activities at tidewater locations in the Continental United States. The Navy shore based logistics system provides direct support to the air, surface, and sub-surface weapons platforms as well as the industrial, administrative, and training efforts necessary to maintain those platforms in a high state of readiness. The diversity of Navy platforms has resulted in a shore based distribution system that is structured on a mission related basis in which Naval Supply Centers support surface and sub-surface Naval units and Industrial Naval Air Stations support Naval aviation units. Three factors, concentration of fleet combatants in specific tidewater areas, size of the individual Naval units and fluid operational deployment requirements have necessitated that a full

[1] JCS Pub 2, op. cit., p. 20.

line of logistics support be established in each tidewater location and highlight the uniqueness of the Navy distribution system. Concentration of the fleet units at selected locations has resulted in the collocation of the distribution facilities with industrial activities, training and support facilities, naval bases, and master jet fields, thus creating an integrated shore based support complex at the tidewater locations with "short legs" to the combatant units. Individual Naval units are manned with miniature logistics staffs and rely on the shore based distribution organization to accomplish distribution related functions such as procurement of locally available supplies and services, materiel accounting services, materiel holding, staging, and shipping, and packaging and preservation of materiel. This requirement has created Navy depots which are dedicated to total support of the customer. Fluid deployment schedules of the fleet require that the distribution facilities and organizations be capable of providing high levels of customer service designed to minimize response time by use of decentralized materiel control and "walk-through" requirements processing. Decentralized materiel control allows the stocking activity to provide materiel directly to the consuming activity without administrative review of the materiel requirement by an inventory control point. The Navy distribution system has accommodated itself to the unique requirement of operating depots which stock a complete line of materiel requirements in order to provide maximum customer satisfaction at the customer point of entry into the distribution system and to permit rapid resupply and turnaround of combatant ships. At each of the tidewater locations, the Navy shore based distribution system stocks "beans, bullets, and black oil." The Navy concept of logistic support can best be described as being strongly customer oriented. The management control and information systems are tailored to support this structure and, understandably, differ considerably from other Services/DLA management control and information systems. Other features of the Navy distribution system which require consideration are summarized below (see Appendix B-1 for detailed description of Navy unique needs).

b. Unique Features/Requirements

(1) Stock Points. All Navy stock points must serve as the preferred point-of-issue for shore activities within their geographical areas and for nondeployed operating units home-ported in the area.[1]

DODMDS Study Position: The technical aspects of the Navy requisitioning system were not a subject of the study. Study alternatives were oriented towards improvement of the entire DOD distribution system while ensuring a high degree of responsiveness to all users of the system.

(2) Mobile Logistics Support Force (MLSF). NSC's Norfolk and Oakland serve as the primary support points for the deployed Mobile Logistics Support Force (MLSF) and overseas shore bases.[2]

DODMDS Study Position: The MLSF was considered as fleet customers with identifiable and predetermined homeports.

(3) Requisitions for Fleet Ballistic Missile (FBM) Stock Points. Stock replenishment and routine Direct Turnover (DTO) requisitions for the Fleet Ballistic Missile (FBM) Intermediate Maintenance Activity (IMA) and FBM submarines will be passed to NSC's Charleston and Puget Sound, which have been designated as FBM stock points. In this connection, NSC Pearl Harbor has sole responsibility for stocking and managing the loadlist materiel for Submarine Base, Pearl Harbor, and submarines operating from that activity.[3]

DODMDS Study Position: Issues from nonstudy depots were excluded from DODMDS model input. The study only reflects those Navy demands from FBM submarines and tenders that were passed to depots within the DODMDS study effort.

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[1] Naval Supply Systems Command letter dated 30 July 1976, Subject: Unique Navy Needs (0421C/MMM).

[2,3] Ibid.

(4) High-cost, critical reparable assets. These assets present a special case for unique requisition response time requirements. For these items the distribution system must continue to attain issue/movement times considerably tighter than UMMIPS.[1]

DODMDS Study Position: Navy demands for all reparables were included in the DODMDS data base regardless of storage locations satisfying the demand. Accordingly, CLAMP/FIRM reparables were included in the DODMDS modeling effort to the extent that such requirements are reflected in Navy ICP transaction history files along with Navy requirements for other reparables.

(5) Submarine Support. Due to limited in-port periods and the inability of submarines to replenish at sea, provisions must be made to provide special expediting efforts well within UMMIPS standards.[2]

DODMDS Study Position: FBM forces home-ported at NSC's Charleston and Puget Sound were included in the study on the basis of demands placed on DODMDS depots in model input. Submarines/tenders were considered as fleet customers subject to UMMIPS.

(6) Special Supply Depot Missions. The Navy requires that wholesale supply depots at tidewater provide customer service beyond the distribution function, i.e., SUBSAFE/Level I program, controlled humidity storage for ATS engines and management of PTFD ships' engines, etc.[3]

DODMDS Study Position: The study recognized that stringent management controls are required. However, these same controls could be exercised at distribution depots other than those cited. Accordingly, the study included an analysis of the flows of SUBSAFE/LEVEL I materiel in a manner analogous to that of other Navy materiel. Controlled humidity requirements for the ATS

[1,2,3] *Ibid*.

engine were considered as a dedicated requirement. All other topics cited are out of the scope of the study and have no impact on the results.

(7) QUICKTRANS. The QUICKTRANS transportation system serves twenty-eight points of high cargo generation which are not adequately served by common carriers. Continued operation of this contract cargo airlift service must be assured.[1]

DODMDS Study Position: Concur.

(8) Sole-Source Requirements. The Navy has two unique sole-source requirements for support of ATS ships procured in England and the PTF engines, which are overhauled only at Subic Bay, P.I.[2]

DODMDS Study Position: These topics were considered in the analysis and solution, only to the extent that demands were reflected in the DODMDS data base.

(9) Collocated Wholesale Materiel and Maintenance. There is a requirement to maintain the current collocation of wholesale stocks at sites supporting major maintenance activities, i.e., current support relationships between Industrial Naval Air Stations and Naval Air Rework Facilities.[3]

DODMDS Study Position: The necessity to support depot maintenance functions and contingency plans will also bear on location decisions. Depot level maintenance facilities were considered a customer and supplier of the DOD distribution system. In addition, implications of the collocation of depot storage facilities were also examined.

(10) UMMIPS. The Navy considers UMMIPS to be the maximum time frames for the issue and movement of materiel within the supply system.[4]

DODMDS Study Position: This position was recognized by the study.

[1,2,3,4] Ibid.

(11) Reparable Items. Reparable items are classified PD 06 under UMMIPS.[1]

DODMDS Study Position. These items were taken into account by the study group.

(12) Airlift to Subic Bay and Naples, Certain PD 09 - 15 items are authorized airlift to Subic Bay and Naples.[2]

DODMDS Study Position. This need was recognized by the study.

3. Air Force

a. Mission

The Air Force must be prepared to conduct prompt and sustained combat operations in the air to gain and maintain air supremacy, to wage strategic air warfare, to furnish close combat and logistics air support to the Army, to conduct strategic and tactical aerial reconnaissance, operating air lines of communications (strategic and theater airlift) for the armed services, and to conduct air defense operations.[3] In support of the Air Force mission several distribution system features/requirements peculiar to the Air Force have been considered and are summarized below. (See Appendix B-1 for detailed description of Air Force Unique Needs).

b. Unique Features/Requirements

(1) Technology Repair Center Concept (TRC). To accomplish its mission, Air Force logistics is tailored to support a myriad of highly complex, high cost, and expensive weapons systems throughout the world that require highly technical skills and responsive support. To this end, the Air Force

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[1] Office of the Assistant Secretary of Defense (Installations and Logistics), Air Logistics Pipeline Study (ALPS), January 1976, p. 5.

[2] Ibid, p. 4.

[3] JCS Pub 2, op. cit., p. 25.

Logistics Command has developed the Technology Repair Center concept. Implementation of this concept provides for the aggregation of depot maintenance workloads using similarity of repair processes and resources as criteria for assignment of repair responsibility to one of five large military industrial complexes called Air Logistics Centers (ALCs).[1]

DODMDS Study Position: The study did not consider changes to current depot maintenance functional alignments or item assignments, but did evaluate collocation of materiel.

(2) High Dollar Value Inventory. The five ALC's rank as the highest of all DOD depots in terms of dollar value of wholesale issues. Over 50% of the value of all issues made in the DODMDS base year were from the five Air Logistics Centers. One way of further illustrating this characteristic is by comparing the high average value of $3,344 per issue from Air Force depots to the DODMDS average value of $885 per issue. This high value of inventory, which supports the Air Force weapons systems, has been a significant factor in structuring a distribution system which minimizes pipeline time and inventory, and maintains visibility at every supply echelon for many of its high value items. Depot processing times are an example of this emphasis. The Air Logistics Centers' average processing time for PRI I through III shipments during the base year ranged from .85 days to 4.32 days compared to the DODMDS average range of 1.25 days to 5.0 days respectively.

DODMDS Study Position: This position was recognized and considered during the study effort.

(3) LOGAIR. In order to provide the desired level of support, an AFLC operated airlift system, known as LOGAIR, has been established to link the ALC's, bases, contractors, and aerial ports of embarkation. LOGAIR provides rapid turn-around of

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[1] Air Force Logistics Command Letter dated 21 April 1976, Subject: Unique Service/Agency Needs.

repair items resulting in reductions in inventory investment and materiel stockage.[1]

DODMDS Study Position: Concur.

(4) Collocation and Operation of Wholesale and Retail Materiel. Each Air Logistics Center is collocated on an operational base with a multitude of missions which include a variety of organizations such as tactical fighter units, SAC bomber units, Military Airlift Command organizations, reserve units, units of other Air Force commands and agencies, and other Services as well. Each ALC installation is, thus, a very large multi-mission complex hosting in the range of 17,000 to 27,000 personnel. To maximize the utilization of logistics resources, the wholesale distribution mission has taken on the added role of being the retail supplier for the local and on-base units and organizations. Retail stocks are collocated/comingled with wholesale stocks and permit taking advantage of the benefits from economies of scale in the handling of such materiel.

The biggest customer of the distribution function is the ALC depot maintenance activity. Approximately 28 to 32 percent of all issues at any ALC are made to maintenance.[2] Another feature which indicates the large impact maintenance and tenant organizations have on the distribution function is the large number of retail receipt transactions, 3,069,000, compared to wholesale receipt transactions, 1,760,127. Likewise, retail issue transactions, 3,672,802, are also significant when compared to wholesale issues,

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[1] Ibid.

[2] Based on AFLC Distribution Study of October 1974. This study reveals the total number of issues during the 1973 - 1974 period to maintenance and other tenants to be in the range of 41 - 50 percent. This compares favorably with the DODMDS data base year which indicates the number of issues to be in the range of 47 - 48 percent of all issues to on-base customers (maintenance and tenants).

4,138,700. The significant point here is the large volume of retail business performed by the ALC distribution function. In summary, the multi-mission character of each ALC affects management and policy decisions regarding the distribution function.

DODMDS Study Position: This position was recognized by the study.

c. Other Unique Requirements

There are other features to the Air Force logistics mission which are either unique in themselves, or are key elements in the AFLC management process. These are discussed below:

(1) Management of Items Subject to Repair (MISTR). This is a management system that requires immediate response from ALC distribution points for providing timely input of end items and repair parts to the depot maintenance activity.[1]

DODMDS Study Position: The study does not have an impact on the MISTR program, since maintenance activities were treated as both customers and suppliers. Maintenance locations and functions were considered fixed, but the study evaluated collocation of materiel.

(2) Air Force Recoverable Assembly Management System (AFRAMS). AFRAMS is an Air Force system for maintaining visibility and control over depot recoverable items. It provides for maximum redistribution of assets, effective use of depot repair resources and for maintaining compatibility between distribution and requirements. This system is considered to be most effective in reducing requisition response times and in providing the best possible support to customers.[2]

[1,2] An Air Force Logistics Command letter dated 21 April 1976, op. cit.

DODMDS Study Position: The DODMDS data base did not include redistributions between bases except in those cases where ALC's are located. Furthermore the study did not consider changes to current materiel management/ICP management systems such as AFRAMS.

(3) Aircraft Engines. Worldwide engine management during wartime and peacetime is dependent upon a minimum response time with a minimum transportation pipeline time of four days in the CONUS and seven days overseas. Rapid return of depot reparables is necessary to assure adequate production to support alert postures and a potential sustained engagement.[1]

DODMDS Study Position: The need for intensive management of minimum inventories was recognized. The study included commodity strategy and modeling, which provided appropriate identification and analysis of aircraft engines.

(4) Air Munitions. Ogden ALC has materiel management of the Air Force Air Munitions program. Geographical proximity to the Hill AFB Range, for testing and disposal of munitions, facilitates the successful accomplishment of this mission.[2]

DODMDS Study Position: The ammunition/munition/nuclear stock numbers were excluded from the study.

(5) Minuteman Missile. Ogden ALC has depot maintenance and inventory control point responsibility for the Minuteman missile. A multi-million dollar engineering test facility has been constructed to accommodate this function. Geographical location puts this ALC in close proximity to prime contractors and major missile support bases.[3]

DODMDS Study Position: The significance of Minuteman missile support was recognized. Engineering test facilities were outside the scope of DODMDS study

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[1,2,3] Ibid.

effort. Minuteman was affected only to the extent the materiel was handled by the distribution system depots.

(6) Military Working Dogs. The DOD Dog Center at San Antonio ALC has DOD-wide commodity management for military working dogs. Unique requirements include special storage, handling, and proximity to Wilford Hall Medical Center's veterinary facilities.[1]

DODMDS Study Position: The DOD Dog Center was not within the scope of the study.

(7) Critical Need Items. Requisitions with PD 09 - 15 are upgraded to PD 06 when the requisition is for an item in short supply.[2]

DODMDS Study Position: The need to upgrade certain requisitions was recognized.

4. Marine Corps

a. Mission

The Marine Corps mission of providing a Fleet Marine Force (FMF) and supporting air, capable of rapid deployment, for seizure and/or defense of advanced Naval bases and for the conduct of land operations essential to Naval campaigns, requires mobile air and ground forces.[3] In support of the Marine Corps mission, several unique distribution system functions must be taken into consideration. The unique mission assignments to the Marine Corps Logistics Support Bases, Atlantic and Pacific reflect a capitalization on the resources carefully placed within an integrated logistics support system. Some of the missions, e.g., storage and care-in-store of prepositioned war reserve stocks, weapons systems and equipments, stem from the statutory responsibility of the Commandant of the Marine Corps to recruit, train and equip a military

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[1] Ibid.

[2] Office of the Assistant Secretary of Defense (Installations and Logistics), Air Logistics Pipeline Study (ALPS), January 1976, p.6.

[3] JCS Pub 2, op. cit., p. 20.

force. Depot level maintenance of weapons systems and combat and tactical equipment, supports and complements the storage and care-in-store mission by providing the required industrial resources and technical skill base. In that the missions are collocated, transportation resources can be conserved. Each of these critical missions has been carefully placed to be supportive of and in turn, be supported by the resources available for performing the total mission of each Logistics Support Base. To accomplish this task, specific knowledge of the needs of the Fleet Marine Forces is required. In summary, each of the following unique missions is an integral part of a coordinated Marine Corps Logistics System. (See Appendix B-1 for detailed description of Marine Corps Unique Needs).

b. Unique Features/Requirements

(1) Special Functions. The Marine Corps Logistics Support Base Atlantic and Marine Corps Logistics Support Base Pacific perform special functions in addition to normal distribution functions, i.e., storage and associated care-in-storage of PWRS, weapons systems, equipment and spares in support of active/reserve forces. The capability to prepare and ship, in tailored blocks, all the materiel held at Albany and Barstow for the Marine Corps Reserve entails movement of all materiel to the site of initial activation in order to meet the time frame imposed by various mobilization plans. These shipments must be picked, packed and shipped to specified individual units. This requirement stems from the fact that facilities and related resources are not available to maintain the equipment in the hands of reserve units.[1]

DODMDS Study Position: It is recognized that storage and care of reference materiel is the responsibility of each military department. However, in consonance with the DODMDS Charter, the study

[1] Headquarters, U.S. Marine Corps letter dated 23 April 1976, Subject: Unique Service/Agency Needs (LPS-4GKe-gr).

effort was conducted in such a manner as to allow freedom in examining the feasibility of collocating and consolidating functions in an unconstrained manner, particularly where they were common to one or more of the other Services/DLA.

(2) Maintenance. Logistics Support Bases Albany and Barstow have responsibility for depot level maintenance of weapons systems and combat and tactical equipment.[1]

DODMDS Study Position: Depot level maintenance facilities were considered as both customers and suppliers of the DOD distribution system. The necessity to support depot maintenance functions and contingency plans had a bearing on facility location decisions.

(3) Opportune Shipping. Logistics Support Base Pacific, Barstow, uses "opportune Navy shipping" for transporting weapon systems and equipment to FMF units deployed on Okinawa and Japan or stationed in Hawaii. Use of this method of shipment results in transportation pipeline times much higher than prescribed by UMMIPS.[2]

DODMDS Study Position: Analysis of Marine Corps shipments from Barstow took into consideration deviations from UMMIPS time standards authorized when "opportune" shipping was utilized.

(4) Changes in Operating Procedures. The Marine Corps has made changes in operating procedures and support channels in the logistics support system that will significantly reduce wholesale assets, shipments and receipts from the numbers included in the DODMDS data base period. The mix of the receipt, storage and issue workload has changed significantly with the major portion of manyears of effort spent on principal end items and secondary level reparable items. The Marine Corps can provide an automated file of NSN's representing those NSN's which the Marine Corps will

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[1,2] Ibid.

continue to position at one or both of the MCLSB's. This file should be used to purge the data base.[1]

DODMDS Study Position: All validated USMC wholesale shipments currently in the DODMDS data base must remain there for modeling purposes, as the sole purpose of the materiel distribution system is to provide the operating forces with required supplies effectively and economically in peace and under mobilization. Impact of the changed USMC wholesale role was analyzed off-line. This was by stratification of the USMC portion of the DODMDS data base to reflect only those throughput transactions relating to the NSN's which the USMC expects to continue receiving, storing, and performing required depot level maintenance at Albany and Barstow.

(5) ICP Relocation. Subsequent to the DODMDS data base period the Marine Corps ICP was relocated from Philadelphia, PA to the MCLSB (Atlantic). This collocation will substantially reduce the supply depot operations functional costs for base operating from those incurred during the data base period. This should be taken into consideration in evaluating the total operating costs of the MCLSB (Atlantic).[2]

DODMDS Study Position: MCLSB Atlantic base operations or installation support costs in support of supply depot operations were reassessed once NAVCOMPT 2168 data was provided and included in model cost inputs.

5. Defense Logistics Agency

a. Mission

The Defense Logistics Agency is responsible for providing supplies and services used in common by the military Services, while items peculiar to weapons

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[1,2] Ibid.

systems are retained for management by the Services.[1] In accomplishing its mission, several unique distribution functions of the DLA system must be taken into consideration (See Appendix B-1 for a detailed description of DLA unique needs).

b. Unique Features/Requirements

(1) Industrial Plant Equipment (IPE). IPE is stored at Defense Depot Mechanicsburg, PA (DDMP), Defense Construction Supply Center, Columbus, OH (DCSC), Defense Depot, Tracy, CA (DDTC) (Stockton Annex) and Defense Industrial Plant Equipment Facility (DIPEF) (Atchison).[2]

DODMDS Study Position: IPE is basically a maintenance function and was excluded from the DODMDS modeling effort. Also, IPE costs at DDMP, DCSC and DDTC were segregated.

(2) Steel Plate and Shipboard Cable. Heavy steel plate (FSG 95) and shipboard cable (FSC 6145) is stored at Defense Depot Mechanicsburg, PA (DDMP), Defense Depot Memphis, TN (DDMT) and Defense Depot Tracy, CA (DDTC). These items require specialized storage aids and materiel handling equipment.[3]

DODMDS Study Position: Specialized storage requirements were taken into consideration. However, the modeling effort was not restricted to the three specified depots since alternates specified in the solution may prove to be more desirable.

(3) Direct Commissary Support System (DICOMSS). DICOMSS is currently operational at Defense Depot

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[1] Office of the Assistant Secretary of Defense (Installations and Logistics), Department of the Army, Navy, Air Force, and Defense Logistics Agency, Department of Defense Supply Management Reference Book, (Washington, D.C.: U.S. Government Printing Office, 1976), Chapter 7.

[2,3] Defense Supply Agency letter dated 8 April 1976, Subject: DODMDS Study, Unique Service/Agency Needs.

Mechanicsburg, PA (DDMP) and Defense Depot Tracy, CA, (DDTC).

DODMDS Study Position: DICOMSS was examined from the perspective of the total DOD cost of operation of the wholesale system.

(4) Drug Storage Vaults. Federally approved vaults for secured storage of drug abuse and narcotics items are installed at Defense Depot, Mechanicsburg, PA (DDMP), Defense Depot, Memphis, TN (DDMT) and Defense Depot, Tracy, CA (DDTC).[2]

DODMDS Study Position: Specified storage requirements were taken into consideration in the analysis.

(5) Government Furnished Materiel (GFM). Storage and distribution of GFM, particularly textiles which require sponging at Defense Personnel Support Center (DPSC), is a specialized mission at Defense General Supply Center, Richmond, VA (DGSC), Defense Depot, Mechanicsburg, PA (DDMP), and Defense Depot, Memphis, TN (DDMT).[3]

DODMDS Study Position: Specialized storage requirements were taken into consideration. However, the modeling effort was not restricted to the depots specified above since alternates specified in the solution may prove to be more desirable.

(6) Perishable Subsistence. Storage of perishable subsistence is performed under contract in commercial warehouses under the DOD Commercial Warehouse Service Plan, DLAR 4145.26.[4]

DODMDS Study Position: Perishable subsistence was not within the scope of the study.

(7) Used Clothing Program. This program is currently operational at Defense Depot, Ogden, UT (DDOU). Used Army clothing is returned for rehabilitation and reissue to the Army at 50 percent of the cost of new items.[5]

[1,2,3,4,5] Ibid.

DODMDS Study Position: The study did not consider changes to depot maintenance functions.

(8) Specialized Examination And Testing Facilities. These facilities are required for quality assurance of nonperishable subsistence stored at DLA/Service depots that store DLA-owned assets.[1]

DODMDS Study Position: Specified facilities and staffing requirements were taken into consideration in the analysis and subsequent solution.

C. UNIFORM MATERIEL MOVEMENT AND ISSUE PRIORITY SYSTEM (UMMIPS)

The basic DOD standards for performance time in the various segments of the pipeline are found in the Uniform Materiel Movement and Issue Priority System (UMMIPS). This system provides: "(1) guidance for the proper ranking of materiel requirements considering the mission importance of the requiring activity and the urgency of need for the materiel; and (2) incremental time standards for requisition processing and materiel movements."[2]

The UMMIPS standards cover each functional segment included within the total order and ship time -- from the date a requisition is initiated to the date the customer receives the requested materiel and updates applicable supply and accounting records. The total order and ship time consists of up to seven segments involved in every materiel movement in response to a requisition. These segments are (1) requisition submission, (2) passing action, (3) inventory control point (ICP) availability determination, (4) depot storage site processing, (5) transportation hold and CONUS intransit, (6) overseas shipment/delivery, and (7) receipt take up by requisitioner. Time standards have been estaLlished for priority designators within each of the segments of the total order and ship time. The number of segments applicable to a given

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[1] Ibid.

[2] DOD Directive 4410.6, Uniform Materiel Movement and Issue Priority System (UMMIPS), February 4, 1974, p. 1.

shipment is dependent upon the geographical location of the customer and the time standard for each segment is dependent on the priority designator on the requisition.

1. Priority Designator (PD)

UMMIPS provides the logic for determining the proper priority designator in three parts. First is a Force/Activity Designator (FAD) to identify the priority of an individual force/activity within the overall force. These are shown as roman numerals (I, II, III, IV or V). Next is a standard Urgency of Need Designator (UND). These are expressed as "A", "B", or "C". Thirdly, a series of numbers from 01 to 15 are assigned to indicate the priority. These numbers are applied to the FAD in relation to the UND, in a matrix which provides the priority designators. The relationship is shown in Table 2-1.

Table 2-1. Priority Designator Relationship to FAD and UND

FAD	Urgency of Need Designators (UND) A	B	C	
I	01	04	11	
II	02	05	12	Priority
III	03	06	13	
IV	07	09	14	Designators
V	08	10	15	

Retrograde (return) of materiel is accomplished without regard to the FAD's of the units involved. The priority designators are assigned based on the importance of the materiel in the overall distribution system. Critical items and approved intensive management items being returned are authorized priority designator 03. Materiel identified by the materiel manager as qualified for automatic return to the DOD distribution system are authorized priority designator 06. All other items that are returned in a routine manner, except surplus and scrap, are authorized priority designator 13.[1]

2. Total Order and Ship Time.

The resultant combination of standards provides a sum of days for the total order and shipment of materiel from the date the requisition is initiated until receipt of that materiel by the customer, as is reflected in Table 2-2.

Table 2-2. Total Order and Ship Time By Priority Designator to UMMIPS Area

Customer	Priority Designators 01 - 03	04 - 08	09 - 15
CONUS	7 days	11 days	28 days
Area 1	11 days	15 days	66 days
Area 2	11 days	15 days	71 days
Area 3	12 days	16 days	81 days

Area 1 - Alaska, Hawaii, South America, Caribbean and North America Customers.
Area 2 - Northern Europe, Mediterranean and Africa Customers.
Area 3 - Western Pacific Customers

Note: Above total days do not include receipt take-up segment and do not reflect standards for PD 01 - 08 when diversion to surface occurs.

Time standards have been established for priority designators within each of the segments of the total order and ship time (See Figure 2-1). Following is a definition of each segment listed in Figure 2-1.

[1]DOD Directive 4410.6, Enclosure 1, p. 1-10.

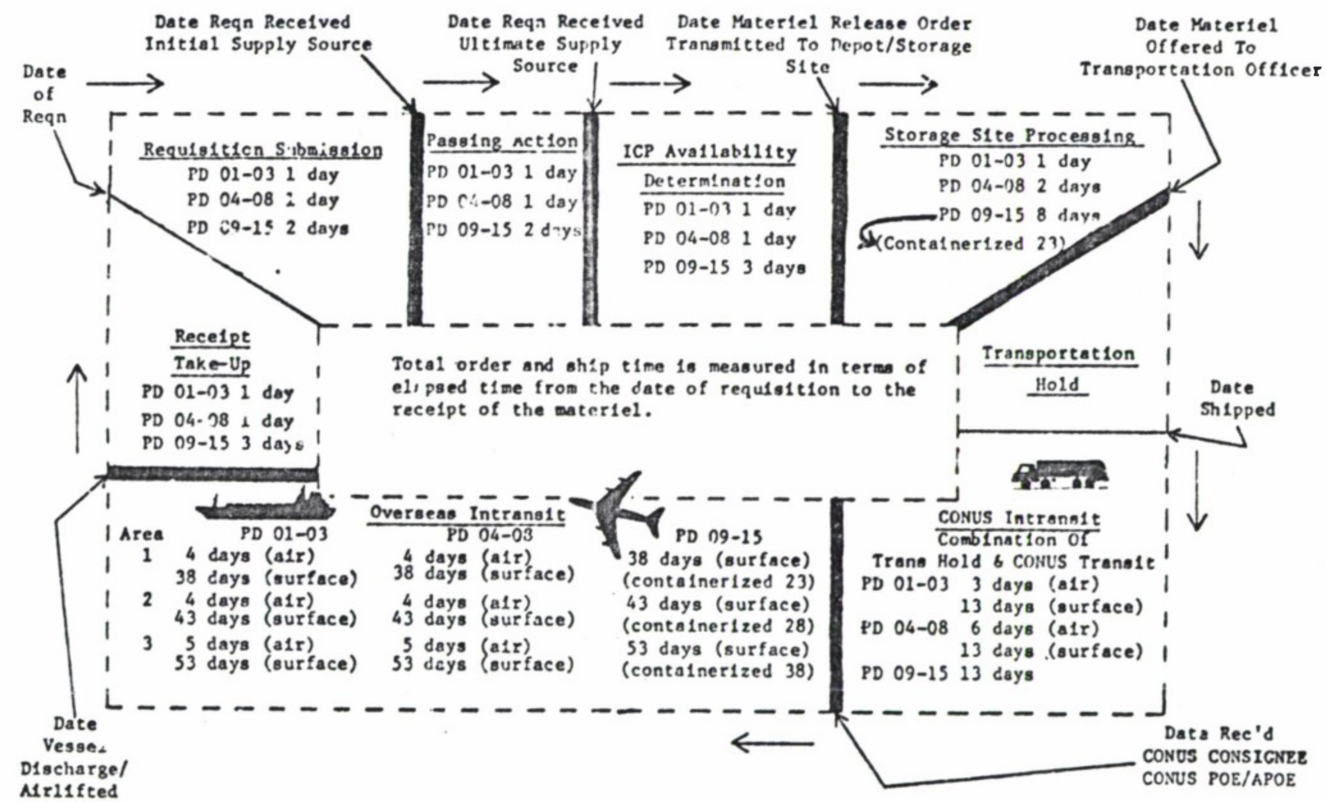

Figure 2 - 1. UMMIPS Time Segments

a. Requisition Submission

This segment is defined as the time between the date of requisition and the date of receipt by the initial wholesale supply source. The date of requisition is the date reflected in the document by the initial requisitioner. This segment includes any time "... consumed by review/approval of control offices which are intermediary between the requisitioner and initial supply source."[1]

In this segment, UMMIPS allows one day for transmission of PD 01 - 03 and 04 - 08 requisitions. Two days are allowed for the transmission of PD 09 - 15 requisitions. This standard applies regardless of the geographical location of the customer, CONUS or overseas.

b. Passing Action

This segment includes that time between the date of receipt of the requisition by the initial supply source until the date of receipt by the ultimate supply source. In this segment, PD's 01 - 03 and 04 - 08 are allowed one day, while PD's 09 - 15 are allowed two days.

c. ICP Availability Determination

This segment includes that time between the date the requisition is received by the ultimate supply source to the date that a materiel release/issue instruction is transmitted to the depot/storage site selected to distribute requested materiel to the customer. This segment not only includes certain edits/reviews of requisitions and depot selection, but also includes keypunching of manually prepared requisitions or any other processing required for input of requisitions into automated data systems which support the materiel managers.

The UMMIPS standard for this segment is one day for PD's 01 - 03 and 04 - 08. For PD's 09 - 15, the

[1] Ibid, Enclosure 2, p. 2-1.

standard is three days. UMMIPS does allow time tradeoffs between this segment and the depot/storage site processing segment, addressed below, for the purposes of measuring total supply source time as a single entity.

d. Depot/Storage Site Processing

This segment includes the time between the date of transmittal of the materiel release/issue instruction and the date that the applicable materiel is made available to the transportation officer. This segment includes those actions required for the issue document to be automatically processed and to select an item from the warehouse, process it and pack it. Once an item has been packed and labeled, it is normally available for shipment.

UMMIPS standard for PD's 01 - 03 is one day. The standard for PD's 04 - 08 is two days. There are two standards for PD 09 - 15 materiel. The normal standard is eight days; however, when consolidation of materiel into SEAVAN containers is accomplished by the origin depot/storage site this standard is extended to 23 days. This is done to accommodate consolidation of materiel to insure container utilization and attainment of the benefits available through source to user container movement. This 15 day extension does not alter the total order and ship time as is pointed out in the discussion of the standards applied to the overseas shipment/delivery segment addressed below.

e. Transportation Hold and CONUS Intransit

As the name implies, this segment contains two sub-segments. The transportation hold sub-segment includes the time between the date that materiel is made available to the transportation officer and the date the shipment is delivered to the carrier at origin. The CONUS sub-segment includes the time between date of delivery to the carrier and the date of receipt by the CONUS customer or, when the customer is overseas, the date when applicable materiel is received at a CONUS aerial or water port of embarkation (A/WPOE).

This segment is the sum of the time materiel awaits transportation after being available for movement and that time for movement within CONUS either to a customer or port of embarkation for onward movement.

The standard in this segment for PD 01 - 03 materiel is three days, 04 - 08 is six days and 09 - 15 is thirteen days. There is an exception to the standard for PD 01 - 03 and 04 - 08 when surface transportation is employed. The standard for PD 01 - 03 and 04 - 08 is extended to that of PD 09 - 15 or 13 days. This merely recognizes the realities in the difference in time for movement of surface carriers versus airlift. High priority requisitions will be diverted to surface movement only when: (1) a temporary, blanket authorization is granted by JCS or the cognizant Commander-In-Chief (CINC), (2) a specific authorization is provided by the requisitioner or (3) the characteristics of the materiel preclude air movement due to size, weight or hazard classification.[1]

f. Oversea Shipment/Delivery

This segment extends from the date that materiel is received by a CONUS port of embarkation (POE) until the applicable materiel is delivered to the overseas customer. This segment includes the time required: to stage materiel at the POE, to obtain lift, to load materiel, for actual line haul,to unload, to obtain onward lift at the overseas port of debarkation and for intra-theater transit. The present UMMIPS standards recognize not only differences based on PD's but also based on the geographical location of the customer. Within this segment the application of standards also recognizes the difference in movement of materiel by air and surface. As done in the transportation hold and CONUS intransit segment, when PD 01 - 08 materiel moves via surface modes, the standard applicable to PD 09 - 15 materiel applies. UMMIPS recognizes three different geographical areas -- Areas One, Two and Three.

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[1] Ibid, p. 2-4.

The standards for customers in Area One (Alaska, Hawaii, South America, the Caribbean and North America) are four days for PD 01 - 08, 38 days for PD 09 - 15. However, as discussed above, 15 days are added to the depot/storage site processing segment standard when PD 09 - 15 materiel is loaded in SEAVAN containers at the origin depot/storage site. In recognition, the standard for this segment is reduced for applicable PD 09 - 15 materiel from 38 to 23 days.

The standards applicable for materiel moving to customers in Area Two (Northern Europe, the Mediterranean and Africa) are the same as Area One (1) for PD 01 - 08 materiel, or four days. For PD 09 - 15 materiel the standard is longer, 43 days. The advantages of origin stuffing of containers are again recognized by a reduced standard for applicable PD 09 - 15 materiel of 28 days. Similarly when PD 01 - 08 materiel movement occurs via surface the standard for 09 - 15 materiel applies.

The standard applicable to customers in Area Three (the Western Pacific) is five days for PD 01 - 08 materiel. PD 09 - 15 materiel has a standard of 53 days, except when loaded into a container at the origin depot/storage site, then the standard is reduced to 38 days for reasons cited above. As in discussion of standards applicable to other areas,the standard applicable to PD 01 - 08 materiel, which is diverted to surface, is the same as that applied to the movement of 09 - 15 materiel.

g. Receipt Take-Up Time

This segment includes the time between date of receipt of the materiel by the customer until materiel receipt is recorded on the customer's inventory records.

The standards applied in this segment depend solely on the PD. That materiel with a PD of 01 - 08 has a standard of one day. PD 09 - 15 materiel has a standard of three days.

D. MOBILIZATION AND WARTIME PLANNING

The Charter of the DODMDS study establishes the requirement to "recommend improvements which will support the Services' requirements effectively and economically in peace and under mobilization...." Further, the study is to "identify future peacetime and mobilization Service support requirements world-wide." This portion of the report describes the experience of the study group in seeking to identify and provide for mobilization and wartime requirements.

1. Background

The Joint Chiefs of Staff and the individual Services possess detailed plans and analyses concerning mobilization and wartime requirements. These analyses generally include new and increased materiel requirements, but these requirements are not readily translatable into increased workload for the DODMDS. Although the need for adequate DODMDS capacity to support wartime operations is fully recognized, definition of this workload in terms acceptable to all parties concerned, and usable in DODMDS computer models, proved to be a complex undertaking involving considerable research and analysis both within the Services and by study group personnel themselves. Among the problems faced by the study group in developing usable DODMDS mobilization workload data were the following:

a. Basis of Computation

Although all Services determine wartime (mobilization) requirements using the same basic DOD guidance,[1] the methods used to compute specific requirements vary considerably among the Services and among inventory managers within a single Service. For example, wartime requirements for aviation items are, for the most part, based on anticipated flying hours. Requirements for missile support items are based on engineering estimates, while food and clothing requirements are based on the population being

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[1] DOD Directive 4140.2, Management of War Reserves, 4 December 1974.

supported. In addition, some reserves are maintained to support specific contingencies or missions not directly related to time-phased requirements.

b. NSN vs Commodity Grouping

Many wartime replacement rates apply to a specific item (NSN) or weapons systems. The DODMDS model, on the other hand, groups all items into 69 commodity groups. A problem exists in relating specific item rates to the rate for an entire commodity group.

c. Mobilization vs Wartime

Considerable ambiguity exists in the literature over whether there is a distinction between "mobilization" and "wartime" requirements. In some cases the words are used to describe separate and distinct aspects of an emergency situation: mobilization refering to actions required to improve the combat readiness of active and reserve forces, while wartime requirements anticipate consumption of materiel as a result of contact with, or actions against, an enemy force. The title of DOD Directive 4140.2 was changed from "Management of Mobilization Reserve Stock" to "Management of War Reserves" when it was republished on 4 December 1974. The new directive defines "war reserve material requirement(s)" as items required to equip and support approved forces less items assumed to be on hand on D-Day or procurable after D-Day to meet wartime requirements. Thus, in the context of this directive, mobilization requirements represent a portion of total war reserve requirements.

2. Alternative Strategies Examined

A series of meetings and discussions was held with Service/DLA and JCS representatives from late 1975 to mid-1976 to determine whether mobilization or wartime planning data existed which could be readily translated into depot workload; or more specifically, net increases in depot workload during mobilization or war. Data concerning mobilization and wartime receipts, storage requirements, and issues were solicited in the following levels of detail:

a. By individual transaction or daily workload.

b. By NSN or FSC.

c. Weight or cube per NSN/FSC per day.

d. Requirement by NSN/FSC per customer/region/country.

e. Mode of shipment per transaction/NSN/FSC.

f. Any other finite requirement which could be logically translated into depot workload.

None of these actions, which were followed by appropriate correspondence, indicated any data currently existed in a suitable format in the Services/DLA or JCS. Research indicated that any mobilization/wartime data usable by the study group would essentially need to be developed internally by the study group to insure standard format and treatment. However, these actions did reveal that a nucleus of data was available upon which a DODMDS mobilization/wartime workload study could be based.

3. DODMDS Developed Mobilization/Wartime Workload

Each Service has mobilization/war reserve requirements, which are procured and stocked for the purpose of sustaining a mobilization or war effort for a prescribed period of time. It is possible to match these reserve requirements against peacetime issues for like items, on a commodity basis, and thereby develop a factor reflecting the relationship between peacetime and anticipated wartime workload. For example, a quantity of 10 tons of a particular commodity may be stocked to support 30 days of wartime requirements, whereas only two tons are issued monthly in peacetime. A wartime workload for that commodity of five times the peacetime rate ($10 \div 2 = 5$) could, therefore, be projected. Similar analysis was conducted across each of the 69 DODMDS product groups. This was done using Army source data, and the factors developed were staffed for the concurrence of the Services/DLA. Based on comments received, minor modifications were made to the data and the revised wartime workload factors are displayed in Table 2-3.

These factors were applied to DODMDS base year data in order to arrive at wartime workload rates. It was recognized that application of these factors had certain shortcomings. The foremost was that it was a one dimensional view of workload increase. That is, it assumes each customer will have the same proportional increase in all commodities as all other customers. Also, it assumes all workload measures will increase by the same proportions, i.e., receipts, storage requirements, and issues will all increase by the same proportions; and increases in the number of issues, by priority, will parallel increases in the total weight shipped. However, admitting these shortcomings, the factors developed exceeded the utility of any other workload forecast suggested for use by the study group. Other factors tended to be highly specialized with regard to a particular item or commodity and/or the requirements of specific Service customers. These specialized factors, applying to only very small segments of the DODMDS, tended to be irrelevant in terms of influencing the basic structure of the total wholesale distribution system.

E. EXCLUSIONS

1. Commodity Exclusions

Appendix A, Section 4, assumption #5 specifically included ammunition, nuclear-biological-chemical materiel (NBC), principal items, bulk petroleum and perishable subsistence items in the study as these items impact transportation and storage considerations. However, these items were subsequently excluded from consideration in the study because of the reasons stated below. The following paragraphs describe the commodities excluded from consideration, the nature and reasons for the exclusion:

a. Ammunition

The unique storage, safety and transportation requirements which exist for ammunition require a specialized study to determine optimum storage and distribution systems. The impact of eliminating distribution functions at a mixed commodity depot was considered in off-line analysis.

Table 2-3. DODMDS Wartime Workload Factors

DODMDS Product Group Number	Factor
101	3.0
102	4.5
104	3.4
111, 131, 132	(Not modeled)
121	2.2
141, 142, 144, 145	3.4
151, 152	2.5
153	2.3
154, 155, 156, 157, 161, 162	2.6
171, 174	2.0
191	2.5
204	6.7
221	2.8
224	2.5
231, 232	2.0
241, 244	2.5
264, 265	2.0
281	4.5
294, 295, 296, 297	3.4
491, 492, 494, 495, 496, 497	2.8
534, 536, 537	2.4
544, 545	4.7
581, 584, 586, 587	5.3
611, 614, 616, 617	3.0
615	6.3
671	4.6
674	6.0
651, 654, 655	8.7
684, 685	3.2
714, 715	2.5
844, 845	2.5
894, 895	2.5
994, 995	2.0

b. Bulk Petroleum

The physical characteristics of this commodity, along with its unique storage requirements (tanks, berms, safety distances) and unique modes of transportation (pipelines, tanker trucks and tanker rail cars) all lend themselves to a specialized and separate study. Like ammunition, the impact of eliminating distribution functions at a mixed commodity depot was considered in off-line analysis.

c. Nuclear, Biological and Chemical (NBC) Materiel

For this study, nuclear, biological and chemical (NBC) materiel and related equipment were considered to be in the same category as ammunition and bulk petroleum since unique storage, security and transportation requirements exist.

d. Perishable Subsistence

Specialized storage and transportation requirements are also required for perishable subsistence items. In the case of fresh fruits and vegetables, these items are often delivered direct from local producers to posts, camps, stations and bases. Perishable subsistence was considered sufficiently unique that it should be the subject of a separate study and was excluded.

e. Industrial Plant Equipment (IPE)

The majority of costs associated with IPE operations are maintenance-related. The study group considered IPE operations to be basically maintenance functions and were, therefore, excluded from the study effort.

f. Communications Security (COMSEC) Equipment

These items, mostly with security classifications, also require specialized storage facilities and specialized transportation considerations.

g. Miscellaneous

(1) This category includes commodities that did not have any issues recorded during the data base period. This was discovered when comparing the DODMDS shipment file with the total listing of Federal Supply Classes. Accordingly, the following commodities were excluded from modeling analysis; however, they were considered in computing storage requirements:

FSC	Commodity	FSC	Commodity
1540	Gliders	3730	Livestock Equipment
1810	Space Vehicles	3760	Animal Power Equipment
1945	Pontoons & Docks	3915	Material Feeders
1950	Floating Drydock	4923	Mine Maintenance Equipment
1990	Miscellaneous Vessels	4927	Rocket Maintenance Equipment
2060	Fishing Equipment	5630	Pipe & Conduit
2340	Cycles, All Types	6116	Fuel Cell, Power
2830	Water Turbines	7022	ADP, CPU, Hybrid
2850	Rotary Engines	7670	Microfilm, processed
3412	Broaching Machines	7830	Recreation & Gym Equipment
3422	Roll & Draw Machines	8325	Fur Materiels
3447	Wire Machines	8425	Underwear, Womens
3461	F/Metal Machines	8720	Fertilizers
3550	Vending Machines	8730	Seeds & Plants
3605	Food Machines	8810	Live Animals - Food
3640	Tobacco Machines	8820	Live Animals - Non Food
3645	Leather Machines	8965	Beverage Alcoholic
3660	Reduction Machines	9910	Jewelry
3685	Container Machines	9915	Collectors Items

(2) It was recognized that certain commodities due to size (e.g., major end items) and volume of demand cube/weight (e.g., subsistence) lent themselves to containerized or volume moves from origin depots. These types of movements do not flow through Consolidation Containerization Points. In recognition of this fact, these commodities were routed directly to Ports of Embarkation for movement to overseas customers. Following is a listing of these commodities:

DODMDS Product Group Number	Commodity
102	Guns over 75mm
151	Fixed Wing Aircraft
152	Rotary Wing Aircraft
191	Ships and Boats
231	Wheeled Vehicles
232	Tracked Vehicles
894	Subsistence
895	DICOMMS

2. Depot Exclusions

The DODMDS Charter and Study Plan specifically limited the study effort to the 34 depots outlined in Appendix A, Section 3. However, statistics generated from the DODMDS data base revealed a total of 28,997,054 depot wholesale shipments during the base year. Of these, 1,613,825 or 5.6 percent were from sites/depots not included in the study effort. These 1,613,825 shipments were excluded from all model runs since they were outside the study scope. It is believed that the data available from the 34 JLC designated depots fairly represented the DODMDS wholesale system.

3. Depot Cost Exclusions

The relative costs at depots were critical factors in the study effort because costs were the decisive function of the mixed integer linear programming model used to assist in optimizing system structure. However, because of the differences in Service/Agency accounting systems, organizational structures for the supply depot operations (SDO) in the individual Service/Agency depots and in the materiel distribution tasks assigned to individual depots by their respective Service/Agency, five cost exclusions criteria were produced for model analysis.[1]

a. Non-SDO Costs

Accounting system/organization structure differences result in costs of functions not related to either basic supply production or support functions being reported as SDO cost. The classic example is costs of operating the DOD Dog Center at San Antonio ALC appearing in the DODI 7220.17 account 1.9 for Overall Depot Support.

b. Non-Comparable SDO Costs

Service/Agency unique distribution tasks, e.g., water cargo operations at NSC's and Maintenance Support Packages (MSP) at two NAS's, result in

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[1] See Chapter 4, Appendix D-3.

reported SDO costs which can not be compared with SDO costs as reported by other Service/Agency depots.

c. Excluded Items

Costs associated with depot processing of excluded items (page 50) were eliminated from depot cost functions developed for modeling analysis.

d. Non-study DODI Accounts

Four DODI prescribed accounts, 1.142 - Customer Service Store, 1.32 - Passenger Processing, 1.33 - Household Goods, and 1.42 - Air Passenger Processing, were considered not to be part of the wholesale materiel distribution system.

e. One-Time Expenses

Costs incurred for special projects, e.g., modernization, rewarehousing, etc., were considered inappropriate for inclusion in depot cost functions.

4. Other Exclusions

a. Shipments which represented redistributions between depots and shipments to disposal were excluded from the modeling effort since they represented movements which were not demands on the wholesale system. The total number of shipments involved was 289,391 or 1.06 percent of total shipments from depots included in the study. However, these shipments were included in an independent analysis in order to develop depot throughput costs.

b. All shipments with completely blank or completely zero NIIN's were excluded. These items were completely unidentifiable. These NIIN's were originally assigned FSC average catalog data; however, in processing through various steps the original catalog data were frequently overwritten with data from a matching blank NIIN which had no relationship to the specific FSC on a specific shipment. These transactions represented less than 1 percent of the total activity in the DODMDS data base and included manufacturer's part numbers with blank entries in the NIIN field.

c. Any transfer of accountability shipment through the DLA wholesale system was excluded by the study group. There were 2,109 of these records which were simply transfers of ownership (no movement) and not demands on the DLA wholesale system.

d. Direct delivery shipments from commercial production sources direct to the user were eliminated because they do not have any impact on system design (they did not pass through the system included in the study). However, sensitivity analysis was conducted to assess the impact of reduced demand on the wholesale system, which would simulate the effect of increased use of direct delivery shipments.

CHAPTER 3
THE BASELINE SYSTEM

A. INTRODUCTION

This chapter examines the characteristics of the baseline Department of Defense Materiel Distribution System (DODMDS). The DODMDS is a conglomerate -- consisting of five separate subsystems, one for each Service and the Defense Logistics Agency. Each consists of complex supply-shipper relationships, materiel movement responsibilities, and storage facilities, some of which are highly mechanized and modern. This chapter delineates the most significant qualitative and quantitative aspects by which the system can be examined, evaluated and compared. Further, it will review the characteristics of the distribution system with respect to the Services and DLA.

In this chapter, system configuration, volumes, performance and costs are discussed within the framework of the data currently available. Data for this effort was collected over a one year period from fiscal years 1975 and 1976. It should be recognized from the outset that the DODMDS study analyses used many different sources of data to develop a concensus on various statistics which characterize the total system. In some cases there will be specific numbers which may not be totally representative of today's volume. This is recognized, and felt to be a characteristic of the dynamics of the DODMDS. In short, the data which were used shows general tendencies, characteristics and possible trends. As a snapshot, it is not meant to be the perfect description of the exact flows or size of any facility. It does represent a relatively reliable assimilation of data and was of considerable value in scoping the analysis of the "what is" part of DODMDS, together with a basis for developing reasonable predictions and implications of "what might be."

This chapter, then, is a macro-view of the wholesale distribution system. It represents the movement of the mainstream of the DOD materiel from producer to customer across a variety of transportation links, storage locations and intermediate facilities, and is designed to provide a starting point for considering the past, present and future within a structured but realistically oriented perspective.

B. SERVICE/AGENCY CHARACTERISTICS

In this section each Service's/Agency's wholesale materiel distribution system is treated separately in order to describe the different aspects of each system as they relate to the baseline system.

1. The Army Wholesale Materiel Distribution System

a. Role

The Army wholesale materiel distribution system is responsible for worldwide support of all DOD users for Army integrated management items. The role of the system within the Army is to support Army organizations in CONUS and overseas under peacetime, mobilization or wartime conditions.

b. Description

(1) Inventory Control Points (ICP's). For DODMDS study purposes, the Army has five ICP's within the U.S. Army Materiel Development and Readiness Command. The ICP's are responsible for materiel management to include cataloging, requirements computation, procurement and disposal. These ICP's and their locations are:

ICP	LOCATION
Armament Materiel Readiness Command (ARRCOM)	Rock Island, Illinois

ICP	LOCATION
Electronics Command (ECOM)	Ft. Monmouth, New Jersey
Missile Materiel Readiness Command (MIRCOM)	Redstone Arsenal, Alabama
Tank-Automotive Materiel Readiness Command (TARCOM)	Warren, Michigan
Troop Support and Aviation Materiel Readiness Command (TSARCOM)	St. Louis, Missouri

(2) Distribution Facilities. The Army has 11 CONUS wholesale distribution facilities that were included in this study; three primarily responsible for storage of secondary items, and eight primarily responsible for storage of major items. Several have secondary and tertiary storage missions. Following is a listing of the 11 Army distribution facilities and their locations:

ARMY DEPOT	LOCATION
New Cumberland (NCAD)	New Cumberland, PA
Red River (RRAD)[1]	Texarkana, TX
Sharpe (SHAD)	Lathrop, CA
Anniston (ANAD)[1]	Anniston, AL
Letterkenny (LEAD)[1]	Chambersburg, PA
Lexington-Bluegrass Depot Activity (LBDA)[1]	Lexington, KY
Pueblo Depot Activity (PUDA)[1]	Pueblo, CO
Sacramento (SAAD)	Sacramento, CA
Tooele (TEAD)[1]	Tooele, UT
Tobyhanna (TOAD)	Tobyhanna, PA
Corpus Christi (CCAD)	Corpus Christi, TX

[1]Depot stocks ammunition.

(3) Management

(a) ICP's/Distribution Facilities. Army ICP's are not collocated with Army distribution facilities.

(b) Operation. All Army depots are managed and operated by the Army.

(c) Ownership. All Army distribution facilities are owned by the Army, except for Corpus Christi Army Depot which is on a Navy installation.

(d). DLA Stocks. New Cumberland Army Depot stocks selected DLA items in support of its Consolidation/Containerization Point (CCP) mission (see para. 1b(3)(j)). These items are owned by DLA until issued.

(e) Storage of Secondary Items. Stockage and issue of secondary items to support worldwide field activities is limited to New Cumberland, Red River, and Sharpe Army Depots. Support areas for each of these secondary item distribution mission depots are delineated in Figure 3-1, page 59. Initial provisioning wholesale stockage is based on the distribution of end items to the areas supported. Stockage for demand-supported items is based on the forecasted requirements for each of the three support areas.

(f) Stockage of Major Items. Major items, which cannot be shipped directly from the producer to a customer, are moved to a depot assigned to the specific commodity as delineated in Figure 3-2, page 59. Consideration is given to depot maintenance capability, space availability, plus the geographic location of the producer and potential consumer.

(g) Multiple Stock Points. Most secondary items are stocked at all three secondary item distribution mission depots.

(h) Ammunition Depots. The Army had six depots included in this study which stock ammunition.

Figure 3-1. Secondary Items Storage Assignments and Distribution Support Areas[1]

Distribution - Storage Assignments[2]

New Cumberland	Red River	Sharpe
ARRCOM	ARRCOM	ARRCOM
ECOM	ECOM	ECOM
MIRCOM	MIRCOM	MIRCOM
TARCOM	TARCOM	TARCOM
TSARCOM	TSARCOM	TSARCOM

Support Area Assignments

New Cumberland	Red River	Sharpe
U.S. Army, Europe	Panama	Pacific
Vermont	Tennessee	Alaska
Maine	Kentucky	Washington
New Hampshire	Florida	Oregon
Massachusetts	Alabama	California
Connecticut	Mississippi	Idaho
Rhode Island	Georgia	Nevada
New York	Texas	Utah
Pennsylvania	Missouri	Arizona
Ohio	Arkansas	Montana
Indiana	Louisiana	Hawaii
Michigan	North Dakota	
Minnestoa	South Dakota	
Wisconsin	Nebraska	
Illinois	Kanasa	
Iowa	Oklahoma	
New Jersey	Wyoming	
Delaware	Colorado	
District of Columbia	New Mexico	
West Virginia		
Virginia		
North Carolina		
South Carolina		
Maryland		

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[1]AMCR 740-4, Stock Distribution, Department of Army, Headquarters U.S. Army Materiel Command, 30 Jan 75.

[2]The commands that these acronyms represent are found on pages 57 and 58.

Figure 3-2. Major Items Storage Assignments[6,7]

Anniston

ARRCOM[1]
MIRCOM[1]
TARCOM[1]
TSARCOM[1]

Letterkenny

ARRCOM[1]
MIRCOM[1]
TARCOM[1,2]

Lexington-Blue Grass

ARRCOM[1]
ECOM[3]

New Cumberland

TSARCOM[1,5]

Pueblo

MIRCOM[1]
TARCOM[3,4]
TSARCOM

Red River

ARRCOM[1]
MIRCOM[1]
TARCOM
TSARCOM

Sacramento

ECOM[1]

Sharpe

TARCOM[3]
TSARCOM[3]

Tooele

ARRCOM[1]
MIRCOM[1]
TARCOM[1,2]
TSARCOM[1]

Tobyhanna

ECOM[1]
TARCOM[3]

Corpus Christi

TSARCOM[1]

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[1] Denotes depots that receive and store serviceable and unserviceable items. Selection of unserviceables will be in accordance with letter, AMCMA-PS, 31 October 73, subject: Prime and Secondary Maintenance Mission Assignments.

[2] Includes materiel handling and construction equipment on transfer from TSARCOM to TARCOM in FY 74 and FY 75.

[3] Denotes authorized storage of serviceable major items only when space is insufficient to accommodate in assigned depots.

[4] Bridging.

[5] Denotes the depot that receives and stores serviceable and unserviceable items. Unserviceables are limited to those to be placed on overhaul contract to commercial sources in the area.

[6] The commands that these acronyms represent are found on pages 57 and 58.

[7] AMCR 740-4, <u>op. cit</u>.

(i) Logistics Intelligence File (LIF). The Army Logistic Control Activity at the Presidio of San Francisco maintains the Army's LIF. The LIF obtains, through the DAAS, image copies of all requisitions, status documents, materiel release orders, and other related documents, providing visibility of the total pipeline from submission of requisition until receipt is posted to accountable records at the supply support activity. Monthly pipeline performance evaluation reports are produced by the Logistics Control Activity.

(j) Consolidation/Containerization Point (CCP). The Army has established CCP's at New Cumberland, Red River and Sharpe Army Depots. All less than container load shipments to United States Army, Europe are moved from CONUS Army/DLA wholesale depots to the New Cumberland CCP for consolidation/containerization. Less than container load shipments for United States Army, Pacific are similarly shipped to the Sharpe CCP for consolidation/containerization. Red River Army Depot consolidates shipments to Panama.

2. The Navy Wholesale Materiel Distribution System

a. Role

The Navy wholesale distribution system is designed to support all DOD users of Navy integrated management items. Within the Navy, the Navy wholesale system must provide responsive and cost effective support to Navy ships and submarines, aircraft, missiles, and supporting shore activities.

b. Description

(1) Inventory Control Points. There are two Navy ICP's. The Aviation Supply Office (ASO), Philadelphia, Pennsylvania, and the Ships' Parts Control Center (SPCC), Mechanicsburg, Pennsylvania. ASO is primarily responsible for equipment and parts for Navy and Marine Corps aviation. SPCC is responsible for equipment and repair parts for ship hulls, submarines, machinery, ordinance, vehicles, and electronics.

(2) Distribution Facilities. The Navy has nine wholesale distribution facilities at the following air

stations and supply centers which were included in the study:

Distribution Facility	Location
Naval Supply Center (NSC)	San Diego, California
Naval Supply Center (NSC)	Oakland, California
Naval Supply Center (NSC)	Pearl Harbor, Hawaii
Naval Supply Center (NSC)	Norfolk, Virginia
Naval Air Station (NAS)	Norfolk, Virginia
Naval Air Station (NAS)	Jacksonville, Florida
Naval Air Station (NAS)	North Island, California
Naval Air Station (NAS)	Alameda, California
Marine Corps Air Station (MCAS)	Cherry Point, North Carolina

(a) Mobile Logistics Support Forces (MLSF). In addition to the ICP and CONUS distribution facilities, the Navy distribution system includes the ships of the MLSF encompassing tenders, repair ships, and fleet issue ships. The MLSF, augmented by the overseas depots, is the first echelon of resupply support for the fleet. This echelon of fleet support backs up the allowance list materiel carried in combat ships.

(b) Overseas Depots. The Navy is continuing to maintain overseas wholesale depots in support of Navy peculiar mission requirements.

(c) DLA Specialized Support Depots (SSD) and Direct Supply Support Points (DSSP). DLA has made arrangements with the Navy to provide SSD's at NSC Norfolk and NSC Oakland and a DSSP at NSC San Diego.

All SSD/DSSP materiel is owned by DLA until issue; however, the Navy may issue materiel from these stocks and notify DLA after the fact (Post-Post).

(3) Management

(a) ICP's/Distribution Facilities. Navy distribution facilities are not located with the Navy ICP's.

(b) Operation. All Navy distribution facilities (except MCAS Cherry Point) are Navy managed and operated. MCAS Cherry Point is operated under Navy supply procedures, but managed by the Marine Corps.

(c) Ownership. All Navy distribution facilities included in the study are Navy owned, except for the facilities owned by the Marine Corps at MCAS Cherry Point.

(d) Multiple Stock Points. An item of supply might be stocked at all Navy distribution facilities. Stockage allocation at distribution facilities is based on the forecasted demands expected to be placed on the various stock points.

(e) SSD/DSSP. DLA has an arrangement with the Navy which places DLA owned stocks in Navy distribution facilities.

(f) MSLF and Overseas Depots. Because of the unique Navy mission, the MSLF and overseas depots are a necessary adjunct to the Navy wholesale distribution system.

(g) Visibility Over Assets. The ICP's retain asset visibility over all centrally procured items stocked at the wholesale distribution facilities in the study.

(h) Post-Post Shipments/Issues. The ICP's are routinely notified of shipments/issues of wholesale assets from Navy distribution facilities after the physical movement of materiel has occurred. The shipment/issue is then posted, reducing the asset balance after the movement occurs, thus the term POST-POST. Delays in notifying the ICP or failure to notify the ICP could result in erroneous asset balances at the ICP with subsequent warehouse refusals and late replenishment procurements. The Navy considers that the increased responsiveness to customers, which accures from post-posting, outweighs this risk.

(i) Variable Requisitioning Channels. Customers may obtain materiel by submitting requisitions to: (1) a designated wholesale distribution facility, (2) one of the ICP's, or (3) a major stock point in the customer's geographical area. In addition, the fleet, when at sea, may obtain materiel from the MLSF, or from overseas depots.

3. The Air Force Wholesale Materiel Distribution System

a. Role

The Air Force wholesale materiel distribution system, like the Army's and Navy's, is responsible for worldwide support of all DOD users for Air Force integrated management items. Within the Air Force, the system provides the necessary stock required to support its bases worldwide, during peacetime and wartime operations.

b. Description

(1) Inventory Control Points (ICP). The Air Force does not use the term ICP internally; however, the role performed by the ICP's in other Services is performed by Item Managers (IM) and System Managers (SM) at five locations termed Air Logistics Centers (ALC). The names of the ALC's and their locations are:

ALC	LOCATION
Warner-Robins ALC	Robins AFB, GA
Oklahoma City ALC	Tinker AFB, OK
Ogden ALC	Hill AFB, UT
San Antonio ALC	Kelly AFB, TX
Sacramento ALC	McClellan AFB, CA

(2) Distribution Facilities. There are five Air Force wholesale distribution facilities, which were included in this study, collocated with IM's/SM's (ICP's) at the five ALC's. Locations are as presented in paragraph b.(1) above.

(3) Management.

(a) ICP's/Distribution Facilities. IM's/SM's and distribution facilities are collocated at the ALC's. This concept provides for the collocation of materiel management, maintenance, and distribution functions to the maximum degree possible. It provides for a fully integrated and coordinated logistics activity that can provide responsive maintenance and supply/distribution support to worldwide customers for those weapons systems and items for which an ALC has management responsibility.

(b) Ownership and Management. All Air Force ALC's are owned, managed and operated by the Air Force.

(c) Weapon System and Commodity Oriented. Items which are peculiar to a specific weapon system are managed by an Item Manager at the ALC responsible for the entire weapon system. Items which are common to more than one weapon system are managed by an Item Manager at the ALC responsible for that Federal Stock Class. In each instance only one ALC is assigned responsibility for each item.

(d) Single Stock Point Policy. In most instances, items are managed and stocked at the same ALC and only at that ALC. Exceptions to this policy occur in cases where depot repair is performed at another ALC and after being repaired serviceable assets are stocked at that repair site. Also, in instances where it is clearly uneconomical to ship new procurements or serviceable returns to the primary stock point another ALC may be requested to provide storage.

(e) Visibility over Retail Assets. The Air Force has daily visibility of selected retail assets through the Air Force Recoverable Assembly Management System (AFRAMS) and the Propulsion Unit Status Reporting System. This visibility allows the Air Force to obtain asset knowledge, compatibility of distribution and requirements, effective use of depot repair resources, and facilitates the redistribution of assets to satisfy higher priority requirements.

(f) Redistributon Authority. IM's and SM's have the authority to redistribute retail assets from one retail activity (Air Force Base) to another to satisfy high priority requirements. This authority is unique within the DOD.

(g) High Priority Requisitions. Due to the combination of several factors (i.e., priority of units supported, dollar value of inventory, etc.) the Air Force is required to respond to a higher percentage of priority requisitions than other DOD wholesalers.

(h) Use of Airlift. The Air Force places greater emphasis on the use of airlift to expedite the flow of high priority items from depots to customers. The shorter pipeline which results from this practice minimizes the Air Force's high dollar value inventory.

4. The Marine Corps Wholesale Materiel Distribution System

a. Role

The Marine Corps distribution system has undergone a major transformation beginning in 1974 and extending through the base period. Prior to July 1974, the system was highly centralized with all Fleet Marine Force (FMF) requirements submitted to the Marine Corps Supply Activity, regardless of the ultimate source of supply. Consequently, the Marine Corps wholesale distribution system of that era involved receipt, storage and issue of up to 355,000 line items; most of which were under the cognizance of Integrated Material Managers (IMM). In February 1975, the FMF began to requisition directly from the IMM's and the process of decapitalizing and attriting peacetime operating stocks of IMM items from the Marine Corps distribution system commenced. Today, the Marine Corps distribution system supports approximately 39,800 Marine Corps managed items as follows:

End items	1,500
Depot reparables	1,300
Other reparables	4,000
*WIMM consumables[1]	33,000

[1]See next page for definition.

The sole role of the Marine Corps distribution system is to support the combat element of the Corps -- The Fleet Marine Force -- in its varied combat roles and environments.

WIMM consumables are those items associated with weapon systems/equipments for which the Marine Corps is the Weapon Integrated Materiel Manager (WIMM).

b. Description

(1) Inventory Control Point (ICP). The ICP functions for all Marine Corps managed items are integrated into the functions of the Marine Corps Logistics Support Base, Atlantic, which is located at Albany, Georgia. The Marine Corps is the only DOD activity with one ICP. While traditional ICP functions are performed for the aforementioned 39,800 items, more importantly, MCLSBLANT is the focus for the management of total logistics support for weapons systems and equipment, whether in the hands of the FMF, in the maintenance cycle, or in storage, without regard to the ultimate source of individual elements of logistics support.

(2) Distribution Facilities. The Marine Corps has two distribution facilities which are termed Marine Corps Logistics Support Bases (MCLSB). The MCLSB's are located at Albany, Georgia and Barstow, California. The MCSLB's in conjunction with their integral depot maintenance capability, provide storage and care-in-storage for weapons systems and equipments and associated secondary items held as war reserve for both active and reserve forces. Approximate numbers of items stocked at the MCLSB's, in addition to those addressed in paragraph 4a above, are as follows:

War Reserve Consumables	47,000
*Provisioning	19,000

*Number of provisioning items fluctuates as new weapons systems are phased into service use and initial support packages are released to users.

(3) Management

(a) ICP/Distribution Facilities. The Marine Corps ICP is part of the MCLSBLANT located at Albany. MCLSBLANT is owned, operated, and managed by the Marine Corps.

(b) Dual Stockage. The MCLSBPAC located at Barstow, California, provides logistics support for FMF units (including reserve) in western United States and the Pacific Theater. The MCLSBLANT at Albany, Georgia, provides logistics support for FMF (including reserve) in eastern United States and the Atlantic Theater.

(c) Marine Corps aviation support is provided by the Navy.

5. The Defense Logistics Agency (DLA) Wholesale Materiel Distribution System

a. Role

DLA functions as the consolidated wholesale manager for military common supply items assigned to the Agency for integrated management, while the Services manage the retail portion of the pipeline through organic supply systems. DLA positions wholesale stocks in its distribution system based on consideration of geographical consumption data, production source locations, and transportation costs.

b. Description

(1) Inventory Control Points (ICP). The DLA employs six ICP's, termed Defense Supply Centers (DSC), which are the integrated materiel managers for the NSN's/commodities assigned. These ICP's are:

ICP/DSC	LOCATION
Defense Construction Supply Center (DCSC)	Columbus, OH
Defense Electronics Supply Center (DESC)	Dayton, OH

ICP/DSC	LOCATION
Defense General Supply Center (DGSC)	Richmond, VA
Defense Industrial Supply Center (DISC)	Philadelphia, PA
Defense Personnel Supply Center (DPSC)	Philadelphia, PA
Defense Fuel Supply Center (DFSC)	Alexandria, VA

(2) Distribution Facilities. There are a total of seven wholesale distribution facilities included in this study -- six Principal Distribution Depots (PDD), and one Specialized Support Depot (SSD)[1] located at:

Type/Name of Stock Point	Location
PDD/Defense General Supply Center(DGSC)	Richmond, VA
PDD/Defense Construction Supply Center (DCSC)	Columbus, OH
PDD/Defense Depot Mechanicsburg(DDMP)	Mechanicsburg, PA
PDD/Defense Depot Memphis (DDMT)	Memphis, TN
PDD/Defense Depot Ogden(DDOU)	Ogden, UT
PDD/Defense Depot Tracy (DDTC)	Tracy, CA
SSD/Defense Electronics Supply Center (DESC)	Dayton, OH

(3) Management

(a) Facility Management. All DLA distribution facilities are managed by DLA.

(b) Ownership. All DLA facilities are owned by the Army except for DDMP facilities which are owned by the Navy and DESC facilities which are owned by the Air Force.

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[1]There are three other SSD's located at NSC Norfolk and NSC Oakland and New Cumberland Army Depot; however, these three SSD's were not considered as DLA distribution facilities, but are considered as a portion of NSC Norfolk and NSC Oakland under Navy distribution facilities and New Cumberland Army Depot under Army distribution facilities.

(c) Commodity Oriented. Items of supply are considered and managed as elements of broad commodity groupings -- Construction, Electronics, General, Industrial, Subsistence, Clothing and Textiles, Medical/Dental, and Fuels.

(d) Multiple Stock Points. DLA-managed commodity groups are positioned in designated stock points consistent with demand patterns and the ability to provide adequate support at the lowest transportation cost from production source through the stock points to customers. This results in commodity groups usually being stocked at four stock points while some specific items are stocked at as many as seven stock points.

(e) Large Volume Low Cost Items. Of the 1.8 million NSN's managed by DLA, nearly 60 percent have a unit cost of five dollars or less. In FY 75, 16.9 million line items, weighing over 1.8 million tons, were received or shipped by DLA stock points.

(f) Specialized Support Depot (SSD). The Navy and Army owned SSD locations stocking DLA owned materiel are a supply management/distribution arrangement.

(g) Support of Army Direct Support System (DSS). DLA supports the DSS by shipping less-than-container-load shipments through the appropriate Army Consolidation/Containerization Point (CCP).

(h) Industrial Plant Equipment (IPE). The DLA has three depots included in the study which stock Industrial Plant Equipment.

C. THE CUSTOMER

1. Introduction

The distribution system exists for one purpose -- to provide effective support to the customers -- the primary customers being the operational units of the military Services. In addition, the DODMDS provides support to the United States Coast Guard, other DOD agencies, other government agencies, defense contractors and friendly foreign governments.

DOD customers are located in the 50 United States, the District of Columbia and in over 80 foreign countries. The DOD Activity Address Directory (DODAAD) maintains address data on over 100,000 DODMDS customer activities including over 50,000 with freight or parcel post addresses. For the purpose of analyzing the DODMDS, these wide-spread and numerous customers were aggregated into 205 major customer groupings. Appendix C, Section 2, Table 2-1 is a listing of these major customer groupings. Figures 3-3 and 3-4 present a geographical distribution of these same customer groupings. Although the customers are identified as Service or DLA customers, it is pointed out that relatively small customers of other Services and their respective demands were aggregated with the identified Service in most cases.[1]

2. Customer Demands

Total materiel demands placed on the 34 distribution facilities by DODMDS customers amounted to 35.8 million issues during the data base period. Of these issues, 27.4 million were wholesale issues and 8.4 million were retail.

a. Wholesale Demands

Of the 27.4 million wholesale issues, 19.8 million (72.1 percent) were to CONUS customers and 4.2 million (15.4 percent) to overseas customers in the Atlantic area and 3.4 million (12.5 percent) to overseas customers in the Pacific area. Wholesale demand by each DODMDS customer grouping is listed by number of issues, issue weight, issue cube, and issue dollar value in Appendix C, Section 2, Table 2-2. Appendix C, Section 2, Tables 2-3 through 2-6 present rankings of customers by the number of issues, issue weight, issue cube and issue dollar value, respectively. Figure 3-5, page 75, illustrates demand by ZIP Code Region and overseas areas.

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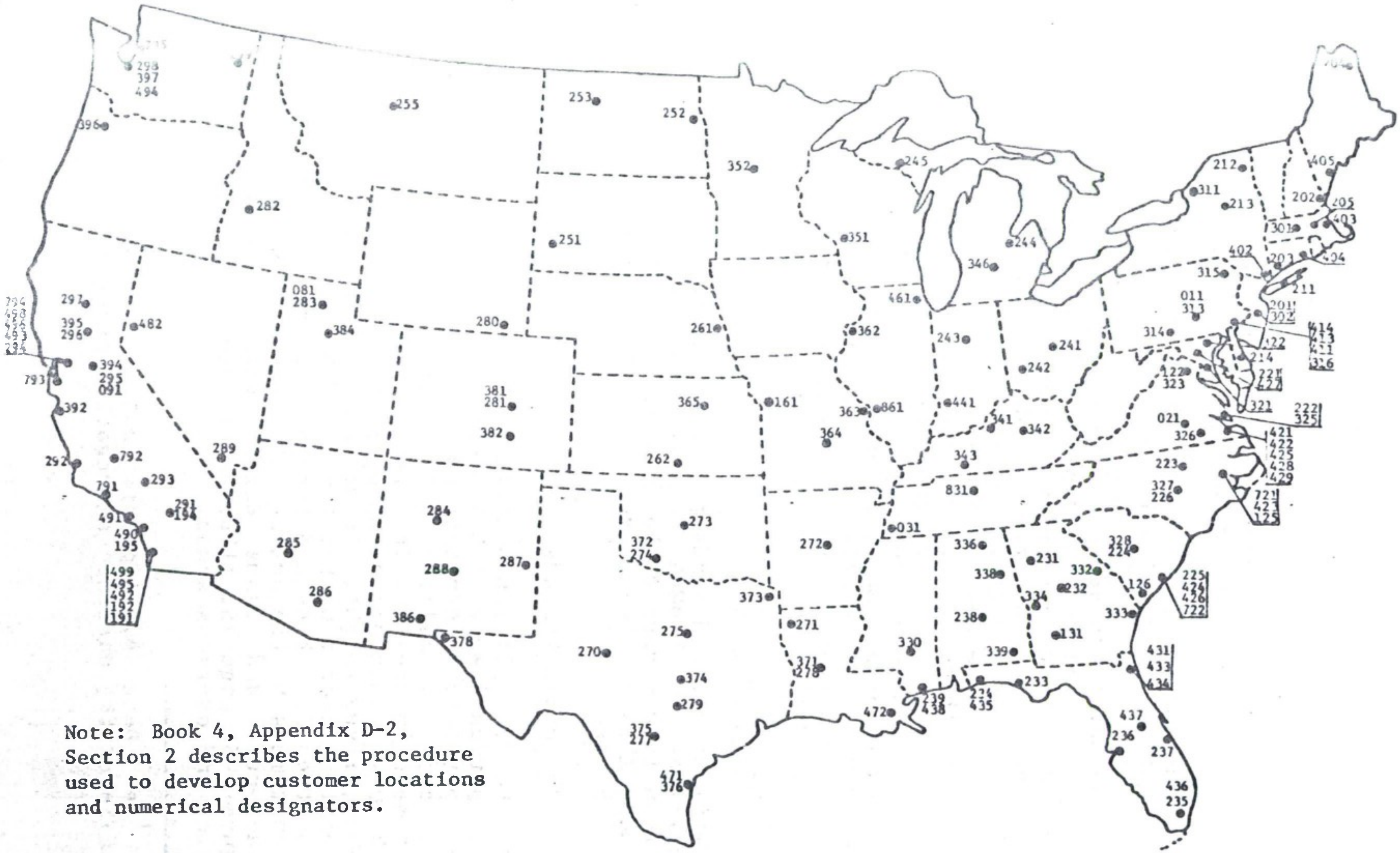
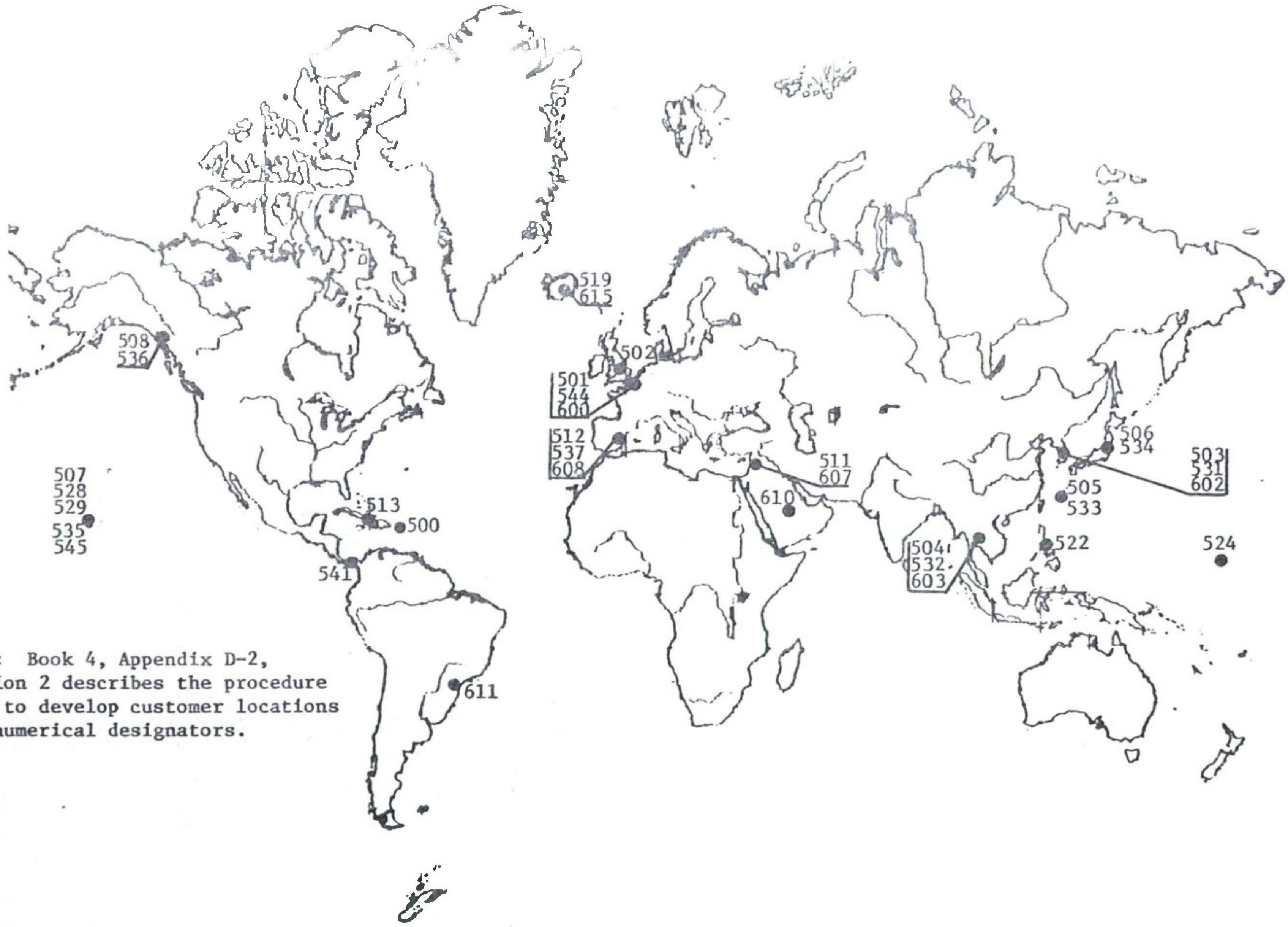
[1]See Book 4, Appendix D-2, Section 2 for details of the customer aggregation process.



Note: Book 4, Appendix D-2, Section 2 describes the procedure used to develop customer locations and numerical designators.

Figure 3-3. DODMDS CONUS Customer Locations



Note: Book 4, Appendix D-2, Section 2 describes the procedure used to develop customer locations and numerical designators.

Figure 3-4. DODMDS Overseas Customer Locations

b. Retail Demands

Retail demands on the 34 depots were collected for the purpose of developing depot workload data.

3. Distribution Facility Issues

To satisfy the customer demands, the 34 depots included in the study made 35.8 million issues. The wholesale issues by each depot are listed in Table 3-1, page 76, by number of issues, weight, cube and dollar value and in Table 3-2, page 77, for retail issues.

D. MATERIEL SOURCES

During the baseline period the DOD depots received materiel from both procurement and non-procurement sources.

1. Procurement Sources

DOD depot procurement receipts include new and repaired materiel from commercial production and maintenance facilities. Total wholesale procurement receipts by the 34 depots under study, amounted to 6.6 billion dollars. Total procurement receipts of wholesale materiel, less ammunition, by DOD depots (including depots not included in the study) amounted to 7.9 billion dollars on over 1.9 million receipt transactions, from approximately 19,000 different producers, under nearly 486,000 unique contracts. For the purpose of analyzing the DODMDS, these 19,000 producers were aggregated into 142 procurement source zones.[1] Appendix C, Section 3, Table 3-1 provides a listing of the 142 procurement source node locations. See Figure 3-6, page 78, for a geographical representation of these procurement source node locations.

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[1]See Book 4, Appendix D-2, Section 4 for details of the procurement zone aggregation process.

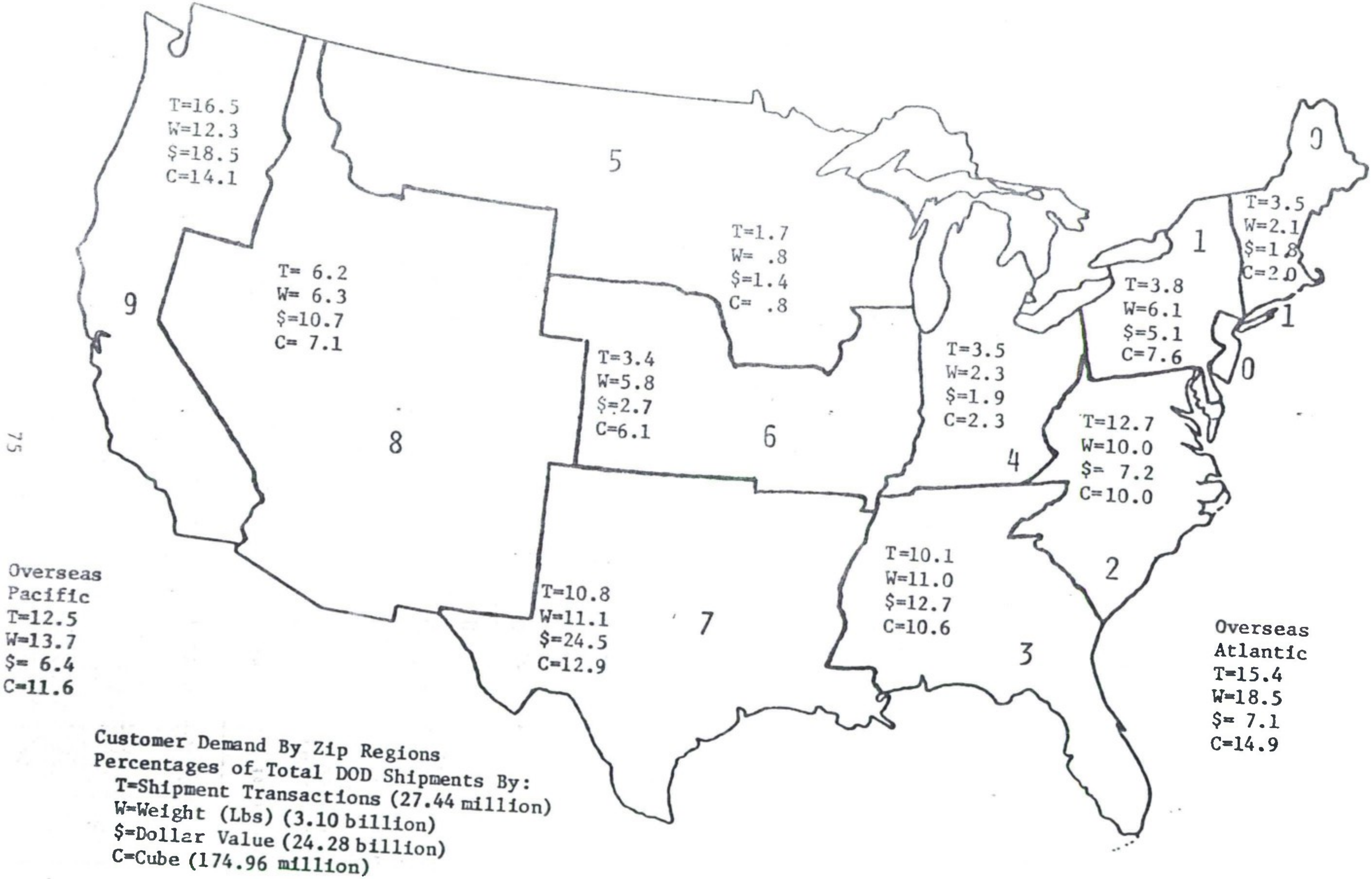

Figure 3-5. Worldwide DOD Customer Demand Pattern

Sources: DODMDS Report A1.103, 20 May 77, and A1.99, 23 May 77.

Table 3-1. DODMDS Wholesale Customer Demands In Issues, Issue Weight, Issue Cube and Issue Value From DODMDS Distribution Facilities[1]

Depot	Issues (000)/pct	Weight Pounds (000)/pct	Cube Cubic Feet (000)/pct	Value Dollars (000)/pct
Anniston AD	101/0.4	210,716/6.8	8,439/4.8	710,919/2.9
Corpus Christi AD	30/0.1	10,833/0.3	2,759/1.6	515,547/2.1
Letterkenny AD	390/1.4	125,357/4.0	6,338/3.6	613,764/2.5
Lexington DA	116/0.4	13,142/0.4	1,023/0.6	111,585/0.5
New Cumberland AD	580/2.1	149,509/4.8	10,018/5.7	620,198/2.6
Pueblo DA	55/0.2	32,680/1.1	2,850/1.6	357,178/1.5
Red River AD	457/1.7	154,128/5.0	10,416/6.0	528,266/2.2
Sacramento AD	531/1.9	58,866/1.9	3,528/2.0	256,990/1.1
Sharpe AD	199/0.7	68,952/2.2	5,453/3.1	192,843/0.8
Tobyhanna AD	137/0.5	36,821/1.2	3,635/2.1	256,368/1.1
Tooele AD	99/0.4	115,269/3.7	7,372/4.2	307,647/1.3
NAS Alameda	290/1.1	11,176/0.4	1,466/0.8	567,803/2.3
NAS Jacksonville	213/0.8	8,542/0.3	1,871/1.1	428,453/1.8
NAS Norfolk	257/0.9	13,039/0.4	1,421/0.8	708,799/2.9
NAS North Island	345/1.3	29,217/0.9	2,605/1.5	647,014/2.7
NSC Norfolk	1,553/5.7	119,942/3.9	4,434/2.5	268,118/1.1
NSC Oakland	1,341/4.9	117,801/3.8	4,830/2.8	273,212/1.1
NSC Pearl Harbor	83/0.3	11,682/0.4	368/0.2	15,833/0.1
NSC San Diego	210/0.8	46,257/1.5	1,851/1.1	105,814/0.4
MCAS Cherry Point	226/0.8	9,504/0.3	1,198/0.7	345,813/1.4
Oklahoma City ALC	1,136/4.1	65,469/2.1	5,664/3.2	4,417,499/18.2
Ogden ALC	734/2.7	46,098/1.5	4,472/2.6	2,069,460/8.5
Sacramento ALC	535/2.0	40,274/1.3	2,966/1.7	2,254,491/9.3
San Antonio ALC	931/3.4	70,707/2.3	5,263/3.0	2,824,968/11.6
Warner Robins ALC	802/2.9	38,933/1.3	4,067/2.3	2,275,423/9.4
MCLSBLANT	99/0.4	30,263/1.0	2,152/1.2	106,000/0.4
MCLSBPAC	181/0.7	48,907/1.6	3,357/1.9	334,439/1.4
DCSC Columbus	2,193/8.0	63,133/2.0	3,506/2.0	136,361/0.6
DDMP Mechanicsburg	1,864/6.8	473,567/15.3	20,418/11.7	521,320/2.1
DDMT Memphis	3,096/11.3	284,507/9.2	13,072/7.5	465,557/1.9
DDOU Ogden	3,772/13.7	90,421/2.9	6,269/3.6	312,310/1.3
DDTC Tracy	1,315/4.8	325,720/10.5	12,667/7.2	320,790/1.3
DESC Dayton	2,434/8.9	7,773/0.3	617/0.4	169,873/0.7
DGSC Richmond	1,132/4.1	175,699/5.7	8,596/4.9	236,656/1.0
DOD TOTAL	27,437/100.0	3,104,907/100.0	174,960/100.0	24,277,310/100.0

[1]DODMDS Report A1.78, 23 May 77.

Table 3-2. DODMDS Retail Customer Demands In Issues, Issue Weight, Issue Cube and Issue Value From DODMDS Distribution Facilities[1]

Depot	Issues (000)/pct	Weight Pounds (000)/pct	Cube Cubic Feet (000)/pct	Value Dollars (000)/pct
Anniston AD	264/3.3	48,265/5.7	2,459/4.2	141,553/5.0
Corpus Christi AD	202/2.5	11,795/1.4	1,751/3.0	208,342/7.4
Letterkenny AD	227/2.8	67,867/8.0	3,445/5.9	189,407/6.7
Lexington DA	111/1.4	23,732/2.8	1,315/2.2	54,774/2.0
New Cumberland AD	135/1.7	42,636/5.0	2,878/4.9	114,752/4.1
Pueblo DA	79/1.0	9,258/1.1	433/0.7	20,063/0.7
Red River AD	157/2.0	96,231/11.3	5,971/10.2	99,387/3.5
Sacramento AD	292/3.6	15,708/1.8	1,632/2.8	65,079/2.3
Sharpe AD	136/1.7	42,490/5.0	2,759/4.7	121,205/4.3
Tobyhanna AD	122/1.5	22,948/2.7	1,794/3.1	51,597/1.8
Tooele AD	107/1.3	27,328/3.2	1,362/2.3	233,870/8.3
NAS Alameda	127/1.6	3,911/0.5	344/0.6	12,562/0.5
NAS Jacksonville	123/1.5	8,989/1.1	508/0.9	15,356/0.6
NAS Norfolk	28/0.3	3,585/0.4	242/0.4	7,905/0.3
NAS North Island	92/1.1	15,769/1.9	1,726/2.9	30,668/1.1
NSC Norfolk	475/5.9	85,298/10.0	4,445/7.6	92,494/3.3
NSC Oakland	115/1.4	20,240/2.4	2,098/3.6	34,387/1.2
NSC Pearl Harbor	290/3.6	34,526/4.0	2,195/3.7	28,771/1.0
NSC San Diego	830/10.3	40,660/4.8	3,144/5.4	86,196/3.1
MCAS Cherry Point	180/2.2	6,461/0.8	501/0.9	16,101/0.6
Oklahoma City ALC	698/8.7	42,324/5.0	4,104/7.0	302,041/10.8
Ogden ALC	735/9.2	24,306/2.9	2,256/3.8	147,867/5.3
Sacramento ALC	883/11.0	36,780/4.3	3,176/5.4	213,871/7.6
San Antonio ALC	607/7.6	63,643/7.5	3,972/6.8	272,254/9.7
Warner Robins ALC	750/9.3	35,084/4.1	2,679/4.6	161,721/5.8
MCLSBLANT	218/2.7	11,732/1.4	689/1.2	31,330/1.1
MCLSBPAC	56/0.7	12,310/1.4	850/1.5	56,845/2.0
DOD TOTAL	8,039/100.0	853,876/100.0	58,728/100.0	2,810,398/100.0

Notes:
1. The cost of processing retail transactions at the DLA distribution facilities is recorded separately from the cost of processing wholesale transactions. Hence, the DODMDS study group used only the wholesale workload for the DLA depots. See Appendix D-3 for additional details.
2. Army provided the retail issue data for period shorter than one year. Appendix D-3, Section 2 presents the procedure used for the annualization of the Army retail issue data.

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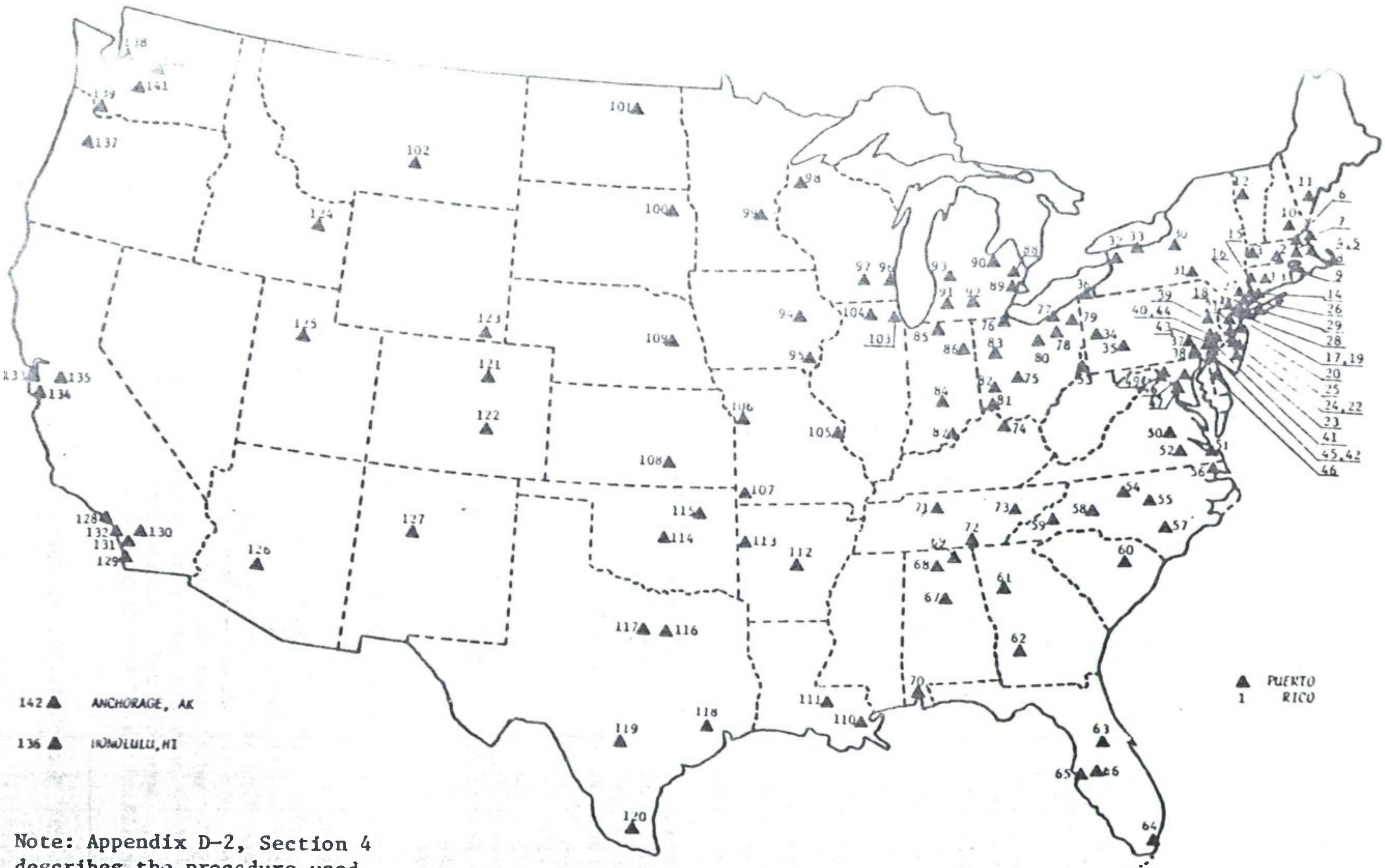
[1] DODMDS Report A1.52, 15 April 77.



Note: Appendix D-2, Section 4 describes the procedure used to develop procurement source locations.

Figure 3-6. Procurement Zone Node Locations

a. Wholesale Procurement Receipts. Total wholesale procurement receipts for the 34 depots are listed in Appendix C, Section 3, Table 3-2, by source node ZIP, by weight, dollar value and number of transactions. Figure 3-7, page 80, quantifies procurement source patterns by ZIP Regions.

b. Distribution Facility Wholesale Procurement Receipts. Receipt volumes for each of the 34 depots by weight, dollar value and number of transactions are listed in Table 3-3, page 81.

2. Non-procurement Sources

Total wholesale non-procurement receipts by the depots under study amounted to 16.5 billion dollars. Non-procurement receipts include customer returns of serviceable/unserviceable materiel, redistribution of materiel between depots, receipts from in-house maintenance, withdrawals from property disposal assets and others (e.g., receipt of frustrated/diverted materiel, returns of loaned materiel). For purposes of the study, the world was divided into 205 customer demand regions as previously stated. The reverse flow of materiel from these regions represent sources of customer returns (non-procurement receipts). These customer locations are listed in Appendix C, Section 2, Table 2-1 and geographically illustrated in Figures 3-3, page 72 and 3-4, page 73.

a. Wholesale Non-Procurement Receipts

Total wholesale non-procurement receipts for the 34 depots by each DODMDS customer grouping are listed in Appendix C, Section 3, Table 3-3 by weight, dollar value and number of transactions. Figure 3-8, page 82, quantifies production source patterns for these non-procurement receipts by ZIP Code Regions.

b. Distribution Facility Wholesale Non-Procurement Receipts

Receipts by each of the 34 depots by weight, dollar value and number of transactions are listed in Table 3-4, page 83.

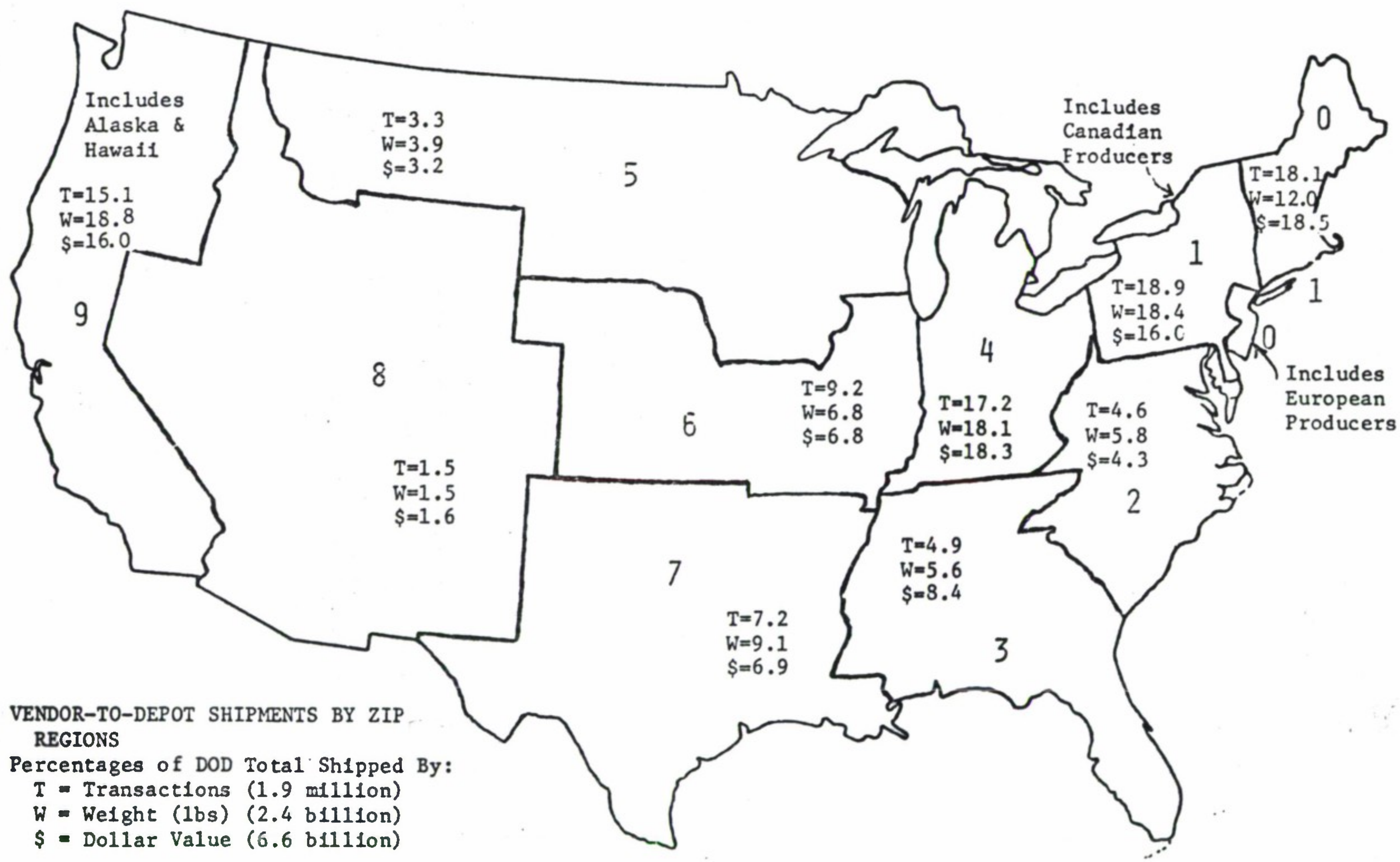


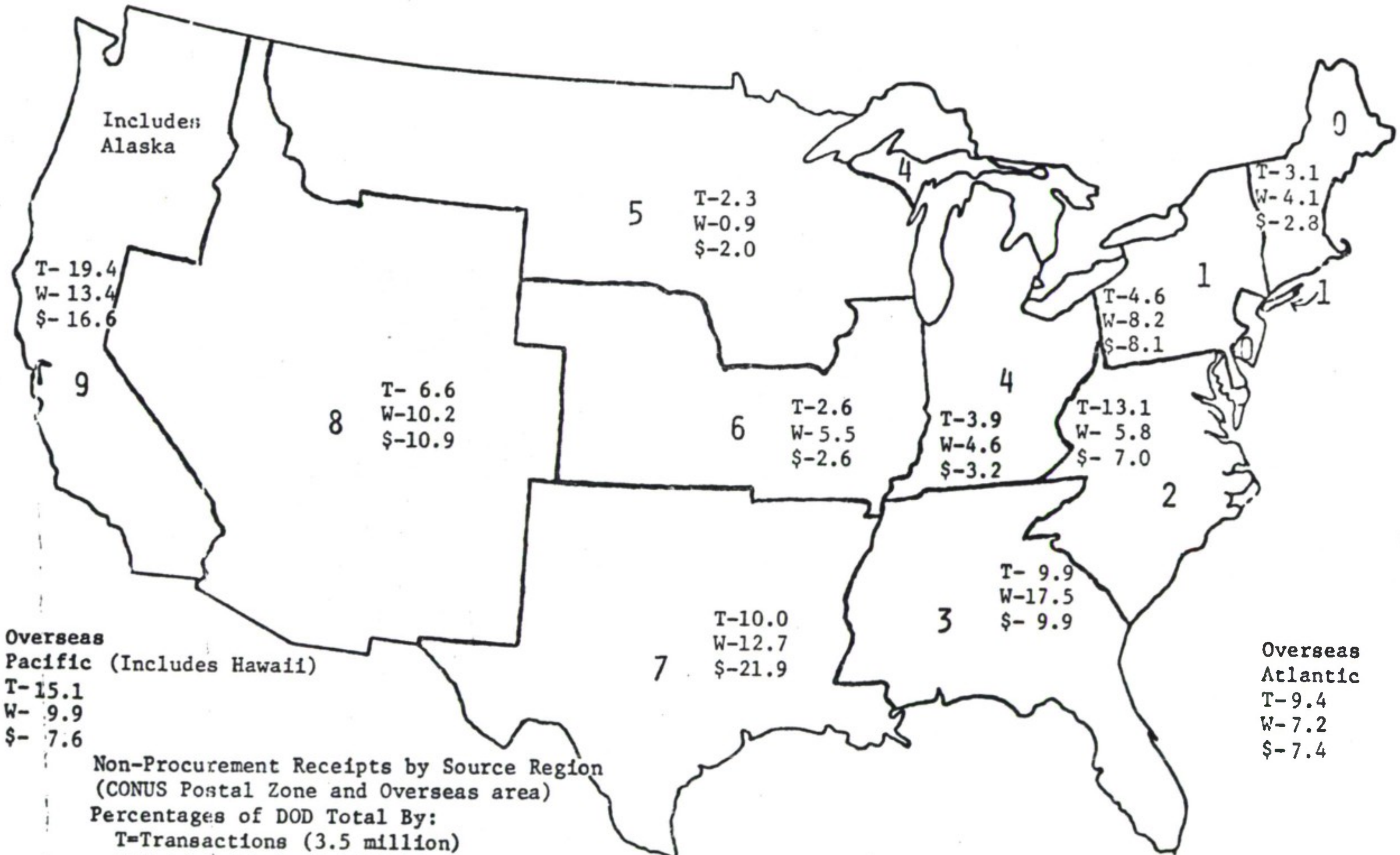
Figure 3-7. Wholesale Procurement Source Patterns

Source: DODMDS Report B1.1, 18 June 77.

Table 3-3. DODMDS Wholesale Procurement Receipts by Transactions, Weight, Cube and Value by DODMDS Distribution Facility[1]

Depot	Receipt Transactions /pct	Weight Pounds (000)/pct	Cube Cubic Feet (000)/pct	Value Dollars (000)/pct
Anniston AD	9,606/0.5	39,659/1.7	3,765/2.5	302,082/4.5
Corpus Christi AD	165/0.009	68/0.003	6/0.004	3,568/0.05
Letterkenny AD	11,389/0.6	57,812/2.4	4,132/2.9	231,677/3.5
Lexington DA	5,021/0.3	5,069/0.2	295/0.2	26,548/0.4
New Cumberland AD	39,582/2.1	126,034/5.3	7,477/5.2	377,480/5.7
Pueblo DA	4,924/0.3	1,489/0.1	259/0.2	22,787/0.3
Red River AD	23,035/1.2	30,708/1.3	2,985/2.1	144,723/2.2
Sacramento AD	22,573/1.2	62,789/2.6	4,241/2.9	137,794/2.1
Sharpe AD	11,350/0.6	29,394/1.2	1,525/1.1	78,075/1.2
Tobyhanna AD	9,401/0.5	8,841/0.4	811/0.6	68,053/0.1
Tooele AD	2,697/0.1	17,256/0.7	1,452/1.0	35,897/0.5
NAS Alameda	30,721/1.6	2,679/0.1	1,739/1.2	107,811/1.6
NAS Jacksonville	19,880/1.1	1,937/0.1	5,318/3.7	65,503/1.0
NAS Norfolk	32,012/1.7	4,033/0.2	2,951/2.1	109,100/1.6
NAS North Island	24,092/1.3	5,020/0.2	3,915/2.7	95,708/1.4
NSC Norfolk	123,644/6.6	138,665/5.8	5,054/3.5	239,532/3.6
NSC Oakland	105,163/5.6	137,571/5.8	4,479/3.1	194,703/2.9
NSC Pearl Harbor	3,484/0.2	5,815/0.2	155/0.1	5,526/0.08
NSC San Diego	12,184/0.6	20,970/0.9	813/0.6	38,932/0.6
MCAS Cherry Point	25,338/1.4	3,702/0.2	1,006/0.7	65,169/1.0
Oklahoma City ALC	94,367/5.0	11,714/0.5	2,525/1.7	532,696/8.0
Ogden ALC	33,889/1.8	14,634/0.6	4,197/2.9	223,847/3.4
Sacramento ALC	35,262/1.9	7,125/0.3	11,148/7.7	180,267/2.7
San Antonio ALC	93,188/5.0	23,469/1.0	2,439/1.7	739,650/11.1
Warner Robins ALC	63,031/3.4	13,013/0.6	2,053/1.4	371,206/5.6
MCLSBLANT	4,825/0.3	2,274/0.1	457/0.3	9,835/0.15
MCLSBPAC	6,298/0.3	1,965/0.1	164/0.1	11,370/0.2
DCSC Columbus	127,667/6.8	82 544/3.5	4,635/3.2	161,151/2.4
DDMP Mechanicsburg	133,286/7.1	508,628/21.4	20,638/14.3	506,304/7.6
DDMT Memphis	180,049/9.6	357,613/15.0	14,955/10.4	498,072/7.5
DDOU Ogden	256,931/13.7	101,138/4.3	6,265/4.3	302,689/4.6
DDTC Tracy	101,889/5.4	345,069/14.5	13,587/9.4	303,495/4.6
DESC Dayton	176,194/9.4	10,710/0.5	913/0.6	214,920/3.2
DGSC Richmond	51,631/2.8	201,225/8.5	8,181/5.6	251,277/3.7
DOD TOTAL	1,874,869/100.0	2,380,630/100.0	144,444/100.0	6,648,982/100.0

[1]DODMDS Report B1.25, 27 June 77.



Non-Procurement Receipts by Source Region
(CONUS Postal Zone and Overseas area)
Percentages of DOD Total By:
T=Transactions (3.5 million)
W=Weight (lbs) (1.1 billion)
$=Dollar Value (14.9 billion)
Note: Does not include inter-depot transfers (redistribution orders)

Figure 3-8. Wholesale Non-Procurement Receipts Source Pattern

Source: DODMDS Report B2.15, 6 July 77.

Table 3-4. DODMDS Wholesale Non-Procurement Receipts by Transactions, Weight, Cube and Value by DODMDS Distribution Facility[1]

Depot	Receipt Transactions /pct	Weight Pounds (000)/pct	Cube Cubic Feet (000)/pct	Value Dollars (000)/pct
Anniston AD	29,308/0.8	214,181/15.8	8,071/7.7	620,936/3.8
Corpus Christi AD	10,763/0.3	8,540/0.6	3,704/3.5	431,436/2.6
Letterkenny AD	44,277/1.2	141,219/10.4	10,704/10.2	846,636/5.1
Lexington AD	65,064/1.7	12,447/0.9	1,111/1.1	135,999/0.8
New Cumberland AD	62,770/1.7	35,804/2.6	3,596/3.4	503,370/3.1
Pueblo AD	15,594/0.4	32,301/2.4	1,884/1.8	341,879/2.1
Red River AD	118,267/3.2	163,455/12.0	11,530/10.9	595,546/3.6
Sacramento AD	70,830/1.9	24,927/1.8	1,896/1.8	201,475/1.2
Sharpe AD	47,233/1.3	43,840/3.2	4,423/4.2	178,786/1.1
Tobyhanna AD	48,853/1.3	34,186/2.5	4,219/4.0	335,605/2.0
Tooele AD	24,649/0.7	89,012/6.6	6,135/5.8	228,168/1.4
NAS Alameda	173,281/4.6	12,013/0.9	1,892/1.8	580,883/3.5
NAS Jacksonville	123,631/3.3	5,984/0.4	2,165/2.1	323,094/2.0
NAS Norfolk	155,645/4.1	10,048/0.7	1,434/1.4	417,062/2.5
NAS North Island	179,134/4.8	12,548/0.9	1,790/1.7	502,092/3.0
NSC Norfolk	139,843/3.7	13,575/1.0	603/0.6	183,971/1.1
NSC Oakland	156,308/4.2	19,930/1.5	824/0.8	150,566/0.9
NSC Pearl Harbor	10,466/0.3	5,291/0.4	182/0.2	8,975/0.05
NSC San Diego	51,337/1.4	15,795/1.2	3,600/3.4	108,820/0.7
MCAS Cherry Point	103,293/2.8	6,076/0.5	1,401/1.3	293,345/1.8
Oklahoma City ALC	339,019/9.0	54,089/4.0	3,668/3.5	3,798,587/23.1
Ogden ALC	220,453/5.9	14,331/1.1	1,863/1.8	1,064,274/6.5
Sacramento ALC	232,516/6.2	16,270/1.2	1,998/1.9	802,591/4.9
San Antonio ALC	276,213/7.4	45,671/3.4	5,186/4.9	1,574,957/9.6
Warner Robins ALC	372,179/9.9	23,731/1.8	2,378/2.3	1,529,533/9.3
MCLSBLANT	54,664/1.5	72,546/5.3	5,601/5.3	206,007/1.3
MCLSBPAC	78,201/2.1	106,387/7.8	7,694/7.3	292,120/1.8
DCSC Columbus	56,222/1.5	8,202/0.6	409/0.4	17,712/0.1
DDMP Mechanicsburg	25,366/0.7	12,043/0.9	690/0.7	23,281/0.1
DDMT Memphis	95,804/2.6	16,783/1.2	918/0.9	43,549/0.3
DDOU Ogden	191,601/5.1	19,068/1.4	1,177/1.1	61,423/0.4
DDTC Tracy	41,297/1.1	28,943/2.1	1,073/1.0	32,071/0.2
DESC Dayton	108,914/2.9	523/0.04	61/0.1	16,219/0.1
DGSC Richmond	34,625/0.9	38,895/2.9	1,512/1.4	27,122/0.2
DOD TOTAL	3,757,620/100.0	1,358,665/100.0	105,391/100.0	16,478,092/100.0

Note: Includes interdepot transfers (redistribution orders), as well as receipts from DODMDS customer groupings.

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[1] DODMDS Report B1.26, 31 May 77.

E. COMMODITIES

Commodities are, perhaps, the most important elements in a distribution system. What they are, how and where they are stored and moved have been the subject of considerable attention and examination during the study. This section describes the magnitude and variety of commodities that moved during the base year period.

The items managed by DOD make up 91 percent of the 4.1 million items identified within the Federal Catalog System. These items are classified into 77 Federal Supply Groups (FSG) which are subdivided into 604 Federal Supply Classes (FSC).[1] Each class contains a relatively homogeneous set of items which are usually requisitioned or issued together or they constitute a related grouping for supply management purposes.[2]

Table 3-5 presents the number of items managed by each Service/Agency as a percentage of DOD total.

Table 3-5. Items Managed by Service/Agency, FY 75[3]

Service/Agency	Items	Percent of Total
Army	303,299	8.2
Navy	693,636	18.6
Air Force	805,293	21.6
Marine Corps	41,119	1.1
DLA	1,881,976	50.5
DOD TOTAL	3,725,323	100 percent

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[1] Procedures for classifying items are contained in: The Federal Catalog System Policy Manual, DODD 4130.2-M, U.S. Government Printing Office, Washington, D. C., 1971.

[2] Cataloging Handbook 2-1, Federal Supply Classification, U.S. Government Printing Office, Washington, D. C., 1975.

[3] Forty-sixth Annual Report on Defense Cataloging and Standardization Programs, Office of the Assistant Secretary of Defense (I&L), 12 April 1976.

1. DODMDS Commodities

For the purpose of analyzing the DODMDS, these 77 FSG's and 604 FSC's were aggregated into 69 DODMDS product groups under 15 major generic categories. These product groups are listed in Appendix C, Section 4, Table 4-1.[1]

2. Commodity Activity

The DODMDS wholesale shipment data base contains 1.6 million National Stock Numbers (NSN's). The wholesale shipment data were collected from the Inventory Control Points (ICP's) and only contain NSN's that moved during the base year period.

DODMDS product groups are listed by number of wholesale issues, weight, cube and dollar value in Appendix C, Section 4, Table 4-2. The DODMDS product groups are ranked by number of issues, weight, cube and value in Appendix C, Section 4, Tables 4-3 through 4-6.

Review of these tables reveals 90 percent of the weight is accounted for by 29 DODMDS product groups and 90 percent of the issues is accounted for by only 23 DODMDS product groups.

Appendix C, Section 4, Tables 4-7 through 4-10, show the commodities handled by each depot in the base data period in terms of numbers of issues, weight, cube and value.

3. Wholesale Asset Data

The DODMDS wholesale asset data base contained 4.4 million separate National Stock Number (NSN) records. The wholesale asset data was a "snapshot in time" picture of the assets in storage at the 34 depots being studied. Duplication of specific NSN's, (and condition codes) between the depots account for the number of NSN's in storage exceeding the 3.7 million previously stated as being managed by DOD.

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[1]See Book 4, Appendix D-2, Section 3 for details of the commodity aggregation process.

DODMDS wholesale assets are reflected by DODMDS product, weight, cube, quantity and number of NSN's in Appendix C, Section 9, Tables 9-1 through 9-5.

Review of these tables reveals 37 percent (1,652,000 line items, serviceable and unserviceable) of the DODMDS wholesale inventory (excluding ammo and nuclear items) NSN's had no recorded demands during the data base period. Items with six or more issues per year accounted for 70 percent of the weight and 34 percent of the NSN's in wholesale DODMDS storage.

F. DISTRIBUTION FACILITIES

1. Location

The 34 wholesale distribution facilities included in the DODMDS study, as outlined in Appendix A, Section 3 are located throughout the United States as depicted in Figure 3-9, page 87. Of the 34 depots, California has nine; Pennsylvania four; Texas, Virginia and Utah three each; Georgia and Ohio two each; and Alabama, Colorado, Florida, Hawaii, Kentucky, North Carolina, Oklahoma and Tennessee one each.

2. General Characteristics

The DOD Materiel Distribution System makes use of a wide range of facilities. Some of the key features are the numbers of buildings, their age, type of construction, type of storage, ceiling height, floorload, and lighting. These are summarized in Appendix C, Section 5, Table 5-1.

a. Buildings

There is a total of 886 buildings at the 34 depots used for receipt, storage, shipment and other materiel processing related functions. As noted in Paragraph 3 below, the primary function of most DOD buildings is storage of materiel, not processing. The relative proportions by operating agency are as follows:

Figure 3-9. DODMDS Activities Under Study

Service/Agency	Number of Buildings
Army	253
DLA	214
Navy	222
Air Force	144
Marine Corps	53
TOTAL	886

All of the DODMDS installations include multiple-building operations. The principal advantages are: separate buildings allow for the segregation of slow moving items; hazardous items can be separated from the bulk of the materiel; individual climatic controls can be applied depending on the type of item stored; loss in the event of fire can be contained; and buildings can be closed during periods of reduced operations. The disadvantages of this situation include: fragments the normal flow process; increases security requirements; delays storage and retrieval; necessitates additional personnel to man each individual building and increases utility resource requirements. The number of buildings used for wholesale receipt, storage, shipment and other materiel processing functions located at each of the facilities under study and by Service/Agency are depicted in Appendix C, Section 5, Table 5-1, Col. 2.

b. Building Age

Although most of the structures can continue to provide adequate protection for the materiel stored for many years, over 80 percent of the DODMDS buildings assigned a materiel storage function exceed their economical life, which is 25 years; and 75 percent of the DODMDS gross space is over 30 years old. By individual Service the situation is as follows:

(1) Army. 82 percent of the Army warehouses and 74 percent of covered space exceed 30 years.

(2) Navy: 93 percent of the Navy warehouses and 95 percent of covered space exceed 30 years.

(3) Air Force. 72 percent of the Air Force warehouses and 52 percent of covered space exceeds 30 years. Although the large percentage of the Air Force distribution facilities in use are in this age category, the heart of the active, daily distribution system at each ALC consists of modern, highly mechanized state-of-the-art facilities built within the past five years or are under construction.

(4) Marine Corps. 38 percent of the Marine Corps warehouses and 35 percent of covered space exceeds 30 years.

(5) DLA. 85 percent of the DLA warehouses and 80 percent of covered space exceeds 30 years.

(6) DOD Average. 81 percent of the DOD warehouses are over 30 years old and 75 percent of the covered space is over 30 years old.

Since 1957, 80 percent of the buildings constructed have been by the Army and Air Force, but this new construction represents only 3 percent of the total DOD warehouse space available. Additional details are provided in Appendix, C Section 5, Table 5-1, Col. 3 for the facilities under study and Table 3-6, page 90 for a composite DOD summary of building age.

c. Type Construction

The facilities being used for warehouse operations are predominately of a durable masonry type construction.

Percentage Total Gross Space - As all buildings have different dimensions, it is necessary to compare the square footage of the buildings constructed during the various periods to the gross space available to determine the percent constructed during each period. This construction includes reinforced concrete, concrete masonry unit, brick or tile walls with wooden or metal columns and standard wooden truss or flat concrete roof construction. Buildings of total wood or corrugated metal construction represent a minority of the storage facilities in the system and in most cases are the type of structure scheduled for razing when permanent construction is contemplated. Additional detail is provided in Appendix C, Section 5, Table 5-1, Col. 4.

Table 3-6. Summary Storage Building Age[1,2]

Construction Period	Number Bldgs.	Percent of Total Bldgs.	Percent of Total Gross Space
1900-1920	25	3	4
1921-1939	15	2	2
1940-1946	676	76	69
1947-1957	142	16	22
1958-1969	16	2	1
1970-Present	12	1	2
TOTAL	886	100	100

Construction Periods:

1900-1920	World War I and prior
1921-1939	Between World War I and World War II
1940-1946	World War II
1947-1957	Post World War II and Korean period
1958-1969	Vietnam period
1970-Present	New Construction

d. Type Storage

The total gross covered storage space within DODMDS can be divided into areas which are (1) general

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[1] Items 3, 9 and 12, Section F-25, DODMDS Data Call.

[2] Excludes outgrants, terminals, sheds, igloos, converted fuel tanks, base operations, commissaries, FY 76 razes, under construction, 1000 sq. ft. and under.

purpose heated (GPH), (2) general purpose unheated (GPUH), (3) suitable for flammable hazardous materiel (FH), (4) provided with controlled humidity (CH), and (5) refrigerated (F/C). By Service/DLA, the percentage of Service/DLA space compared to the DODMDS total is as follows:

Service/ Agency	Gross Covered Space	GPH	GPUH	FH	CH	F/C
Army	23.50	6.7	8.3	0.1	8.3	0.10
Navy	24.30	6.7	16.1	0.4	0.3	0.80
Marine Corps	6.21	2.0	3.6	0.1	0.5	0.01
Air Force	16.43	13.2	3.1	0.1	0.0	0.03
DLA	29.51	14.0	12.5	0.2	2.7	0.11
DOD TOTAL	100%*	42.6%	43.6%	0.9%	11.8%	1.05%

*Figure is rounded up.

Additional details are provided in Appendix C, Section 5, Table 5-1, Cols. 5 through 10.

e. Ceiling Height/Column Spacing

Two factors which can reduce the flexibility and efficiency of the DODMDS facilities are ceiling height and column spacing. The 886 buildings which are used for the storage function were built over a broad span of time, by different Services, using concepts and designs that suited immediate requirements. A multiplicity of ceiling heights and column spacings existed. Although there are some instances where ceiling heights exceed 20 feet,[1] it is more common to find ceiling heights ranging from 10 to 20 feet.

Although column spacing ranges over a wide span in the DODMDS warehouses, it is frequently less than the desired 30 feet. Column spacings less than 30 feet, on center, reduces the types of materiels that can be

[1]These larger structures are ideal candidates for exploiting technological adaptivity, that is, taking advantage of existing facilities for state-of-the-art processing capacity.

easily stored, restricts layout of materiel handling systems and reduces storage area. For additional detail, see Appendix C, Section 5, Table 5-1, Cols. 11 and 12.

f. Floorload

The maximum floorload for the Army ranges from 335 to 6,000 pounds per square foot; for the Navy from 500 to 4,000; Air Force from 500 to 3,000; for the Marine Corps 500 to 1,500; and for DLA 400 to 3,000. See Appendix C, Section 5, Table 5-1, Col. 13 for additional details.

g. Lighting

The preponderance of the DODMDS facilities do have lighting. In the majority of cases, the lighting is provided by incandescent lamps having relatively low illumination levels and low illumination to power ratio. See Appendix C, Section 5, Table 5-1, Cols. 14 and 15.

3. Assignment of Gross Covered Storage Space

The purpose of this section is to provide a statistical, functional view of how covered storage space is utilized at each depot.[1] In the storage function, the space is categorized as: (1) bulk, (2) rack, (3) bin and (4) other. The operational functions are classified as: (1) receiving, (2) shipping, (3) administration, (4) preservation and packaging, (5) packing, (6) containerization, (7) transshipment and (8) unit assembly. Within DOD, 85 percent of the available gross space is used for the storage function while the remaining 15 percent is

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[1]Three DODMDS-sponsored AFIT graduate student studies reviewed selected warehouse design issues; titled A General Warehouse Model Conceptual Design and Cost Analysis, A Computer Simulation Methodology for Predicting Performance and Cost of High Rise Storage Facilities, A Computer Simulation Model of a DOD Depot, they are available from the DODMDS study group. None of the studies have been validated, as yet.

employed for the operational function. The Service/Agency breakout by percentage is as follows:

Service/Agency	Storage (%)	Operation (%)	Total (%)
Army	88	12	100
Navy	87	13	100
Marine Corps	87	13	100
Air Force	83	17	100
DLA	85	15	100

For additional detail, see Appendix C, Section 5, Table 5-2.

4. Installation Mobile Equipment

One of the essential ingredients in the rapid and efficient movement of materiel through and within a distribution center is the availability of appropriate mobile equipment. Ten types of materiel-moving mobile equipment are employed in DODMDS facilities: forklifts, stock selectors, straddle trucks, transporters, tractor/tugs, trailers, trucks under five tons, trucks over five tons, cranes, and locomotives. Forklifts are the predominant piece of equipment, due to their flexibility and ease of operation. Over 60 percent of the forklifts are gasoline powered. This energy source is more frequently found in the larger capacity vehicles. Battery power is more popular for the smaller capacity forklifts. More than 70 percent of the forklifts are less than ten years old and 95 percent are less than 15 years old. This profile of forklifts generally holds true within each Service. Examination of the other types of mobile equipment reveals that in most categories, at least 50 percent of the equipment is less than ten years old. Notable exceptions are locomotives, all but four of which are over 15 years old; and transporters all but one of which are less than ten years old. For additional detail, see Appendix C, Section 5, Table 5-3.

5. Installation Fixed Equipment

The proper blend of mechanized materiel handling equipment, based on the mix of commodities being processed, is important to an efficient distribution center operation. This type of fixed equipment consists of a variety of conveyors, tote pans, automated storage and retrieval systems, diverters, carrousels, overhead monorails, etc. The selection, application and amount of fixed equipment employed at a distribution center is dependent upon mission, funding, throughput, materiel processed, building configurations and concepts invoked by the various headquarters materials handling and warehousing engineers. A rough idea of the degree of sophistication of DODMDS warehouses may be gleaned from the following:

a. The Army generally has various types of conveyors and overhead monorails, four guided electric stock selectors, and two automated storage and retrieval systems in support of maintenance.

b. The Navy operates primarily with conveyors, overhead monorails, selectors, and one automated storage and retrieval system (NAS Norfolk).

c. The Air Force Air Logistics Centers have conveyors and overhead monorails, guided electric stock selectors and three have automated storage and retrieval systems.

d. The Marine Corps uses conveyors, document conveyors, pallet loaders and overhead monorails.

e. The DLA depots have conveyors, overhead monorails, document conveyors and pallet loaders at most depots; and automated storage and retrieval systems at four of their seven depots.

For additional detail, see Appendix C, Section 5, Table 5-4.

6. <u>Supporting Activities/Facilities</u>

This section describes the physical characteristics of the supporting activities and facilities available at the 34 distribution facilities. See Appendix C, Section 5, Table 5-5, for a summary of supporting activities and facilities by each depot included in the study.

a. Acreage

The acreage for depot installations is divided among the Services/Agency as follows:

Service/Agency	Acreage	Percent of Total
Army	140,743	56
Navy	70,325	28
Marine Corps	9,609	4
Air Force	24,871	10
DLA	4,914	2
DOD TOTAL	250,462	100

Twelve of the 34 distribution facilities have less than 1,000 acres: Four of the Army's, two of the Navy's and six of DLA's.

b. Transportation Support and Facilities

(1) Air. Of the 11 Army depots, two are collocated with airfields, five are within 20 miles, two more are within 35 miles and the remaining two are within 68 miles of airfields. C-5 airfield capability is within 12 miles for six Army depots, within 35 miles of two depots, and the other depots are 54, 68 and 86 miles away, respectively.

The nine Navy distribution facilities have air facilities capable of C-5 use either on base (six depots) or within five miles (three depots). The five Air Force ALC's are all on bases with C-5 capability.

None of the Marine Corps depots are on a C-5 capable airfield; however, one depot is within seven miles, and the other depot is within 37 miles of a C-5 capable airfield.

Of the seven DLA depots, four are within five miles of an airfield, two within 15 miles and one within 18 miles. C-5 airfield capability is within five miles of three DLA depots, 15 miles of two and 71 miles of two other depots.

(2) Sea. The nearest seaport for the Army's 11 depots range from 20 miles to 850 miles:

East Coast Port:	Four depots are within 500 miles, three of which are within 100 miles.
Gulf Coast Port:	Three depots are within 290 miles, only one of which is less than 50 miles.
West Coast Port:	Four depots are within 850 miles, two of which are less than 85 miles.

The Navy's depots are located at seaports except for NAS Jacksonville -- ten miles inland, and MCAS Cherry Point -- 19 miles inland.

The Air Force depots range from 83 to 771 miles from seaports:

East Coast Port:	One depot is within 176 miles.
Gulf Coast Port:	One depot is within 546 miles and one depot is within 684 miles.
West Coast Port:	One depot[1] is within 83 miles and one depot is within 771 miles.

One Marine Corps depot is 140 miles from an east coast port, one depot is 230 miles from a west coast port.

The seven DLA depots range from 55 to 766 miles from seaports.

East Coast Port:	Four depots are within 498 miles, two of which are within 76 miles.[2]

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[1]This depot is the Sacramento ALC which does have deep sea access via the Sacramento River.

[2]One of which is DGSC which has deep water access via the James River.

Gulf Coast Port: One depot is within 401 miles.[1]

West Coast Port: One depot is within 55 miles and one depot is within 766 miles.[2]

(3) Rail. All Service/DLA distribution facilities are located on installations that have rail spurs which connect with commercial rail switching yards or hubs.

(4) Highway. The distance to the nearest highway network capable of accommodating heavy equipment ranged from 0 miles to 18 miles for all Services/DLA facilities.

Ten of the eleven Army depots are within ten miles of adequate highway facilities. The other Army depot is within 13 miles.

Of the nine Navy distribution facilities, seven are within ten miles of adequate highway facilities and two are within 18 miles.

All Air Force distribution facilities are within one mile of adequate highway facilities.

Both Marine Corps distribution facilities are within four miles of adequate highway facilities.

All DLA distribution facilities are within ten miles of adequate highway facilities.

(5) Depot Capabilities. Detailed depot transportation capabilities are provided in Appendix C, Section 10. Tables 10-1 through 10-5 provide the commercial resources available at the depots. Outloading and receiving capability at the depots is reflected in Appendix C, Section 10, Table 10-6.

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[1] DDMT has deep water access via barge on the Mississippi River.

[2] DDTC has deep water access at Rough and Ready Island, Stockton, CA via the San Joaquin and Sacramento Rivers.

c. Supply Depots Collocated with Maintenance

During the DODMDS base year, all Service operated depots were collocated with maintenance activities. Two DLA depots have small maintenance activities and three of them support Industrial Plant Equipment (IPE) storage and maintenance complexes.

d. Supply Depots Collocated with Ammunition. Ammunition intermediate storage (for an ultimate user at another installation) collocated with supply depots, exists at six of the Army facilities and one Air Force facility.

G. TRANSPORTATION

1. General

This section describes the role transportation plays in the DOD Materiel Distribution System, as the connector between the supply sources and the distribution facilities and the military activities they support. Also, this section presents the percentage of volume of materiel moved by the different transportation modes in the data base period.[1] DOD relies on commercial transportation resources in addition to maintaining an organic transportation capability of its own. The transportation system, whether it be organic, from the private sector, or combined, must respond quickly and effectively against any threat to United States interests anywhere in the world.

Policies and procedures have been developed to make possible rapid movement of equipment and supplies to support forces in peace, mobilization and war conditions at the least possible cost without sacrificing responsiveness. Strategic mobility is foremost in present defense planning. A large share of the DOD logistics budget is obligated to paying for

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[1] For details on transportation rate and mode development, both inbound to the depot and outbound from the depot, see Appendix D-4, Sections 2 and 3.

transportation services. In addition, DOD has a large capital investment in transportation hardware and facilities. Recognizing that transportation must be prepared to meet any emergency defense need in minimum time and on short notice, in addition to day-to-day support, DOD has designated transportation single-manager agencies.[1]

a. Department of Defense Transportation Policy

The Secretary of Defense has designated the ASD (M,RA&L) as the principal staff assistant in matters of transportation.[2] The ASD (M,RA&L) has overall responsibility for "establishing policies and providing guidance to DOD components concerning (1) the efficient and effective use of DOD and commercial transportation resources and (2) the establishment and operation of transportation single-manager agencies."[3] The transportation policy and/or implementing instructions issued by the ASD (M,RA&L) include (1) reporting requirements for the single-manager operating agencies,[4] (2) tasking the single-manager operating agencies to represent the DOD in transportation regulatory proceedings, and (3) DOD policy relative to use of containers in surface transportation.[5]

b. Service/Agency Policies. This section describes the Services/DLA transportation policies and practices.

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[1] DOD Directive 4500.9, Transportation and Traffic Management, 29 November 1971.

[2] DOD Directive 5126.22, Assistant Secretary of Defense (Installations and Logistics), 30 January 1961

[3] DOD Directive 4500.9, Transportation and Traffic Management, 29 November 1971.

[4] DODI 4100.31, Reports on Single Manager Operations, 2 September 1960, and DODD 5160.2, "Single Manager Assignment for Airlift Service, 17 October 1973

[5] DODI 4500.37, Ownership and Use of Containers for Surface Transportation and Configuration of Shelters/Special Purpose Vans, 5 October 1972.

(1) Army

(a) Policy. Selection of the mode of transportation is governed by the transportation priority, required delivery date (RDD) when specified, weight and size of shipment, nature of the materiel, cost of transportation, distance to be shipped and modes of transportation available between consignor and consignee.[1] Although DOD policy (DODR 4500.32R, Appendix L) authorizes airlift or use of premium transportation for movement of TP 1 and TP 2 materiel, DARCOM transportation officers are provided further direction by AMCR 55-8 "Control of Premium Transportation." This regulation governs the use of air transportation for transportation priority 1 and 2 shipments based on commodity and weight. All shipments in excess of 500 pounds, which fall within the category of air eligible, require confirmation of airlift delivery prior to release of shipment. Per message directive,[2] transportation officers were further directed to ship all TP 2 CONUS shipments via surface modes. TP 2 overseas shipments eligible for airlift were restricted to shipments coded NORS, ANORS, Aviation Intensive Managed Items (AIMI) and commodities limited to specific missile systems. Challenge criteria for shipments in excess of 500 pounds applied.[3] All TP 3 shipments are afforded surface transportation.

(b) Direct Support System (DSS).[4] Direct Support System (DSS) is the Army standard supply

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[1] AR 55-16, Movement of Cargo by Air and Surface-Including Less Than Release Unit and Parcel Post Shipments, 18 September 1968.

[2] Message Department of Army - DA 2020302 Feb 1975 and DARCOM 2820242 Feb 1975 AMC-SU-BT.

[3] Since the data base was developed, the Department of Army has implemented Air Line of Communication (ALOC) which directs airlift of repair parts through the New Cumberland CCP to 89 specific maintenance repair units in Northern Europe, regardless of assigned transportation priority. These shipments are not subject to challenge action.

[4] Field Manual 38-725, Direct Support System (Management and Procedures), 30 January 1976.

distribution system for selected classes of supplies. DSS uses high speed communications and containerized or palletized shipments direct from the CONUS designated distribution depots to overseas/CONUS supply support activities (SSA). The Army has designated three DSS distribution depots with specific areas of support. New Cumberland Army Depot supports Europe and eastern CONUS; Sharpe Army Depot supports Pacific area, Alaska, Hawaii and western CONUS; and Red River Army Depot supports Panama and mid and southern CONUS. Transport of DSS shipments is made in full van or pallet loads from a single designated depot to one or more overseas/CONUS SSA's within the particular support region. When more than one SSA is represented in a shipment, a divider is placed between each SSA's materiel. For all overseas shipments, depots within a CONUS designated distribution support area make shipments to a consolidation/containerization point (CCP) which is collocated at each of the designated DSS distribution depots. At the CCP, shipments from various depots, within the depot support area, are consolidated and containerized for shipment overseas. As far as practicable, each designated distribution depot receives, stores and issues all items required to support its designated geographic area (refer to Figure 3-1). MAC is used to transport air shipments to designated overseas ports of discharge and MSC for surface movement to overseas customers. For shipments to CONUS customers, the designated DSS depots support all customers within designated support area. Shipments from these designated depots to CONUS customers are made by truckload, or less than truckload, on an established schedule.

(2) Navy.

(a) Policy. The Department of the Navy exercises traffic management practices in accordance with DOD directives. The Naval Materiel Transportation Office (NAVMTO) provides technical direction, guidance and assistance to Navy shipping activities worldwide on transportation matters.[1]

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[1] NAVSUP Instruction 5450.90B, Functional Mission Statement of the Navy Material Transportation Office, Norfolk, Virginia, 24 November 1976.

NAVMTO has additional responsibility in performing air clearance functions for Navy transportation offices.[1] Shipment in excess of 500 pounds are challenged by NAVMTO prior to release into the MAC system for overseas movement.

(b) QUICKTRANS. The Navy sponsors QUICKTRANS, a commercially operated transportion system utilizing dedicated trucks and aircraft. It serves Navy and Air Force installations, including aerial ports of embarkation. The system is a free-flow operation in that few shipments are challenged. NAVMTO performs as air clearance authority for shipments weighing in excess of 5,000 pounds, outsize cargo, shipments requiring special handling, and shipments requiring specific flights or to destinations not serviced by QUICKTRANS.

(3) Air Force

(a) Policy. Air Force policy directs that the means of transportation selected will be that which will meet DOD requirements satisfactorily at the lowest overall cost from origin to the final known destination (in CONUS or overseas).[2] The selection of the mode of transportation is governed by the transportation priority, required delivery date (RRD) when specified, weight and size of shipment, nature of materiel, cost of transportation, distance to be shipped, and modes of transportation available between consignor and consignee. The Air Force Logistics Command (AFLC) directs air challenge actions for shipments originating from Air Logistics Centers to overseas activities per AFLC Manual 75-1.[3] There are five basic criteria for determining if challenge action is required for transportation priorities 1 and 2. Shipments in excess of 1,000 pounds per line item,

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[1]NAVSUP Instruction 4630.21, Use of Air Transportation by Navy Shippers, 10 February 1976.

[2]AFM 75-1, Transportation of Materiel, 30 November 1970.

[3]AFLC Manual 75-1, Shipment Processing and Documentation, 20 January 1970.

exceeding nine feet in any one dimension, weighing less than five pounds per cubic foot or cube in excess of 100 cubic feet, containing excessive quantities and/or when requisition date or RDD is past 180 days and the shipment is over 1,000 pounds. Shipments consigned to CONUS customers, where commercial air could be the selected mode of transportation, are also subjected to air challenge action. All transportation priority 3 shipments are afforded surface transportation. An exception to this policy is when TP 3 cargo is used as filler for LOGAIR to the first downline station from the originating point.

(b) LOGAIR. The Air Force Logistics Command operates LOGAIR, an Air Force contract commercial carrier providing dedicated air service to the five ALC's and other AF and Navy installations. LOGAIR shipments are directed to the air terminals based on allocation and airlift capability as appropriated by HQ AFLC.

(4) Marine Corps

Policy. Transportation officers perform traffic management functions within the guidelines set forth by Marine Corps Headquarters. Challenge action is performed on shipments weighing in excess of 70 pounds, assigned transportation priority 1 and which are eligible for MAC airlift to overseas customers. Marine Corps policy directs that all transportation priority 2 shipments move via surface modes. Challenge actions are performed by the local transportation officers direct to the requisitioners per Marine Corps Phamphlet (MCOP 4600.7B). Transcontinental shipments weighing in excess of 5000 pounds are also challenged.

(5) Defense Logistics Agency

Policy. Transportation officers perform traffic management functions in accordance with DOD directives. DLA does not have direct assignment of transportation funds to an installation but closely monitors all shipments moving from DLA depots. Challenge actions are initiated on air eligible shipments and maximum transportation unit consolidation achieved to effect cost savings.

2. Department of Defense Transportation System

DOD transportation requirements are provided by the Military Traffic Management Command as single manager for military traffic, land transportation and common-user ocean terminals,[1] the Military Sealift Command as single manager for ocean transportation,[2] and the Military Airlift Command as single manager for airlift service.[3] These operate under the Departments of the Army, Navy and Air Force, respectively. Each command acts as the single manager for the particular transportation provided and either purchases transportation service from commercial carriers, or arranges shipment via DOD organic transportation systems.

a. Military Traffic Management Command (MTMC)

The commanding general of MTMC is the executive agent for the Secretary of the Army, the DOD's single manager responsible for ocean terminal service and land transportation in the continental U.S. MTMC recently expanded operations to include ocean terminal services in some overseas areas. It manages the day-to-day movement of DOD freight in the U.S. and provides an interface with shippers and commercial carriers, and with the air and sea transportation commands. In addition to its basic mission of traffic and terminal management, MTMC is responsible for the planning and administration of other defense activities including strategic movement planning to support the Joint Chiefs of Staff, the unified and specified commands and the military services. MTMC controls and directs the operations of the Defense

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[1]DODD 5160.53, Single Manager Assignment for Military Traffic, Land Transportation, and Common-User Ocean Terminals, 24 March 1976.

[2]DODD 5160.10, Single Manager Assignment for Ocean Transportation, 24 March 1967.

[3]DODD 5160.2, Single Manager Assignment for Airlift Service, 17 October 1973.

Freight Railway Interchange Fleet which is made up of military owned railway rolling stock used to assure basic military needs are met, supplementing with commercial rail cars when they are not available or to supply equipment when the requirement is for a type peculiar to military needs. MTMC's terminal management operations are industrially funded. The military customer pays MTMC for the service rendered. Traffic management functions are funded by the Department of the Army.

b. Military Sealift Command (MSC)

MSC is an operating agency within DOD whose fleet commander is the executive agent of the Secretary of the Navy, who in turn is the single manager for all DOD sealift. MSC operates a nucleus fleet of Government-owned ships, and procures commercial lift under various arrangements to meet DOD needs. It is responsible for the transoceanic movement of military supplies and equipment in both peacetime and emergencies. MSC operations are industrially funded. The command bills the Services, including the Navy, for the sealift they use. The billings include all costs of providing the service with the exception of military salaries.

c. Military Airlift Command (MAC)

Military Airlift Command operates aerial ports -- Air Force bases under MAC operational control, that can handle the full range of DOD air freight and passenger movement requirements. MAC operates aircraft and other equipment in support of the military worldwide. It acts as the executive agent to obtain commercial airlift for DOD under contract. This agency performs airlift for deployment and logistical support of ground and air forces in addition to other services and functions, including air transportation for the President, other top American officials and foreign dignitaries. The Services' airlift operations are industrially funded, that is, users are billed for services provided. The Airlift Service Industrial Fund (ASIF) finances most airlift expenses, but not military pay or aircraft depreciation.

d. Contract Commercial Carriers

The Departments of the Air Force and Navy each have a dedicated domestic airlift system (previously described) operating between the air logistics centers/supply depots and Air Force/Navy installations. These systems are for the specific purpose of providing rapid transportation of high priority cargo to meet immediate requirements of the users.

(1) LOGAIR. This system, operated by the Air Force, is completely airlift dedicated with scheduled flights into and through Air Force and Navy installations, including aerial ports of embarkation.

(2) QUICKTRANS. This system, operated by the Navy, is comprised of dedicated trucks and aircraft whose mission is to manage delivery/pick up of high priority cargo into and through Navy installations, including aerial ports of embarkation.

3. Commercial Transportation

Department of Defense transportation requirements for CONUS movements are satisfied primarily by use of civilian transportation industries. DOD encourages "extensive use of commercial transportation resources involving all modes of transportation to assure a large, viable system to meet the demands of DOD and the Nation in the event of a national emergency."[1] The transportation industry is regulated by government agencies who regulate routes and rates, protecting the shippers who use the services and the carriers who provide them. Selection of a mode of transportation by DOD shippers is governed by economics and service.

Commercial modes of transportation used by DOD shippers are as follows:

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[1] Paul H. Riley, DOD Transportation: Management Problems and the Search for Solutions, Defense Management Journal, Vol. II, No. 2 (April 1975), p.2.

a. Highway

Motor carrier transportation is used extensively by DOD shippers. Motor carriers utilized are primarily common carriers who provide service according to a published tariff and often a published schedule, operating under close regulation. Common carriers are given authority to operate within a geographical area, or between defined terminal points, and sometimes for specified commodities. Contract carriers, also used by DOD shippers, operate under regulatory authority to provide transportation service at individually negotiated rates to selected individual customers. Common carriers at times provide contract services. DOD shippers utilize non-regulated or exempt carriers on a limited basis. These are primarily agricultural carriers who move commodities for compensation, but the service is specifically exempt from economic regulation by virtue of the goods carried or nature of the service.

b. Rail

Use of rail by DOD is limited primarily to bulk and outsize shipments, not conducive to or restricted from other modes of transportation. Rail is competitively uneconomical for small shipments; uneconomical and inefficient for short hauls.

c. Air

In comparison with rail and truck transportation, DOD's use of commercial air freight is limited. Nevertheless, air cargo service is important because of its capabilities for rapid delivery over long distances and without the necessity for cargo transfers that sometimes cause loss and damage of goods shipped by surface modes. Domestic trunk lines carry cargo between major cities of the nation and international flag airlines fly between major U.S. and foreign airports. The commercial airlines have expanded their role as a mode of transportation for more varied and configured shipments by operating with wide body jets and improved ground handling technology.

d. Freight Forwarder

This service is performed by carriers authorized to engage indirectly in the transportation of goods. DOD uses this service when it is advantageous in effecting expedited transportation, or will produce the lowest overall costs consistent with military requirements. Although other carriers physically transport the shipments, the transportation charges assessed are based on published tariff rates, or tenders issued by the freight forwarders, as regulated and approved by either the CAB or ICC.

e. Ocean

For the transoceanic movement of equipment and supplies, DOD shippers utilize a nucleus fleet of Government owned ships. However, additional lift is procured by MSC from the commercial sector under various arrangements to meet total DOD needs. Commercial shipping entails space on regularly scheduled U.S. berth lines, voyage charter of privately owned merchant vessels, or foreign flag shipping when requirements cannot be met by other means.

f. Small Parcel Shipments

(1) United States Postal Service (USPS). USPS is used extensively by DOD shippers, the single largest user of this service. USPS provides air and surface parcel post; surface moving at fourth class rates and air at additional costs to the shipper.

(2) United Parcel Service (UPS). UPS is another mode of transportation utilized by DOD shippers, but is dependent on company operating authority within an area. UPS is a regulated carrier, providing shippers with a door-to-door parcel pickup and delivery. Its rates and services are competitive with other common carriers and parcel post service. UPS has interstate service in CONUS for surface transportation and operating authority for air service in the eastern and western coastal states.

(3) Federal Express Corporation (FEC). FEC is engaged in the air transportation of small packages, documents and hazardous materiel between selected cities in the U.S. FEC is a nationwide, all cargo airline, suited for transportation of hazardous materials that are restricted from movement on passenger-cargo airlines. Use of this service by DOD is primarily for movement of hazardous cargo.

(4) Bus Express. Commercial bus package express service is provided by commercial passenger busses. This service provides an expeditious method of moving small shipments on short hauls. Additionally, there are instances where this service is economically advantageous. DOD shippers utilize this service on a limited basis as it contains restrictions based on weight, size and commodity.

4. Transportation Links

Transportation is the circulatory system of logistics. It serves as the link for moving the large variety of materiel in DOD from source of supply to the consumer and/or repair facility. It accomplishes this by using a wide variety of transportation modes.

a. Inbound to Distribution Facility from Supply Source.

(1) Vendor/Procurement (procurement receipts). These are links from commercial production and maintenance facilities, for new and repaired materiel, to the depots. Table 3-7 presents a summary of inbound wholesale materiel from procurement sources by transportation mode.

(2) Customer Returns (non-procurement receipts). These are links from the customers to the distribution facility. A distribution facility obtains a portion of its stock for reissue to other users through return of serviceable assets. Also, reparable unserviceable assets are returned from the customers to the depot where they are repaired by the maintenance facility and placed into depot stock for subsequent issue.

Table 3-7. Percentage of Wholesale Materiel Received from Procurement Sources by Transportation Mode

Transportation Mode	Percentage of Total Weight
Less-than truckload (LTL)	10.5
Truckload (TL)	31.0
Carload (CL)	56.4
Commercial air (CA)	0.0
Surface small parcel (SSP)	1.3
	100.0*

*Figure rounded up.

b. Outbound from Distribution Facility

(1) Off-base Movement. These are links to customers geographically located outside the local delivery limits of the distribution facilities (generally a 50 mile radius). Table 3-8, and Table 3-9, page 111, present a summary of outbound wholesale materiel by transportation mode and by mode by distribution facility. Appendix C, Section 6, Table 6-1 presents the same information by Service/DLA.

Table 3-8. Percentage of Wholesale Materiel Shipped Outbound by Transportation Mode

Transportation Mode	Percentage of Total Weight
Less-than truckload (LTL)	28.7
Truckload (TL)	31.2
Carload (CL)	7.3
Commercial air (CA)	0.5
Surface small parcel (SSP)	3.1
Air small parcel (ASP)	1.4
Domestic Military Air (DOMMA)	3.8
Local delivery (LOCAL)	23.8
Military Airlift Command (MAC)	0.1[1]
Military Sealift Command (MSC)	0.1[1]
	100.0*

*Figure rounded up.

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[1] Includes only those shipments that are shipped outbound directly from a depot; does not include those shipments shipped from a port facility.

Table 3-9. Percentage of Wholesale Materiel Shipped Outbound by Transportation Mode by Distribution Facility

Transportation Modes by Percentage of Total Weight[1]

DODMDS Depot	LTL	TL	CL	CA	SSP	ASP	DOM MA	LOCAL	MAC	MSC
ANAD	2.5	9.5	35.0	0.0	0.4	0.0	0.0	50.7	0.0	1.3
CCAD	14.7	20.4	2.1	1.3	1.8	0.8	3.2	53.7	1.0	0.0
LEAD	10.0	31.4	9.6	0.3	1.5	0.0	0.0	46.4	0.0	0.0
LBDA	23.6	22.4	4.4	3.4	7.6	4.1	1.4	31.8	0.0	0.0
NCAD	30.9	27.8	9.3	0.5	4.2	0.4	0.0	25.5	0.0	0.0
PUDA	8.3	30.8	15.6	1.0	0.8	0.5	0.0	39.8	0.0	2.4
RRAD	9.9	33.6	11.3	0.4	0.7	4.5	0.0	38.8	0.0	0.0
SAAD	27.6	49.3	1.9	1.8	4.7	1.7	0.0	11.9	0.0	0.0
SHAD	17.8	24.6	9.9	0.5	1.0	0.7	0.0	44.4	0.0	0.0
TOAD	17.8	26.1	8.6	0.9	1.4	0.6	0.0	43.7	0.0	0.0
TEAD	10.9	17.0	21.9	0.3	0.9	0.2	0.3	47.7	0.0	0.0
NASAL	7.0	10.0	0.1	0.4	2.9	6.4	27.5	35.0	7.6	0.9
NASJAX	7.3	2.3	0.9	0.0	3.7	7.5	36.6	39.8	0.0	0.0
NASNOR	10.2	4.5	0.2	0.2	6.5	8.6	30.6	36.7	2.0	0.0
NASNI	3.9	8.0	0.0	0.3	3.2	31.9	15.7	35.0	0.8	0.2
NSCNOR	10.6	5.3	0.0	0.1	6.2	4.8	13.9	56.7	1.4	0.4
NSCOAK	31.6	23.5	1.1	0.1	4.3	1.9	10.4	25.9	0.0	0.0
NSCPH	40.1	0.6	0.0	0.0	1.1	0.2	1.6	52.4	1.1	0.0
NSCSD	10.8	2.0	0.0	0.0	2.5	3.1	7.6	73.1	0.0	0.0
MCASCP	9.3	4.6	0.3	0.0	4.5	8.9	25.2	45.8	0.0	0.0
OCALC	13.9	7.1	0.0	0.3	1.6	0.2	23.6	51.1	1.1	0.0
OOALC	18.7	10.0	1.7	0.4	2.8	1.1	28.8	35.0	0.1	0.0
SMALC	8.1	12.1	0.5	0.7	1.6	0.6	19.4	56.0	0.0	0.0
SAALC	18.1	11.4	0.1	0.5	1.9	0.6	23.5	42.2	0.0	0.0
WRALC	12.6	12.3	1.8	0.7	2.9	1.8	29.4	37.4	0.0	0.0
MCLSBLANT	3.6	20.0	45.7	0.0	2.3	0.0	0.0	26.8	0.0	0.0
MCLSBPAC	10.8	37.9	23.3	0.0	2.8	0.1	0.2	22.3	0.0	0.0
DCSC	50.3	19.2	11.0	0.8	13.7	1.1	1.5	1.1	0.0	0.0
DDMP	24.8	70.4	0.4	0.1	1.1	1.1	0.0	0.0	2.6	0.0
DDMT	67.1	10.9	4.8	1.0	4.5	0.6	0.1	0.1	0.0	0.0
DDOU	75.2	0.2	3.4	0.7	10.0	2.8	0.0	6.7	0.0	0.0
DDTC	39.2	51.6	1.3	0.1	2.0	0.1	0.2	4.7	0.0	0.0
DESC	26.7	0.0	0.0	2.9	51.6	5.3	3.8	8.8	0.0	0.0
DGSC	41.4	47.5	3.2	1.0	3.3	0.3	0.0	1.9	0.0	0.0
DOD TOTAL	28.7	31.2	7.3	.5	3.1	1.4	3.8	23.8	.1	.1

(a) CONUS Customers. A variety of modes, both outside of and within the defense transportation system, were used to transport commodities from supply depots to domestic customers. The selection and utilization of a mode of transportation used in shipping materiel to a CONUS customer is predicated on transportation priority, distance factor, shipment weight, configuration and physical characteristics. The objective is to effect delivery at final destination, on or before, required delivery time and at the lowest overall total cost to the government.

(b) Overseas Customers. The defense transportation system is the primary source of movement of commodities to overseas customers. Distribution facility to overseas customer links are supported by use of Military Airlift Command (MAC) channel service, Military Sealift Command (MSC) in MSC vessels or in commercial space procured by MSC and mail service tendered through APO/FPO points. When regularly scheduled channel service does not serve the overseas destination area directly, or does not adequately provide the service needed, shipments are routed by commercial transportation. Overseas customers are also supported by use of Special Assignment Airlift Missions (SAAM). SAAM is utilized when special considerations are required due to weight or size of the cargo, the urgency or sensitivity of the movement, or other valid factors.

(2) Local Delivery. DODMDS depots shipped 23.7 percent, or 700 million pounds, of the total shipment weight to local customers. This mode of shipment, using government truck, is utilized to effect deliveries between the depot and air/water terminals, tenant organizations, maintenance facilities and military installations/contractors within close proximity (generally not exceeding a 50 mile radius) of the depot.

Appendix C, Section 6, Table 6-2 presents a summary of wholesale materiel received by DODMDS customer groupings by transportation mode.

5. Traffic Routing Procedures

Military Traffic Management Regulation AR 55-355 NAVSUP PUB 444 (REV), AFM 75-2, MCO P4600.14A, DSAR 4500.3 directs policy and procedures applicable to the performance of traffic management functions by the military Services and other DOD components within CONUS.

a. Procedures

(1) Transportation officers are authorized to route shipments, select modes of commercial transportation and origin carriers within each mode, and the connecting carriers when it is advantageous to the government to name such carriers in the bills of lading when shipments tendered via common carrier and bus/air express weigh less than 10,000 pounds. Shipment weights in excess of above limitations, or falling within the following categories, require submission of requests for CONUS routing instructions or export release authority from the Military Traffic Management Command who acts as single manager operating agency for military traffic, land transportation and common-user ocean terminals:[1]

(a) General Commodities - 10,000 pounds or more to a single CONUS customer or overseas POD.

(b) Explosives and poisons, Class A and radioactive Yellow-III lable materiel. (All shipments by rail, motor carrier or freight forwarder.)

(c) Vehicles by driveaway service.

(d) Less-than-carload or less-than-truckload quantities, tendered as carloads or truckloads.

(e) Oversize/overweight shipments requiring special permit.

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[1] DODD 5160.53, Single Manager Assignment for Military Traffic, Land Transportation and Common-User Terminals, 24 March 1967.

(f) Shipments which are consolidations of less-than-release-unit shipments of export traffic moving to and through the same port of embarkation with total weight exceeding 10,000 pounds.

(g) Shipments requiring special military service or exclusive use of carrier equipment.

(h) Shipments occupying full visible capacity of a railway car or motor vehicle.

(i) Bulk liquids and gases.

(2) Export shipments that do not require export release instructions from MTMC are cleared for MSC movement by submission of an advance Transportation Control and Movement Document (TCMD) to the appropriate water terminal clearance authority in accordance with Military Standard Transportation and Movement Procedure, DODR 4500-32R, Vol. I.

(3) Clearance of airlift shipments into the DTS airlift system (MAC). The shipping activity transportation officer is responsible for submission of advance TCMD's to the appropriate Shipper Service Control Office (SSCO) for determination of air eligibility and/or consignment instructions.

Appendix C, Section 6, Table 6-3, presents a listing of DODMDS commodities by the transportation mode in which they moved in the base year. The table is in hundredweight and percentage of hundredweight for each product.

H. SYSTEM PERFORMANCE

This section presents the system performance of the distribution facilities and transportation links involved in moving materiel through the DODMDS during the base year. This performace can be compared to the UMMIPS standards during the distribution facility processing segment, CONUS intransit segment less transportation hold time and the overseas intransit time segment. The other UMMIPS time segment standards outlined in Chapter 2 did not impact the system structure nor would the study recommendations impact these segments.

Appendix C, Section 7, contains the system performance times experienced during the base year. Table 7-1 lists the distribution facility processing times. Tables 7-2 and 7-3 provide CONUS intransit times to each DODMDS CONUS customer grouping and from each DODMDS distribution facility, respectively. Tables 7-4 and 7-5 are summary tables for CONUS intransit times by mode and priority, respectively. The transportation hold time segment was not included in the performance analysis. Tables 7-6 through 7-14 list the overseas intransit time segments according to CONUS region and overseas customer groupings. Tables 7-15 and 7-16 are summary tables of overseas intransit times by MAC and MSC, respectively.

I. SYSTEM COSTS

Total distribution system cost for the DODMDS is derived from two key elements -- the supply depot operations cost and the transportation cost. The costs for these two elements, presented in this section, will serve as a base line for comparing alternative system configurations.

1. Distribution Facility Costs

Supply depot operations (SDO) costs represent a portion of the dollars expended by DOD to perform materiel distribution in the data base year. The internal configuration, and hence cost of operation of each depot, is a function of the mission of the depot, commodities handled and volume of issue activity, even though the basic functions associated with supplying materiel to ultimate consumers are the same at all depots. All 34 depots included in the study effort provided wholesale materiel support to worldwide users of the DODMDS and retail supply support to customers located on the same installation. The DLA cost accounting system segregates the cost of retail operations while each of the Services' accounting system collects and combines the cost of wholesale and retail supply operations. The total cost (less DLA retail supply operations) of supply depot operations at the 34 depots during the base period is presented in Table 3-10, page 117. For study purposes the cost of providing the retail supply support to customers on the same installation, or in the proximity of the supply depot, was considered to be a continuing cost to the DOD. Since the focus of the study was to examine the wholesale materiel distribution system, only the depot costs associated with the wholesale materiel distribution operations were used as model input variables. Chapter 4 provides the details of the methodology used to arrive at the depot costs associated with wholesale and retail materiel processing.

2. <u>Historical Depot Costs</u>

The basic goal in developing historical depot costs, associated with the DOD materiel distribution process, was to identify those cost elements which could be reasonably compared across all depots in order to develop a cost prediction capability for reflecting varying commodity mixes and mission conditions at individual depots. This process required the development of the capability to predict unit costs of depot throughput for individual materiel distribution facilities under conditions which may differ from the historical basis. In achieving this goal three types of costs were required:

a. Cost of primary supply production, i.e., receipt, storage and issue of materiel.

b. Cost of secondary supply functions associated with materiel distribution in the DOD, e.g., physical inventory, quality control, traffic management, etc.

c. Cost of supporting the first two categories, e.g., upper level echelons of supervision, clerical management, ADP, motor pool, building maintenance, civilian personnel office, administrative services, etc.

Table 3-10. <u>Base Period DODMDS Depot Cost by Service and DLA</u>[1]

Army	160.5
AF	128.6
Navy	96.5
MC	28.6
DLA	155.9
DOD TOTAL	570.1M

The majority of annual recurring, operations and maintenance (O&M) costs associated with DOD supply depots are reported within the framework of the individual Service/Agency accounting system established in accordance with DODI 7220.17, Cost Accounting for Central Supply Management. The intent of this directive is to prescribe standardized terminology and a structure for accumulating and reporting costs for DOD activities involved in the materiel distribution process. The prescribed cost accounting structure for supply depots has been adopted by each Service and DLA to satisfy the DOD requirement for uniformity, while fulfilling the management information needs of the Services and DLA. As such, the "standard" cost accounting system, as implemented by the DOD supply depots, reflects the distribution philosophy, organizational structure, and accounting system prerogatives of the individual Service/Agency managers. These differences collectively produced two conditions: (1) the presence of non-supply depot related costs in the accounting structure and (2) supply depot related costs which are not included in the accounting structure.

To overcome the effect of these conditions, the following steps were taken:

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[1] Summation of Service/DLA cost accounts presented in Appendix C, Section 8, Tables 8-1 through 8-25.

a. Non-supply depot costs which were reported in the source data, were subjected to special analysis. Chapter 4 provides the detail on the methodology used.

b. Where supply depot related costs were incurred, collected and reported outside the scope of the DODI 7220.17, manual procedures were developed to capture the costs. The materiel distribution costs in this category are for those installation functions associated with personnel, facility and/or mission support of supply.

The total supply depot operations costs for each depot included in the study are presented in Table 3-11, page 119. These costs are a summation of the detailed depot cost by functional account contained in Appendix C, Section 8, Tables 8-1 through 8-25 and represent the cost of wholesale and retail activities. They are grouped by Service/DLA, into four categories of cost for study purposes: supply handling, supply storage, supply support, and overhead support.[1]

3. Transportation Costs

Transportation is the connector for the movement of materiel from the 347 (142 procurement and 205 non-procurement) materiel sources to the 34 distribution facilities and from these facilities to the 205 customer groupings. Transportation cost is based on commodity, mode and weight, and the particular link traveled. For purposes of analyzing the DODMDS, approximately 2 million individual rates had to be developed and applied to the materiel source-to-distribution facility links and the distribution facility-to-customer links.[2] The costs of these links are presented in Table 3-12 for each distribution facility inbound from procurement and non-procurement sources. Table 3-13 provides transportation costs by distribution facility outbound to customers.

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[1] See Appendix D-3 for detailed information on the methodology used in developing distribution facility costs.

[2] See Appendix D-4 for details on transportation rate development.

Table 3-11. DOD Total Supply Depot Operations (SDO) Cost ($000)[1]

Depot	Supply Handling Costs	Supply Storage Costs	Supply Support Costs	Supply Overhead Costs	Total
Anniston AD	3594	4771	2818	4182	15365
Corpus Christi AD	1830	955	1090	2187	6062
Letterkenny AD	5010	4091	2939	4439	16479
Lexington DA	3378	2664	1544	3354	10940
New Cumberland AD	6781	2535	3386	5169	17871
Pueblo DA	2112	1386	721	2949	7168
Red River AD	7373	5647	4676	7013	24709
Sacramento AD	7466	2869	3243	5190	18768
Sharpe AD	4685	2352	2310	3826	13173
Tobyhanna AD	3436	2960	1398	5255	13049
Tooele AD	5312	3568	2025	6005	16910
NAS Alameda	3315	1318	1800	2631	9064
NAS Jacksonville	2299	876	1092	1657	5924
NAS Norfolk	2091	726	1072	1674	5563
NAS North Island	2649	1492	1943	2291	8375
NSC Norfolk	10566	1597	4795	8271	25229
NSC Oakland	8379	1391	4688	8562	23020
NSC Pearl Harbor	1776	431	853	2095	5155
NSC San Diego	3095	578	1097	3369	8139
MCAS Cherry point	1736	841	1210	2278	6065
Oklahoma City ALC	9702	3798	8557	4853	26910
Ogden ALC	6883	3307	8048	4214	22452
Sacramento ALC	6434	3548	8409	4048	22439
San Antonio ALC	12195	3446	9713	4699	30053
Warner Robins ALC	9503	3755	9348	4141	26747
LSB Albany	1930	2251	1487	6016	11984
LBS Barstow	2456	4331	3394	6461	16642
DCSC Columbus	8800	2652	3141	9052	23645
DDMP Mechanicsburg	10177	2142	3414	4420	20153
DDMT Memphis	13820	3160	3362	7079	27421
DDOU Ogden	13687	3790	2639	8547	28663
DDTC Tracy	11162	3069	3128	7264	24623
DESC Dayton	6016	1276	1739	5642	14673
DGSC Richmond	7481	1353	2069	5825	16728
DOD TOTAL	207129	84926	113148	164650	570161

[1] Summation of individual cost accounts presented in Appendix C, Section 8, Tables 8-1 through 8-25.

Table 3-12. Inbound Transportation Costs[1]

Depot Locations	Procurement Flows Cost (Dollars)	Non-Procurement Flows Cost (Dollars)
Anniston AD	$1,066,278	$8,060,016
Corpus Christi AD	174,042	1,407,849
Letterkenny AD	1,565,602	6,936,978
Lexington DA	250,942	1,526,829
New Cumberland AD	3,647,360	9,002,346
Pueblo DA	1,072,194	2,144,988
Red River AD	3,030,346	8,254,102
Sacramento AD	3,346,452	4,429,868
Sharpe AD	2,074,298	4,680,858
Tobyhanna AD	603,963	3,793,326
Tooele AD	2,319,040	7,320,865
NAS Alameda	373,851	1,628,151
NAS Jacksonville	170,526	1,261,753
NAS Norfolk	327,487	1,856,249
NAS North Island	1,130,188	5,175,991
NSC Norfolk	4,589,200	1,614,571
NSC Oakland	6,503,805	2,152,089
NSC Pearl Harbor	1,438,808	128,513
NSC San Diego	2,495,063	760,361
MCAS Cherry Point	296,251	1,290,984
Oklahoma City ALC	766,985	8,609,897
Ogden ALC	1,573,089	5,895,002
Sacramento ALC	945,290	6,279,634
San Antonio ALC	1,361,085	8,791,459
Warner Robins ALC	819,007	5,723,622
MCLSBLANT Albany	498,301	1,556,691
MCLSBPAC Barstow	1,742,816	3,147,499
DCSC Columbus	1,808,690	1,699,221
DDMP Mechanicsburg	17,992,107	1,670,177
DDMT Memphis	15,707,727	2,692,614
DDOU Ogden	9,563,428	2,839,701
DDTC Tracy	17,271,904	2,343,754
DESC Dayton	231,502	335,120
DGSC Richmond	7,413,160	3,708,041
TOTAL:	$114,170,787	$128,719,120

[1] Baseline Run, 8 November 1977.

Table 3-13. Outbound Transportation Cost[1]

Depot Locations	Cost (Dollars)
Anniston	$9,563,339
Corpus Christi	1,227,729
Letterkenny	10,056,067
Lexington	1,828,410
New Cumberland	16,131,251
Pueblo	4,274,921
Red River	12,331,409
Sacramento	10,529,179
Sharpe	10,022,772
Tobyhanna	3,853,057
Tooele	7,988,127
NAS Alameda	2,093,661
NAS Jacksonville	1,245,591
NAS Norfolk	2,175,927
NAS North Island	10,139,455
NSC Norfolk	7,376,727
NSC Oakland	16,175,487
NSC Pearl Harbor	299,828
NSC San Diego	2,724,920
MCAS Cherry Pt	2,124,590
Oklahoma City	6,785,129
Ogden ALC	8,561,544
Sacramento ALC	4,580,476
San Antonio ALC	10,648,057
Warner Robins ALC	6,420,289
MCSC Albany	3,000,219
MCSC Barstow	5,691,612
DCSC Columbus	10,692,513
DDMP Mechanicsburg	46,068,661
DDMT Memphis	19,396,512
DDOU Ogden	17,620,682
DDTC Tracy	38,895,818
DESC Dayton	1,955,939
DGSC Richmond	18,507,923
TOTAL:	$330,987,821

[1] Baseline Run, 8 November 1977.

J. SUMMARY

The DODMDS baseline is the aggregate of a system of 27.4 million wholesale issue transactions, 5.63 million wholesale receipt transactions, and movement of 3.1 billion pounds. The cost is approximately $570.1 million for depot operations and $574 million for transportation.

CHAPTER 4
METHODOLOGY

A. INTRODUCTION

This chapter delineates specific research issues which evolved from the overall objectives of the study, and relates analysis methodologies and tools used to generic groupings of those issues. In addition, the chapter covers the methodology for acquisition and processing of required data.

B. OBJECTIVES

In order to accomplish the task levied by the Charter, it was essential that the overall study objectives be recognized and related to specific research questions; in short, given a "universe" of possible analytical issues and strategies, it was necessary to focus on a subset which adequately met the objectives and mission of the study group.

1. Principal Objectives

As discussed in Chapter 1, Section C, the Charter required examination and recommendation of "... alternatives to optimally integrate, consolidate and/or standardize Service or Agency distribution system functions and facilities within the fifty states where it is clearly beneficial in terms of response and cost in peace, mobilization and wartime conditions."[1]

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[1] DODMDS Charter, Volume III, Book 2, Appendix A, Section 2, para II B.

Thus, the structure and projected performance of system alternatives had to to be responsive, as well as ecomomical, so as not to compromise the logistics support mission within DOD. These major objectives also implied certain related goals. The alternatives had to be theoretically sound and intuitively reasonable to those charged with review and implementation of the proposed alternatives. The guidance and evaluation criteria were interpreted to mandate an examination of both the structure and operation of the DOD logistics system. It was in these two areas that the specific research issues were developed.

2. System Structure Research Issues

Five specific structural research questions were posited for investigation, with the target period for the proposed system structure to be FY 80 - FY 90.

- How many depots should be maintained by the Department of Defense, and where should these be located?

- What should be the size of each depot, both in terms of throughput capacity and storage capacity?

- Which commodities, or classes of commodities, should be stocked at each depot?

- Should the DOD support a system of (a) regional, full-line depots with support missions defined by geographic areas; (b) partial line depots with worldwide support missions defined for the commodities uniquely stocked at a given site; or (c) a combination of these alternatives?

- Which depot or group of depots should be assigned to support each customer?

a. Relationship to Study Objectives

The DODMDS study group had a clear mandate to examine facility (i.e. depot) locations and size, as well as stock positioning alternatives appropriate to a given set of facilities. In other words, it was to formulate proposed system designs that would minimize cost subject to customer service constraints.

b. Relationship to Logistics System Theory

Central to any proposed design of a logistics system, given sets of demands and supplies, was the location and sizing of intermediate facilities. The location/sizing issue was itself a function of transportation, warehousing, and materiels handling costs, as well as the required levels of customer service. Therefore, complicated system trade-offs existed among these parameters and the relevant factors had to be addressed simultaneously if these interdependencies were to be correctly assessed. It followed that the structure question was really a series of subquestions: the location of depots, the sizing of depots, the location of inventory, the assignment of customers to depots, and the assessment of materiel flows across the linkages thus defined. In short, the fact that the charter addressed optimum integration, consolidation and/or standardization of facilities necessarily implied that all of the above be explicitly treated.

c. Relationship to Methodology

Careful consideration of the above suggested a monumental combinatorial problem: there were literally millions of possible combinations of depot locations and sizes, stock location alternatives, customer assignments, supplier assignments, and materiel flows. To assess each one individually was clearly an impossibility; fortunately, it was also unnecessary. In general, structural questions such as these, readily lend themselves to static optimization techniques which explore cost/performance trade-offs on an aggregate (e.g. annual) basis. The nature of the tools used were such that the mathematically optimum combination of variables was, in fact, selected from the enormous number of initial possibilities. This served as an excellent "sifting" device which efficiently identified system structure configurations that deserved further analysis.

3. System Operations Issues

Specification of a logistics system structure was a necessary, but insufficient step in the design process. Of considerable concern were dynamic performance characteristics of proposed alternatives. Of the innumerable possible research questions, several were selected for consideration by the DODMDS study group:

- What were the specific response characteristics of each alternative logistics system configuration in terms of the following criteria:

  - Depot capability to process assigned demand within specified time limits.

  - Customer service levels in terms of response times across all assigned depots for each customer.

- Given a sudden shift in demand patterns (i.e., contingency, mobilization, or war scenarios) how would a proposed DOD logistics system respond in terms of:

  - Customer service measures, as defined above;

  - Processing queues at the depots, as a function of internal capability.

a. Relationship to Study Objectives

As has been previously established, the Charter required an examination of distribution system functions. Further, it explicitly identified responsiveness, materiel movement, and the peace/mobilization/wartime scenarios as appropriate topics.

b. Relationship to Logistics Systems Theory

The logistics system under analysis operated over time, and certain of its capabilities and performance measures could be accurately assessed only over a selected period, not at a static point. This was particularly true with respect to depot loading, customer service, and scheduling. While a static analysis would prohibit the selection of linkages which could never meet established service criteria, there remained the problem of variable performance for depot processing and transportation functions. Taken together, the net result of the performance of these subcomponents might be vastly different than the sum of their average performance times. In other words, a given customer would be interested in the distribution of depot processing and ship times actually occurring, not simply an average time about which the system varies considerably.

A related problem was that of surge requirements. Due to capacity limitations (issue/receipt processes, depot materiels handling, shipping docks, availability of transportation, etc.), a given system would eventually arrive at an overload or saturation condition. This could result in order backlogs, queueing problems, etc. -- phenomena that occur over time, not statically. Annualized capacity constraints, the typical input to a static optimization model, would not get at potential short-term bottlenecks.

c. Relationship to Methodology

The performance issues were suitable for investigation with a dynamic simulation. Such a tool treats demand on an individual order basis over a specific period of time (e.g. daily demands for a month or quarter). This batch-by-batch daily treatment of orders made possible the consideration of dynamic performance questions. Depot processing, queueing, and shipping were all addressed at a considerable level of detail on an event-by-event basis. The result was a detailed examination of a proposed system in action; an assessment of whether a seemingly acceptable static design actually worked on a day-to-day basis. Clearly, this was a vital step in the evaluation of possible alternative system configurations.

4. Related Research Issues

The intent of the research objectives was to define the basic system structural and operational issues addressed in the DODMDS study and to relate those research issues to specific methodologies available to treat such questions. There were other critical factors which influenced how the research questions were addressed. Such constraints and parameters to the actual conduct of the study included the following:

- What will force structure and deployment be in the target period?

(The above item will influence future customer demand patterns)

- What will transportation, warehousing, order processing, materiel handling, and packaging technology be in the target period?

- What will energy sources, supplies and costs be in the target period?

C. METHODOLOGY

As the research issues were being developed, briefings were provided by the Services and DLA to study group members. The purpose of these briefings was to provide individual study group members with a deeper understanding of each Service and DLA system, mission, and available data. During this phase additional meetings were held with consultants and contractors regarding the availability of models capable of dealing with a system as large as the DODMDS. Based on the inputs of these meetings, data required for conducting the study were identified, and models to be used in the analysis were selected.

1. Data

Data required to conduct a study of the DODMDS were data which described the principal elements of the system: the supply sources, the customers and their demands, the distribution facilities, the products and the transportation network which linked these elements together. Table 4-1, page 130, presents a summary of the data requirements and sources.

a. Collection Process

(1) Data Call. Considering data processing resources at the Inventory Control Points (ICP) and the fluid state of the data element requirements list, the decision was made to obtain copies of "raw data" on magnetic tape of existing files, rather than to require each Service/DLA to develop a capability to extract files in order to provide the desired data. It was realized that extensive programming effort and computer time would be required to merge data from different sources into a DODMDS data base. The programming effort was accomplished in-house with contractor support, and computer resources were made available by the Army Military Personnel Center, located in the same building as the study group. The first data identified as necessary for the study were requisition, shipment, and receipt data from the Services/DLA Inventory Control Points. Letters were prepared to request such data in September 1975, with data file copies delivered to the study group during November 1975.

(2) Manual Collection. Additional data required for the study (i.e., cost data, facilities data, inventory in storage data, etc.) were requested in January 1976 and delivered by June 1976. Some of these data were collected simply by copying raw data magnetic tape files, while other data were collected manually, in some cases using sampling techniques. Once received by the study group, the data had to be arrayed manually. Other data had to be extracted from existing DOD reports, the results of which were verified by the Services and DLA. In general, the types of data that had to be collected and manipulated manually were distribution facility cost data and distribution facility physical characteristics data:

(a) Distribution Facility Cost Data. Historical cost data were primarily developed from accounting reports using the DODI 7720.17 account

DATA REQUIREMENTS

Data Sources	Demand Data	Materiel Source Data	Depot Characteristics Data	Depot Cost Data	Depot Performance Data	Commodity Aggregation Data	Customer Aggregation Data	Material Source Aggregation Data	Transportation Cost Data	Transportation Performance Data	Mobilization Data
Requisition History Files	x	x		x	x	x	x		x	x	
Transaction History Files	x	x				x	x		x	x	
Catalog Data Files	x	x				x					
DOD Activity Address Files	x	x							x		
Vendor Address Files	x	x					x	x	x	x	
Contract History Files		x				x		x	x	x	
GBL Files						x		x	x		
DOD MILSTEP Files										x	
Depot Operations Cost & Performance Reports			x	x							
OSD Storage Space Management Report			x								
Depot Asset Balance Files			x								
Depot Data Questionnaire			x	x							x
Mobilization Planning Reports											x

Table 4-1. Summary of DODMDS Data Requirements and Sources

structure. Non-distribution cost data reported in the source data were excluded. Where distribution costs were incurred outside the scope of DODI 7720.17, procedures were developed to capture these costs which were then validated and approved by the Services and DLA.[1]

(b) Distribution Facility Physical Characteristics Data.[2] These data were collected by data call in the first half of calendar year 1976 and revalidated during the summer of 1977. Physical characteristics data were required for developing depot physical parameters for investment/modernization purposes and for determining depot capacities.

b. Data Base Development

(1) Specification of Files. The DODMDS data base was developed from the data submitted by the Services and DLA. The data files were created to describe system materiel flows and characteristics in the following categories:

a. Outbound (depot to customer).

b. Inbound (vendor/customer to depot).

c. Inventory (assets in storage).

d. Cost (depot fixed and variable costs and transportation rates).

e. Facility (physical characteristics and capacities).

f. Catalog (commodity physical descriptions).

(2) Data Base Build Process. Two processes were used to build the DODMDS data base, automated and manual:

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[1] See Volume III, Book 5, Appendix D-3 for distribution facility cost methodology.

[2] See Volume II, Chapter 3, para F and Volume III, Book 2, Appendix C, Section 5.

(a) Automated Process. The automated process converted the "raw data" source tapes into data formatted for use in the analyses. Several steps were required in this process :

(1) Extract Files. To create files suitable for analysis, the study group extracted selected data elements from the source files. Steps were then taken to validate the contents of each data element and to fill data voids or reject invalid records in accordance with specified extract/validation rules.[1]

It was determined that the files should be structured by the following functional categories:

(a) Customer address data.

(b) Demand data.

- Wholesale

- Retail

(c) Receipt data (procurement and non-procurement).

- Wholesale

- Retail

(d) Catalog data (item characteristics).

(e) Procurement data (contractor data).

(f) Transportation data.

(g) Asset data.

(2) Intermediate Files. These files were constructed for the primary purpose of matching, merging, appending or rejecting certain data where

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[1] Detailed procedures used for extraction and validation of each source file are contained in Volume III, Book 3, Appendix D-1, Data Base Development.

appropriate, and included the following intermediate files:

- Depot shipments.
- Catalog.
- Transportation.
- Contract.
- Depot receipts.
- Asset.

(3) Master Files. These files were constructed by combining the essential elements from the extract and intermediate files, and appending DODMDS study group derived customer numbers, product numbers and materiel source zone numbers to the appropriate files.[1] The master files constituted the DODMDS data base and were the primary sources for the majority of data required for the optimization and simulation models, and for special analyses by the study group. The master files were comprised of the following transaction and reference files:

(a) Master transaction files.

- Depot shipments (wholesale).
- Depot procurement receipts (wholesale).
- Depot non-procurement receipts (wholesale).
- Depot shipments (retail).
- Depot procurement receipts (retail).

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[1] For customer, product, and materiel source aggregation methodology, see Volume III, Book 4, Appendix D-2.

- Depot non-procurement receipts (retail).

(b) Master reference files.

- Catalog.
- Customer.
- Contract.
- DLSC freight data.
- MTMC freight routing.
- NSN/DODMDS product group cross-reference file.
- Retail assets (location/status).
- Wholesale assets (location/status).

(4) Data Base Validation and Correction. The DODMDS data base purification effort was conducted for the purpose of correcting errors in raw data that would have the greatest impact upon subsequent DODMDS efforts. The approach was based on the concept that emphasis should be placed on correcting those FSC's reflecting the largest amount of weight shipped or issues made during the base year.[1]

2. Model Methodology

This section describes the modeling techniques used to analyze the DODMDS.

a. Research Objectives

As a result of translating the general guidance and objectives in the Charter into specific research questions to be answered by the study group[2], it was

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[1]See Volume III, Book 3, Section 10 for details of the data base purification effort.

[2]DODMDS CHARTER, op. cit., para IV B.

realized that no single technique could be employed to satisfy all of the DODMDS research objectives. As mentioned earlier in this chapter, there were two fundamentally different kinds of research issues which had to be addressed: a set of structural questions, which were best handled by static optimization techniques, and a set of time-oriented performance questions most amenable to analysis through dynamic simulation. Thus, the analysis of the DODMDS was organized around two computer models: a static optimization model and a dynamic simulation model.[1]

b. Structural/Stategic Issues

The structural/strategic issues were: (1) how many wholesale distribution depots should be in the DODMDS, and where should they be located; (2) what commodities should each depot carry; and (3) which customers should be supplied which products from which depots?

As noted earlier, no single modeling technique allowed examination of all research questions simultaneously. It was recognized that to render the overall problem tractable, some bounding of alternatives had to occur before operational evaluation of specific alternative structures could be accomplished.

The static optimization methodology was selected as the means to achieve the desired bounding of the problem. With this technique, the criterion of total system operating cost could be used directly. Various alternative structures could be postulated and analyzed to evaluate the desirability of any of those alternatives in terms of least total system cost. The relative speed of doing optimization model runs compared to simulation model runs made it possible to evaluate many alternative structures in terms of the least cost criterion, reserving for dynamic simulation only those structures which looked most promising.

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[1] Selection, formulation, and validation of these models are covered in Appendix D-5, Section 2 (Optimization Model) and Section 3 (Simulation Model).

Further, the kinds of sensitivity analysis possible with the optimization technique allowed the study group to focus its analysis quickly on those independent variables which impacted most heavily on total system cost.

(1) Optimization Model Usage Strategy. "A number of different trial cuts will ... be necessary in order to obtain the desired insights into the planning problem in its full complexity. The synthesis of these insights into a plan for action must, of course, remain within the domain of executive responsibility ..."[1]

This section presents the detailed plan for formulating the "trial cuts" with the optimization model for DODMDS configuration studies. There was an enormous number of alternatives in the set of possible DODMDS system structures. The intent of the modeling strategy was to direct the research efforts to a realistically manageable subset of these alternatives. The problem was bounded somewhat by the parameters established by the Charter, Study Plan and Assumptions formulated early in the study. The modeling strategy further bounded the problem in practice, and allowed establishment of an initial run structure.

Analysis of early model outputs provided the basis for selection of promising alternatives from the universal set of possible system structures. The analytical framework provided for continuous management-model interface to insure intuitively reasonable, as well as mathematically sound, solutions.

(a) Analytical Framework. The purpose of the modeling strategy was to define a conceptual framework of model runs which could be used to test alternative

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[1] A.M. Geoffrion, "Distribution Systems Configuration Planning: Case Study in the Application of a New Computer-Based Method," Working Paper No. 219, Western Management Science Institute, UCLA, November 1974.

DODMDS scenarios and "develop insights into system behavior which could be used to guide the development of effective plans and decisions."[1]

The central focus of the research effort was clearly one of depot location. Consequently, the analysis methodology pivoted around the testing of alternative DODMDS configuration scenarios.

(b) Depot Configuration Scenarios. The major scenarios posited for analysis with the optimization model were:

(1) Baseline; creation of a reference run which could be used as a standard for comparing all other optimization model runs; price out the base year system as close to actual as possible, given modeling assumptions and conventions.

(2) Resolution exercises; parametric manipulation of key input variables to evaluate how the model would behave with actual DODMDS data; identify where critical sensitivities existed, and extent of impact of various ranges of input variables on output variables.

(3) Realigned present system; permit the model to find the least cost materiel flows and depot mission assignments without closing any of existing depots; all depots locked into solution.

(4) Present system configuration analysis; permit model to find the least cost materiel flows and depot mission assignments allowing the closure of depots; all depots free to open or close.

(5) Nominal system configuration analysis; permit model to find the least cost materiel flows and depot mission assignments assuming unlimited investment in state-of-the-art depots as opposed to historical depot costs used in scenarios (1) through (4) above.

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[1] A. M. Geoffrion, "The Purpose of Mathematical Programming is Insight, Not Numbers,". Interfaces, Vol. 7, No. 1 (November 1976).

Certain major scenarios were further subdivided to define additional analyses on the sensitivity of outputs to individual variables in the objective function.

(c) Sensitivity Analysis Strategies.

(1) Overview. Sensitivity analysis can be defined as the controlled, systematic manipulation of input variables for the purpose of observing the effect on selected output measures. There were six categories of input variables which were systematically manipulated in order to ascertain their influence on model outputs (solutions). These were procurement patterns, transportation costs, demand levels, demand patterns, and depot costs. These variables spanned the entire range of significant optimization model inputs. Therefore, examination of their influence in conjunction with depot configuration strategies provided the study group with sufficient insight into the workings of the DOD distribution system to formulate conclusions and recommendations with confidence.

(2) Procurement Policies. The model possesses the capability to force a percentage of total procurement for a given commodity at each procurement region. Supply source shifts can be specified at various levels to evaluate the impact on the DODMDS structure and cost of industry shifts or DOD procurement pattern shifts. For example, a shift of industry from the northeast to the southeast was posited and evaluated to determine the sensitivity of a future DODMDS structure to such a change in procurement patterns.

(3) Transportation Costs. The sensitivity analysis for this variable was based on several alternative transportation rate structures to be evaluated. Specifically, a set of inflation driven rates and a set of reduced rates were generated and tested.[1]

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[1] See Volume III, Book 6, Section 5 for a transportation forecast.

(4) Demand Data. With regard to alternate peacetime demand levels; shifts in demand patterns were evaluated. This took the form of reallocating base year demand levels among customers or customer regions to reflect deployment pattern shifts, base realignments, etc. For mobilization/wartime conditions, scaled up sets of customer demand were constructed and tested with the optimization model. The relative capacities of depots were of particular significance for these analyses.

(5) Depot Cost. The depot cost function for modeling purposes consisted of fixed costs and variable costs by commodity. The sensitivity of system structures to these parameters was conducted to evaluate the impact of changes in both the variable and fixed depot cost.

(d) Other Issues.

(1) Facility and Materiel Ownership. The study charter (paragraph III) specifically includes facility and materiel ownership as a part of the DODMDS. While it is readily acknowledged that ownership is of fundamental importance, the relevance to model usage is less clear. Facilities ownership is a managerial issue that can be examined by means of an off-line analysis. No model inputs require change as a function of ownership. Demand levels and procurement patterns would not change nor should transportation, depot costs, or performance levels. The fundamental questions of storage and flow remain essentially unchanged, regardless of stock or depot ownership.

(2) Collocation of Supply and Maintenance Activities. The DODMDS Study Plan directed that the impact of depot level maintenance (DLM) functions on location decisions be explicity considered. DLM activities were some of the largest DODMDS customers and suppliers, and some distribution facilities performed numerous supply support functions for DLM activities and shared overhead support with them. Any

plan to separate supply and DLM functions could result in a change to the source-depot-customer relationship, thereby increasing the transportation links required to handle the flows involved. The approach taken to this problem was to consider DLM sites as fixed, and to obtain system configurations from the model which explicitly evaluated cost trade-offs of collocated and non-collocated depots.

(2) Optimization Model Input. This section summarizes the data requirements of the optimization model and the methodology used for deriving the data.[1]

(a) Procurement Zones. The model requires identification of procurement and non-procurement supply sources, defined as production zones. Individual supply sources in CONUS and overseas were identified through analysis of depot receipts data. Once identified, supply sources in CONUS and overseas were grouped geographically into production zones based on ZIP code areas for procurement sources and customer numbers for non-procurement sources (materiel returns).[2]

(b) Product Groups. The optimization model has the capability to handle several hundred distinct products. The number of unique items in the DODMDS, however, exceeded 3.5 million. Thus, it was necessary to aggregate NSN's into product groups.[3]

(c) Production Availability. The model operates on the premise that supply must be at least equal to demand and, therefore, requires input of the

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[1] More detailed discussions of data development can be found in Volume III, Book 3, Appendix D-1.

[2] See Volume III, Book 4, Appendix D-2, Sections 2 and 4 for details of the customer aggregation and materiel source aggregation processes.

[3] Specific methodology and criteria by which product/commodity aggregation were accomplished are described in Volume III, Book 4, Section 3.

annual percentage of total demand for each product group which can be supplied from each production zone. Analysis of procurement and non-procurement receipt data by production zone provided percentages of each product supplied from each production zone. These data were contained in transaction history and contract history files provided by each Service and DLA.

(d) Current and Alternate Depots. The optimization model requires that all possible depot alternatives be specified as input. This includes existing facilities, possible modernized versions of existing facilities, and possible new facilities in different locations. The depots are described explicitly in terms of fixed costs, variable costs, and capacities.[1]

There were 34 distribution facilities under consideration. Several facility alternatives at each location were examined, differing according to which product groups were carried, which expansion or modernization projects were carried out, etc.

(e) Product Groups at Each Depot. The model requires definition of the product groups that are allowed to be carried at each depot. This stock/no-stock situation is expressed to the model in terms of customer bundles (see paragraph j, page 139). Any combination of full-line or partial-line depots is possible.

(f) Product Difficulty Factors. In recognition of differences among products as to their relative difficulty in handling and storage, product difficulty factors were developed. These were composite factors which took into account cube, value and numbers of transactions. The difficulty factor developed for each product group was then put into the model.

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[1]See Volume III, Book 5, Appendix D-3, Section 4 for details of depot capacity development.

Multiplying the annual CWT of each product group through a depot times the corresponding difficulty factor, then summing over product groups, yielded a composite measure of depot workload referred to as weighted throughput.[1]

(g) Depot Capacity. The model requires designation of minimum and maximum allowable annual throughput. Maximum throughput capacity represents the maximum processing capability of the depot, while the minimum throughput limit represents the smallest practical level of operation if the facility should be open. The DODMDS study group used zero as the minimum level.[2]

(h) Customers. There were over 50 thousand activities which drew supplies from the DOD wholesale system. Thus, activities and their corresponding data were aggregated for input to the model.[3]

(i) Customer Demand. The model requires an input record of annual demand for each product group by each customer. Shipments direct from procurement sources to customers were netted out of both demand and supply since these were flows which did not go through the depot system and thus could not be evaluated as depot throughput.

(j) Bundles. Effective and flexible use of the model is enhanced by aggregation of product groups into bundles. Each bundle may contain one or more product groups. Each customer may be supplied any bundle from any depot. The model will select the depot(s) which will, in fact, supply a customer, given only that a customer will receive all product groups in a particular bundle from a single depot.[4]

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[1] See Volume III, Book 5, Appendix D-3 for details of difficulty factors.

[2] See Volume III, Book 5, Appendix D-3 for details of depot capacity development.

[3] See Volume III, Book 4, Appendix D-2, Section 2 for details of the customer aggregation process.

[4] See Volume III, Book 4, Appendix D-2, Section 5 for bundling.

(k) Inbound Transportation Links. The model requires definition of permissible inbound links between production zones and supply depots by product group. Links are excluded from input data when a production zone has zero capacity for a product group, or when a depot is not permitted to stock a product group.

(l) Outbound Transportation Links. The model also requires definition of permissible outbound transportation links between supply depots and customers for each product group. Links are excluded when a depot is not permitted to stock a product group, when the customer has zero demand for a product group, or when a given customer is not permitted to obtain a particular product group from a certain depot.

(m) Transportation Rates. The model requires transportation rates ($/CWT) by product group for each permissible inbound and outbound link. The model can accept only one transportation rate by link, by commodity. Therefore, the charges for all relevant transportation modes must be collapsed into a single weighted average for each link-commodity combination.[1]

(3) Model Outputs. For each model run, the model provided both printed reports and an output tape. In general, the following types of data were available:

(a) A list of depots (their wholesale distribution activities) in/out of solution (i.e., remain open or closed)

(b) Supplier-depot flows, by link and commodity

(c) Depot-customer flows, by link and commodity

(d) Transportation costs of both inbound and outbound flows

(e) Depot costs, by site, for all open facilities.

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[1]See Volume III, Book 6, Appendix D-4, Section 2 for methodology for developing transportation rates.

(4) Analysis of Model Output. Mathematical programming models do not generally provide solutions which can be readily implemented without further analysis. The "purely numerical results must be supplemented by intuitively reasonable explanations as to why these results are as they are."[1] The goal of all analysis is to gain valid insights into system behavior which can help guide the design of an improved system. The models used by the DODMDS study group only provided information for analysts and decision makers to consider.

c. Operational Evaluation of Structural Alternatives

The optimization model provided the analysis of various DODMDS structures in terms of simultaneously minimizing system transportation and depot costs. However, it did not provide any direct evaluation of the day-to-day dynamics of system operation. System operation research questions (see Appendix D-7) could only be satisfied by directly introducing a time-dimensioned analysis of system flows. In essence, these time-oriented research questions dealt with day to day responsiveness of DODMDS wholesale depots to customer demands and the ability of DODMDS depots to accommodate surges in demand, given certain capacity constraints.

It was to introduce the time-dimension necessary to analyzing the above issues that a dynamic simulation technique was decided upon.

(1) Simulation Model Assumptions and Constraints.

(a) Assumptions. Assumptions had to be made about the system in order to use the model with realistic computer running times. The following key assumptions were made for simulation purposes:

(1) Infinite availability of materiel at the depots was assumed. Depot capacity was measured in terms of outbound activity, thus there was no need to model receipts from vendors. The infinite availability of materiel greatly decreased simulation run time.

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[1] Geoffrion, Working Paper No. 249, op. cit.

(2) Customer demands were aggregated into daily blocks of demand called orders. This aggregation greatly decreased computer run time and did not affect accuracy of the results.

(3) A sample of the total DODMDS data base was used for simulation purposes. Data processing run times to process the total data base would have been prohibitive without sampling. It was proved that the techniques used to sample the data base resulted in accurate representation of the DODMDS base year data.

(4) The simulation model used the transportation links defined for a given structure by the optimization model as well as the weighted freight rates developed from the optimization model for those links.

(5) Customer demands were factored up, using the factors presented in Chapter 2, to simulate mobilization requirements.

(b) Constraints. The simulation model selected for use by the DODMDS study, the Long Range Environmental Planning Simulator (LREPS), can model a complex distribution system consisting of hundreds of vendors, products, distribution centers, and customers. The model treats almost all aspects of distribution on a daily basis. This capability has a price. In order to have this level of detail, the user must supply a vast amount of information to the model. The preparation of these data is a time-consuming job. Since the model operates on a transaction by transaction basis, computer run time can be extremely long. The more detail that is allowed, the longer the run time.

(2) Simulation Model Usage Strategy

(a) Introduction. Simulation provides a micro view of the distribution system under study. The system can be observed on a day-by-day basis. This detail allows the user to pinpoint impacts to the distribution system which are time related. For any configuration of depots, response to the individual customer can be measured. This is done by observing how long it takes the customer to obtain his order, i.e., the customer order cycle time. The order cycle time is normally made up of communication time, order processing time, backorder time, shipment hold time, and transit time. However, since the purpose of the DODMDS study was to develop alternate depot structures and then evaluate how well those structures could satisfy customer demand, only two factors were considered: depot queue time (because of capacity constraints at the depots) and transit times. These times are kept by priority group. Also, the ability of any depot configuration to meet workload requirements can be measured. If the capacity of a depot is exceeded, the simulator can report how long the depot was overcapacitated, as well as by how much.

(b) Simulation Model Utilization. The overall study objective, as previously stated, was to develop recommendations on DODMDS improvements to support the Services' requirements efficiently and effectively in peace and under mobilization and wartime conditions. The results of this study must support recommendations for distribution system improvements where service response under various conditions and costs are major considerations.

LREPS was used to determine if proposed systems would be responsive to the Services' needs. The simulation measures customer service, depot response, and depot workload capacity.

Three operational issues were investigated using LREPS. These were:

(1) Evaluate mission response for the baseline DOD logistics system. The objective of this operational issue was to defi..., in terms of the LREPS model, performance measures of depot activity and service. The model and inputs were set up to simulate depots and customers in their current logistics channels. This run served as the reference or base point for other simulation runs. Changes in system response due to alternate depot configurations were then compared to this base run.

(2) Evaluate mission response of selected alternative logistics system configurations for peacetime demand patterns. The objective was to define for each selected distribution system configuration the mission response characteristics for peacetime demand levels and patterns. From the outset of the study, it was decided that only the most promising distribution system configurations that evolved from the optimization model analysis would be evaluated by LREPS. The main interest was in the depot response and capacity statistics for these peacetime depot configurations.

(3) Evaluate mission response of selected alternative logistics system configurations for mobilization requirements. The objective was to define for each selected logistics configuration the mission response characteristics for sudden demand level shifts. A separate demand file was created to represent the mobilization impact on the distribution system. The demand on the peacetime file was factored up to produce the increased workload that would be expected at the depots. The simulation reports the surge capability at the depots during mobilization as well as customer service. Surge capability was measured by how long and by how much the depot's capacity was exceeded. Customer service was measured by the order leadtime.

(3) Simulation Model Inputs. LREPS requires that the distribution system under study be completely described. That is, the model must know which customer demanded how much of which product from what distribution center each day. Each attribute of the distribution system must be described in detail.

(a) Line item and order file. In order for the model to process demands on an incremental (daily, weekly, etc.) basis, these demands must be fed into the model. Demand files were developed from the same master files that were used to develop the aggregated demand for the optimization model. The line item file contained each customer requisition. That is, Customer A requisitioned product B with a priority 1 from depot C on day 10. The number of units demanded was input, as well as the weight, cube, dollar value, etc., on a requisition basis. The order file required by the simulation model contained the same information, except summarized. All of the demand from a customer in a given priority group to a depot for a day constituted an order.

(b) Transportation linkages-inbound/outbound. Each transportation link must be specified. For each customer-depot combination (outbound) and vendor-depot combination (inbound) a freight condition is specified. A freight condition defines a specific mode of transportation and shipping weight interval. Each freight condition has associated with it a transportation rate, and a transit time probability distribution. The transit time distribution allows a random selection for a transit time that falls within the transportation priority group associated with a particular requisition.[1]

(c) Product Attributes. Each product must have its attributes specified in the model. These attributes include the item's unit weight, price, cube, and vendor source.

(d) Depot Attributes. LREPS requires that the depots under study be fully described. This description includes products carried, customers served, and processing capabilities. Each depot is assigned a stockage list of products and a list of materiel sources that supplies each product to each depot.

Depots are further described in the model by their associated fixed and variable costs. The fixed costs are depot specific, while the variable costs are by product across all depots.

(4) Simulation Model Outputs. LREPS reports are generated by the data preprocessor, LREPS Data Analysis System (LDAS), and by the simulator itself. LDAS reads the customer line item and order files and

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[1]See Volume III, Book 6, Sections 2 and 3, respectively, for weighted freight rates and for transit time development.

produces a number of reports which display information by customer, product, and depot. Typical reports show the materiel flows to each customer from each depot, flows from each shipping depot by product, and total materiel flow to each customer.

The simulator is capable of producing 30 different reports. Many of the reports show depot and customer service. These reports display the segments of the order cycle time as averages and standard deviations. Distribution center reports show sales data to customers, order costs, storage costs, inventory costs, and total costs. Also, inbound and outbound transportation costs are shown.

Capacity reports show for each depot, by priority group, the number of days the capacity limitations were exceeded and by how much. The capacity limitations were defined as follows:

- the number of lines to be processed in an 8-hour shift.
- the total weight of the demands to be processed in an 8 hour shift.

The capacity reports also show the orders which were not processed during an eight-hour period due to capacity constraints. The capacity reports show the total capacity overflow (dollars, weight, and lines) and an average and standard deviation for each constraint for the simulated period.

LREPS provides a number of other depot and customer service reports. In particular, the order cycle time for each depot is reported. The order cycle time is made up of capacity delay and transit time. The depot order cycle time report shows the average and standard deviation in days. The customer order leadtime is also reported. This leadtime is made up of depot capacity delay and transit time for all depots supporting a given customer.

D. SUMMARY

The analytical methodology was central to accomplishing the objectives of the DODMDS Study. It provided an orderly and rigorous framework for defining, collecting, processing, and integrating data on the critical variables which represent the DODMDS. A distribution system is described quantitatively by the key data elements of product demand, product supply, location, transportation links and costs, and depot capacities and costs. Simultaneous assimilation of these driving variables into a comprehensive analytical framework where cost trade-offs were possible required the use of computer-based modeling techniques. The static optimization technique was used to generate cost-based structural alternatives. The dynamic simulation model was used to introduce the time dimension by providing an evaluation of structural alternatives on a day-by-day, order-by-order basis.

CHAPTER 5
ANALYSIS

A. INTRODUCTION

1. Purpose of Chapter and Approach

The purpose of this chapter is to describe what was done in the integrative analysis phase of the DODMDS study, how it was done, and why. This includes the use of the models to assimilate the mass of data described in preceding chapters as well as the off-line analysis which evolved from the modeling efforts.

At the beginning of the analysis phase, all of the key ingredients were ready in some form. The data base had been constructed; initial cost analysis had provided preliminary depot cost information required for modeling; the transportation rate data and generation procedures were available; the modeling strategy had been developed; and basic assumptions had been agreed upon. The optimization model was also ready for operational use although the software was to pass through several stages of refinement over the course of the analysis phase. The development and nature of all of these key elements have been described separately in the preceding two chapters. It was the role of the integrative analysis phase to bring together all of these elements in an orderly and disciplined way. Results would consist of (1) insights necessary to understanding the essence of DODMDS, and (2) management actions indicated for the future based on that understanding.

The order of this chapter is essentially the order of sequential steps taken from the time the data and models were ready, through the many model runs, to the end point of having sufficiently reliable information to draw conclusions and make recommendations. It is believed this approach to the presentation of the analysis phase is the most logical, as it permits the reader to share the evolutionary learning process experienced by the study group members.

The analysis phase covered a period of about nine months starting in June 1977. Over 250 optimization model runs were made during that period. No attempt will be made in this chapter to describe each of those runs; each model run resulted in upwards of 40,000 lines of printed output. However, the runs themselves are all available among the study group's files, and all the runs are catalogued in Volume III, Book 1.

An extremely important factor to be borne in mind throughout this chapter is that the models were not simply tools to assimilate the mass of data collected. Rather, they were tools that also aided all of the study group's analysts to better understand the various types of data they had prepared, the assumptions initially made, and the kinds of adjustments to techniques and data necessary to achieving the study objective: the best possible DOPMDS for the future. In short, learning occurred every day the analysis was being done. There was no precise break between data preparation and modeling; they were parallel and interactive processes once the initial set of input data had been prepared. Data improvements and software improvements were made throughout the modeling phase. In fact, much of what has been described in Chapter 4 on methodology evolved through this interactive process of continually learning, improving, and converging toward the point where study group analysts were satisfied that all factors in the analysis were good enough to draw reliable conclusions.

Although numerous detours were necessary through the course of the analysis because of what was learned in a preceding step, the analysis did follow the basic roadmap of the modeling strategy outlined in Chapter 4. All of the major strategies were modeled and will be reported:

- DODMDS baseline.
- Resolution exercises.
- Materiel realignments without closing depots.
- Materiel realignments allowing depots to close.
- Investment options.

To illustrate the types of detours made as the analysis progressed, the technique of clustering depots was not envisioned at the outset, nor were the use of standard variable costs and standard inbound freight rates. These techniques, which appear obvious in hindsight, were arrived at only after dozens of model runs and the learning that occurred from analyzing the results. It was also discovered that some of the modeling scenarios originally envisioned were impossible or impractical, such as attempting to model fast versus slow moving materiel separately. Commodity and customer aggregations, combined with the nature of a static optimization, made this seemingly desirable approach far more costly in time and data preparation than warranted by the marginally improved insights that were likely to emerge. However, this was only seen clearly after substantial experience with the optimization model.

In sum, then, the overall strategy for modeling, defined months before modeling commenced, was followed. All major objectives of that strategy were met, and all research questions posed were answered.

2. Macro-Analysis and Micro-Analysis

The analysis phase was divided into two general categories related to the techniques used: macro-analysis and micro-analysis. The macro-analysis was performed with the optimization model and provided the overall structure of what the DODMDS should be, based primarily on economic criteria. Although other criteria, such as depot storage capacity and vulnerability, were used to bound reasonable solutions to be explored with finer grain off-line analysis, the optimization model is by its very nature a cost-minimizing model. The quality of any solution set in terms of measures of merit other than cost could only be approximated or deduced based on judgment and interpretation of model results.

Completion of the macro-analysis yielded a bounded and generally reasonable system structure which then had to be refined to make good logistics sense. This refinement was accomplished by detailed off-line analysis of the "Objective System" defined by the optimization model. This "Refined System" was subjected to operational evaluation by the simulation model to determine how well the system held up under the fluctuations of day to day demand both in terms of depot performance and customer service levels. It was essential to establish that any refined system to be recommended provide at least as good customer service as that provided by the baseline system.

B. CRITERIA FOR EVALUATING RESULTS

An objective of the DODMDS study group was to recommend alternatives to integrate, consolidate, and/or standardize the DOD distribution system facilities. To obtain that objective, it was necessary that a series of criteria be applied to the various alternatives. Since the DODMDS is extremely complex, with a large number of interacting variables, the criteria had to focus on the significant aspects of the system.

Criteria for evaluating the various alternatives were required for three reasons. First, an extremely large number of alternatives could be developed. Criteria were intended to assess the "goodness" or "badness" of those alternatives. Criteria provided a framework for screening the various alternatives. Second, an analytical framework has certain inherent limitations. Models are only intended to generate insights, not make decisions. Additionally, a model can provide insights only in regard to the data provided. A model does not have a cumulative memory across runs nor will it assess factors or considerations not explicitly provided by input data. Third, certain nonquantitative factors had to be considered with each alternative.

Two echelons of criteria were required to evaluate DODMDS alternatives: (1) those criteria to be used in evaluating the structural alternatives, i.e., the macro-system structures formulated from the optimization analysis; and (2) those criteria to be used in evaluating micro-level alternatives regarding specific customer and commodity assignments.

1. <u>Macro-Level Criteria</u>

The macro-level, or structural criteria, were as follows:

a. Minimum total system cost, i.e., depot fixed and variable cost plus transportation inbound and outbound cost.

b. Minimum delay in satisfying customer demand.

(1) Depot delay due to violations in estimated depot throughput capacity.

(2) Transportation delay due to assets positioned in relation to the demand (customer) concentrations.

c. Sufficiency of depot storage capacity for hypothesized annual volumes of throughput.

d. Change in vulnerability of the system structure.

e. Structural sensitivity to the input data reflecting:

(1) Transportation costs.

(2) Supply source shifts.

(3) Demand shifts.

(4) Demand fluctuations.

(5) Mobilization.

(6) Area wage rates.

2. <u>Micro-Level Criteria</u>

The micro-level criteria were as follows:

a. Minimum total system cost.

b. Reasonableness of proposed depot missions.

c. Sufficiency of depot capacity in terms of daily throughput and storage capacity.

d. Minimum delay in satisfying customer demand.

C. PROBLEM REPRESENTATION FOR MODELING

1. Introduction

The results of any analysis effort are dependent upon assumptions made and the manner in which key data are handled in the models used. Critical issues of problem representation are, therefore, always present when using mathematical models. These issues typically grow out of consideration of (1) limitations of the project scope and objectives, (2) nonstandard features of the system under study, and (3) data availability. The DODMDS study group experience has been consistent with this observation. In the course of the DODMDS study, a number of important problem features were incorporated into the mathematical representation of the DODMDS. To assist the reader in understanding the analysis phase of the research, these special treatments are described below.

2. Supply Source Availability

Procurement sources for defense materiel are determined by a variety of factors, many of which have nothing to do with minimizing inbound transportation costs. Further, DODMDS customers (ships, troop units, etc.) which generate returns to the depot system would not be relocated just to save distribution system dollars. These facts precluded the DODMDS study group from recommending alternative geographic procurement and non-procurement patterns for the DODMDS. Therefore, the relative availability of any commodity group was established across all supply source regions (procurement) and all customers (non-procurement), based upon historical supply patterns. The resultant systemwide proportions remained fixed regardless of the changes made to the distribution system structure. Additionally, these proportions of supply availability applied to each depot, regardless of location. Although the study group established depot-specific supply patterns for each commodity, these historical depot-specific patterns were deemed to be unsuitable for modeling purposes. This conclusion was based upon the underlying philosophy of the study group: since depots could potentially be assigned missions substantially different from those accomplished in the base year, their historical resupply patterns could not reasonably be expected to remain stable. However, the systemwide proportions would be stable, regardless of depot mission realignment, because (1) a given customer would return only a certain amount of a commodity, regardless of depot stockage patterns, and (2) procurement policies are based upon competitive bids, small business set asides, regional equalization policies, and other factors not related to stockage patterns.

Yet another reason existed for imposing a systemwide supply availability pattern on each depot. Left to its own devices, the optimization model would flow materiel to a depot from the closest suppliers. The implicit assumption necessarily made by the model is that the "micro-mix" of constituent NSN's for a given commodity group is stable for each supply source; that is, each supplier can provide the entire range of aggregated stock numbers. However, it was impossible to enforce such a restriction when the NSN's were being aggregated, as the resultant number of groupings would have been far too large. The lack of micro-mix stability at each supply source meant that the model, in actuality, could not satisfy a depot's true demand for a commodity from only proximate supply sources. The proximate suppliers simply could not provide all the NSN's required, and hence, flows would be required from more distant suppliers that could provide them. Imposition of systemwide supply source allocation proportions for each depot insured that this mixture of flows would take place. This was a most conservative representation which tended to overstate inbound transportation costs somewhat. However, analysis revealed the overstatement to be modest (less than 15 percent in the Baseline System) and preferable to the untenable assumption of NSN micro-mix stability across supply sources for a given commodity.

3. Supply of Reparable Commodities

As described elsewhere in this report, reparable and consumable NSN's were aggregated into separate commodity groupings. Furthermore, all reparables were split into two separate commodity groupings for optimization modeling purposes: serviceables and unserviceables. However, this raised a potential problem in terms of the supply source echelon: while it is entirely reasonable that serviceable reparables would be obtained from procurement and non-procurement supply sources, the same could not be said for unserviceable reparables. Therefore, the latter were modeled so as to be available only from customer return sources of supply.

4. Elastic Capacity Penalty

As originally designed, the optimization model provided for rigid lower and upper limits on depot throughput (i.e., capacity). However, both contractor and DODMDS study group analysts concluded that a more realistic representation would provide for flexible or "elastic" bounds. Several reasons support this view. First, depot capacities can never be assessed with the accuracy that a single numerical value would imply. It is impossible to determine, for example, the precise quantity of issues, weight, cube, etc. that a facility can process in a day, much less a year. Second, even if such data were available, the daily operations of a depot could not be expected to rigidly conform to those capacities. To illustrate, it is most unlikely that a depot with a supposed daily processing limit of 10,000 issues would automatically cease operations once that quantity had been worked. Third, a flexible capacity can be seen to have real world applications since actions can be taken to increase effective capacity at some price. These include, for example, overtime and (or) additional shifts.

With the above analysis in mind, flexible capacities were implemented as follows. First, minimum and maximum weighted throughput limits were specified for each depot. Second, a per unit penalty charge was developed for each throughput limit. This penalty was assessed (in addition to the depot variable cost) against each unit of weighted throughput which exceeded the boundary. In other words, the model had the option to violate a capacity constraint, but it could do so only by paying an additional charge.

It should be pointed out that the analysis loses nothing with this formulation; rather, a great deal of flexibility is gained. Setting a given penalty rate to zero effectively removes a particular capacity constraint, since the model is then free to violate it without cost. On the other hand, establishment of a rate at a sufficiently high level (derivable via experimentation) will effectively reestablish a rigid bound, since the model then perceives any violation to be prohibitively expensive. In practice, DODMDS analysts always set the lower throughput bound and its corresponding penalty rate to be at zero for each depot.

Elastic depot capacities provide additional benefits in terms of solution quality. For example, it may be far less expensive to accept a small capacity violation at a given depot rather than open an additional facility. Should only rigid limits be available to the model, it would have no choice in such an instance but to open additional depots to obtain the needed capacity. For small violations this is an expensive and wasteful alternative, since only a small fraction of the capacity of the additional depot is required. Of course, as the violation, with its corresponding penalty charges, increases at the first depot, the opening of additional facilities becomes more economically viable. Such trade-off analyses are automatically performed by the model.

5. DSS Overseas Customers

In the section on customer aggregation, it was explained that, where appropriate, Army overseas customers were aggregated separately. This was done to accommodate the Army Direct Support System (DSS) policy of supplying certain overseas Army customers via an assigned Consolidation/Containerization Point (CCP). After a series of early model runs, from which the impact of CCP routings became evident, all Service/DLA depots were required to ship materiel to overseas Army DSS customers via the appropriate CCP. This was done to insure that no bias across depots would be introduced by the higher movement costs for these customers. Extensive analysis indicated that movement costs were generally higher for CCP routings than for shipments via WPOE's, APOE's, and postal gateways. Therefore, Navy, Air Force, and Marine Corps depots were provided rates to overseas Army DSS customers that reflected an appropriate CCP routing to preclude unfavorably prejudicing the Army and DLA depots which currently follow the CCP procedure.

6. CCP-Ineligible Commodities

Investigation by the DODMDS study group analysts revealed that certain commodity groupings were typically not shipped to Army DSS customers via a CCP. Therefore, these commodities were provided with transportation rates from all depots which reflected routings via appropriate WPOE's, APOE's, and postal gateways. A listing of the commodity groupings so designated is shown below.

Product Group Number	CCP-Ineligible Commodities
102	Guns over 75mm
151	Fixed Wing Aircraft
152	Rotary Wing Aircraft
191	Ships and Boats
231	Wheeled Vehicles
232	Tracked Vehicles
894	Subsistence
895	DICOMSS

7. Supply/Maintenance Interface Penalty

As noted earlier in the report, an analysis was made of the cost implications of supplying a collocated maintenance customer from other than the collocated depot. It was concluded that implementation of such a policy would, in effect, create a second depot handling (receipt, store, and issue) of a commodity where only one existed in the current DODMDS structure, thus generating additional costs. To make the optimization model "aware" of such cost implications, the following technique was adopted: a charge equal to the unit variable cost of the collocated depot would be imposed upon each unit of flow from a non-collocated depot for selected reparable products. The commodity/depot/ customer combinations qualifying for this non-collocation "penalty" were very tightly defined in light of observed historical support patterns and were, as noted, limited exclusively to reparable commodities. This very conservative application was predicated on the premise that the cost penalties for non-collocated depots would be most obviously present in cases of collocation between a depot and an on-base maintenance customer. Appendix E, Section 1 contains a listing of collocated reparable commodity/depot/ customer combinations.

D. THE DODMDS BASELINE FOR ANALYSIS

In using modeling techniques to analyze a complex system, one does not achieve the "answer" with any given run. Values used are only estimates, no matter how carefully they were developed or how rigorously they were tested. Therefore, the results generated by any model run are only estimates; they are certainly not absolute values. As pointed out earlier, the purpose of modeling is to gain insights, i.e., to permit the analyst or decision maker to better understand both the nature of the system under study and the interaction of the key input variables in determining its performance on chosen criteria. For these reasons, it is the differences from run to run that are most important to the analyst rather than the actual values computed for any one run.

For comparisons to be made across runs, there must be a baseline or point against which all else can be measured. This baseline becomes the "standard" against which all other scenarios can be compared across relevant criteria for "goodness" or "badness." The reference run, or "Baseline System", must be constructed using the same basic techniques and data that will be used in the modeling excursions. Otherwise, comparisons between it and these other runs would be meaningless. Seldom will such a modeling baseline look just like the conventional accounting reports. Modeling is aimed at finding the driving forces or essence of any system. Wherever extraneous or non-crucial variables can be eliminated from consideration, the modeling process is simplified without loss of power in providing insights.

In the DODMDS study, two separate modeling baselines were created to provide cross-checks both on the model itself and, especially, on the problem representation techniques described in the previous section. The "Off-line Baseline" was generated from a separate computer program developed just for the purpose of creating a baseline. The "On-line Baseline" was generated with the optimization model by forcing the model to price out base year flows as they occurred, thus not permitting it any latitude to optimize. These two baseline techniques used identical input data for demand, supply sources, depot costs, and transportation costs. Additionally, the same problem representation assumptions and techniques discussed in section C were used in both baselines. The results of the two approaches were within .2 of 1 percent of each other on total system cost. This extremely close agreement between the two entirely different approaches to pricing out the DODMDS baseline provided assurance to study group analysts that the problem representation techniques were functioning reliably and that a valid baseline had been established against which all other model runs could be evaluated. It was the Off-line Baseline which was used for the comparative analyses and is referred to hereafter as the Baseline System.

The Baseline System for modeling had the following costs and flows (see Tables 5-1 and 5-2).

Table 5-1. Modeling Baseline Cost: System Operating Cost ($ Millions)

Depot Variable Cost	309.9
Depot Fixed Cost	120.4
Inbound Transportation (Vendors & Customer Returns to depots)	242.9
Outbound Transportation (Depots to Customers)	331.2
Total Cost	1004.4

Table 5-2. Modeling Baseline Shipments by Depot

Depot	CWT
Anniston AD	2107005
Corpus Christi AD	108200
Letterkenny AD	1253352
Lexington DA*	131187
New Cumberland AD	1494753
Pueblo DA*	325554
Red River AD	1540876
Sacramento AD	588346
Sharpe AD	689214
Tobyhanna AD	367986
Tooele AD	1152420
NAS Alameda	115503
NAS Jacksonville	85158
NAS Norfolk	130108
NAS North Island	291899
NSC Norfolk	1199105
NSC Oakland	1177677
NSC Pearl Harbor	116707
NSC San Diego	462435
MCAS Cherry Point	947765
Oklahoma City ALC	654397
Ogden ALC	460677
Sacramento ALC	402476
San Antonio ALC	706753
Warner Robins ALC	388988
MCLSBLANT Albany	302447
MCLSBPAC Barstow	488877
DCSC Columbus	631177
DDMP Mechanicsburg	4735560
DDMT Memphis	2844762
DDOU Ogden	903989
DDTC Tracy	3256965
DESC Dayton	77708
DGSC Richmond	1756807

*Depot Activities

It is essential to note that the modeling baseline costs and weights are not the same as the depot costs and weights found in Chapter 3. The reason is that the models evaluated only wholesale materiel flows, while depot cost rates used in the modeling process were developed from total depot workloads (retail, disposal actions, interdepot transfers, etc.). See Book 8, Appendix E, Section 2, for a detailed reconciliation of the differences between the two sets of depot costs.

E. THE DODMDS MACRO-ANALYSIS

This section describes the iterative use of the optimization model to arrive at what came to be called the "Objective" DODMDS.

1. Discrete Depot Analysis

The first runs that were made with the optimization model concentrated on developing an understanding of how the model behaved with the DODMDS data and the sensitivity of model results to such key variables as depot costs, transportation costs, demand patterns, bundle structures, supply patterns, and permissible linkages. The first 59 runs were made with the 34 depots treated separately, or discretely. All of these runs were considered to be resolution exercises, and were extremely valuable in providing the learning process so essential to effective use of the model. Each run provided some new insight into the effects of the assumptions that were initially made, the correctness of the data being processed, and the behavior of the model under varying data input conditions. During these runs, the model proved to be a powerful tool for isolating residual data errors which would never have been found otherwise, given the millions of separate data elements which comprised the DODMDS data base.

In addition, it became apparent very quickly that the initial version of the optimization model was not powerful enough to effectively handle the DODMDS problem. This information was relayed to the contractor, Optimal Distribution Systems, and resulted in significant expansion of the model's capability during the course of the project.

It was known at the start of the modeling phase that the depot cost analysis was not yet completed, and that improvements to the depot cost inputs would be forthcoming as the modeling progressed. However, it was also recognized that early use of the model with estimated cost data would provide invaluable insights to the cost development group that would assist in the continuing analysis and refinement of depot costs.

The first 24 model runs were accomplished with the skeletal problem structure. The elastic capacity factor and the penalty factor for moving reparable materiel away from collocated maintenance activities were not yet ready for use. Further, an upper limit of only 15,000 outbound link combinations greatly constrained the possible customer-depot-bundle combinations. For these initial 24 runs, only 13 bundles were defined to permit more customers to be linked to more depots for more bundles. However, even with only 13 bundles, 90,610 outbound link combinations were possible (13 bundles X 205 customers X 34 depots), and the model only allowed 15,000 such link combinations at that point. To determine which 15,000 linkages to permit, historical depot workloads by bundle were developed, and assignments of bundle-customer combinations to depots were generally made on that basis.

The types of resolution exercises that were run during this initial period were:

- Setting depot fixed costs equal for all depots at various levels from $0 through $50 million.

- Setting depot variable costs equal for all depots at various levels from $0 through the highest variable costs for any depot in the system.

- Setting transportation rates at .5 and 2 times the base year rates.

The above settings of key variables were in addition to the initially available historical depot and transportation costs. Through analysis of the various combinations of these variables across several runs, some of which locked all depots into solution and some of which allowed depots to close, critical insights were gained.

First, it was apparent that the 13 bundle structure with permissible linkages based on historical workload by bundle was far too restrictive and was biasing results toward maintenance of the status quo. Because so few possibilities were being evaluated at one time, the true transportation economics of the alternative systems were not being considered. Second, it was clear that differences in depot variable costs were dominating model solutions. These large differences were due to the immense disparity in base year depot missions and, consequently, associated base year variable costs. These two key insights became the basis for the next phase of modeling and analysis.

Runs 25 through 59, were also considered resolution exercises with discrete depots, and were used both to introduce several new features into the modeling analysis as well as to test refined cost data and new bundling structures. The penalty factor for exceeding depot capacity was implemented, as was the first version of the supply/maintenance interface penalty for moving materiel away from collocated depots/maintenance activities. Three new bundling structures were developed and tested: 21, 24, and 27 bundles versus the 13 used in the initial runs. As the depot cost analysis progressed, new depot cost factors were introduced. Finally, the transportation rate generation process was modified to require any Service/DLA depot shipping to an overseas Army DSS customer to incur the rate for the CCP serving that DSS customer. Initially, since only Army and DLA depots had historically shipped materiel to overseas DSS customers, the CCP charge was imposed only on shipments from those depots. Analysis of early model results revealed that this procedure was unfairly biased against Army and DLA depots because Navy, Marine Corps, and Air Force depots incurred lower overall movement costs due to the absence of CCP handling costs. As indicated above, the modification made to the transportation rate generation procedures to rectify this bias was to require all shipments of eligible bundles to overseas DSS customers to be routed through the CCP, regardless of originating depot.

The key insights gained through this second series of runs were:

- The number and composition of bundles used (21, 24, or 27) did not have any significant impact on the resulting system structure or cost.
- The outbound customer-depot-bundle linkages permitted were critical to the results.
- The disparities among depot variable costs were still dominant in model solutions.
- The very close proximity of depots within some geographic areas prevented any realistic discrimination among individual depots in those groups based on transportation costs.

2. Cluster Development

a. Twelve-Cluster Analysis

The major insight gained from the first 59 optimization model runs was that the discrete depot problem representation was not an effective means to get at the fundamental location economics of the DODMDS. Because of the large disparities in discrete depot variable costs that resulted from drastically different base year depot workloads, and because of the proximity of depots in some areas, it became clear that the only way the optimization model could be used effectively to meet the DODMDS objectives was to cluster proximate depots together, treating the cluster as one depot, and to use standard depot variable costs. Taking this approach allowed the natural location economics of the entire system to emerge. It also permitted "completely dense" outbound link combinations which meant that every customer could be linked to every cluster for every bundle. The basic thrust of the modeling analysis in runs 60 through 148 was 12-cluster analysis. However, as changes were made to data or problem generation software during the two months these runs were being done, further discrete runs were also executed to determine the impact of the changes on the discrete depot problem representation.

When the decision was made to adopt a depot clustering approach, 12 geographic areas were identified as natural groupings. While it was recognized that several alternate clustering arrangements were possible, the major requirement was to select one as a starting point. It was expected that modifications to the initially selected arrangement would emerge through further analysis.

The assignment of the 34 depots to the 12-clusters is shown in Figure 5-1 along with a map showing their locations.

As was pointed out earlier, it was found that the choice of bundling structure among the 21, 24, or 27 bundle patterns was a matter of managerial convenience. That is, there was no statistically significant difference among the resulting system structures and costs when the identical problem was run with each of the three bundling patterns. The 27 bundle pattern was selected to be used for 12-cluster modeling analysis since it provided the greatest amount of discrimination among the product types which were bundled together. (See Appendix D-2, Section 5, for the product-bundle assignments.)

Since all of the original data and problem representation formulations had been developed for discrete depot analysis, certain modifications had to be made to transition to cluster analysis. As the decision was made to use standard depot variable costs by product, no change was required for that factor. Depot fixed costs were merely added together for all depots in a cluster to arrive at the cluster fixed costs. The depot capacity data were handled just like the fixed cost data; i.e., added together for all depots in a cluster to get a cluster capacity. Table 5-3 shows the fixed cost and capacity data for each of the 12-clusters:

Figure 5-1. Twelve Depot-Clusters

Cluster Number	Depot Name	Cluster Number	Depot Name
1	Sacramento AD	6	Lexington DA*
	Sharpe AD		DCSC Columbus
	NAS Alameda		DESC Dayton
	NSC Oakland		
	Sacramento ALC	7	Anniston AD
	DDTC Tracy		DDMT Memphis
2	NAS North Island	8	NAS Jacksonville
	NSC San Diego		Warner Robins ALC
	MCLSBPAC Barstow		MCLSBLANT Albany
3	NAS Norfolk	9	Corpus Christi AD
	NSC Norfolk		San Antonio ALC
	MCAS Cherry Point		
	DGSC Richmond	10	Red River AD
			Oklahoma City ALC
4	Letterkenny AD		
	New Cumberland AD	11	Pueblo DA*
	Tobyhanna AD		
	DDMP Mechanicsburg	12	NSC Pearl Harbor
5	Tooele AD		
	Ogden ALC		
	DDOU Ogden		

*Depot Activities

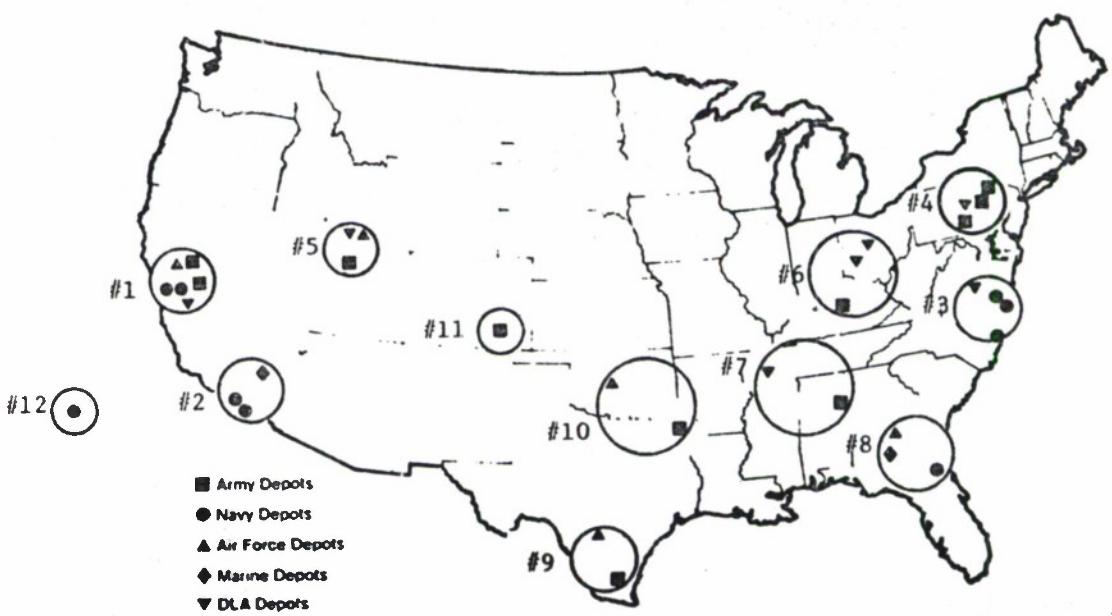

Table 5-3. Twelve-Cluster Fixed Cost and Capacity

Cluster Number	Number of Depots	Cluster Name	Fixed Cost ($ Mil)	Capacity (WTP-Mil)*
1	6	No. California	24.3	76.2
2	3	So. California	7.7	20.0
3	4	Virginia	14.2	41.7
4	4	Pennsylvania	14.8	67.8
5	3	Utah	14.8	45.9
6	3	Ohio/Lexington	16.3	29.0
7	2	Memphis/ Anniston	9.3	39.2
8	3	Georgia/Florida	6.3	22.4
9	2	Texas	3.3	26.8
10	2	Oklahoma City/ Red River	7.1	39.2
11	1	Pueblo	1.8	4.5
12	1	Pearl Harbor	.5	.7
	34		120.4	413.4

*Note - See Appendix D-3, Section 4, for a description of Weighted Throughput (WTP) and the means used for computing WTP capacity for the optimization model. The WTP capacity data were used as indicators of potential overloading of clusters in the optimization modeling. Detailed data on physical capacity by lines and weight were used in the simulation modeling.

The remaining key factor which had to be adjusted to move from discrete depot modeling to cluster analysis was the transportation rates. As described in Chapter 4, a weighted transportation rate was computed in the model input generation stage for every depot to customer link for each of the 69 basic product groups. In addition, the maintenance interface penalty was depot-customer-product specific. To generate a transportation rate for each product for each customer from each cluster, the depot-specific rates for each link were first computed, including the maintenance interface penalty, then averaged across all the depots in a given cluster. This resulted in a cluster-average transportation rate to each customer for each product. Shipments to customers which received local delivery from any of the depots in the cluster were treated as local delivery from the entire cluster, thus incurring no outbound transportation charge. The same procedure was followed for generating inbound transportation rates: discrete depot rates from each supply source were first computed, then averaged across all the depots in a given cluster.

Finally, because the objective of the cluster analysis was to get at the natural location economics of the DODMDS, the elastic capacity penalty factor was set at zero to permit any cluster to handle as much throughput as the model wanted to give it.

When the first runs were made with the 12-cluster structure, it was found that the fixed costs of some clusters were so high that transportation savings accruing to such a cluster for proximate customers were not great enough to offset the high fixed costs. As a consequence, a whole cluster would be closed. The following results from one of the 12-cluster runs (#136) illustrate this point:

Depot Fixed Cost	55.8M
Depot Variable Cost	309.9M
Inbound Transportation	267.2M
Outbound Transportation	265.6M
Total System Cost	$898.5M

Clusters in Solution

- Southern California
- Virginia
- Pennsylvania
- Georgia/Florida
- Texas
- Oklahoma City/Red River
- Pueblo
- Pearl Harbor

Clusters not in Solution

- Northern California
- Utah
- Ohio/Lexington
- Memphis/Anniston

The model results were showing that there was excess capacity in each of the areas "closed down." In an economic sense, capacity equates to cost; the greater the capacity, the larger the cluster or depots in a cluster, the greater the fixed charges. The four clusters closed did not have dense enough economical support patterns to generate enough marginal transportation savings over some other cluster to warrant paying their high fixed charges.

It was quickly recognized, however, that although the economics of the system dictated against retaining all the depots in the clusters that were closed, there was as yet no evidence that no depots were warranted in those clusters. In fact, each cluster closed had at least two depots in it; the Northern California cluster had six depots.

Therefore, the next stage of the analysis was aimed at finding a maximum threshold level of cluster fixed cost for each cluster which would bring all 12-clusters into solution. Various combinations of reduced fixed costs were tried for the four clusters that had dropped from solution. It was found that the Northern California and Memphis/Anniston clusters could be brought into solution at two-thirds of their actual total cluster fixed costs. The Utah cluster could be brought in at one-third of its cluster fixed cost. However, the Ohio/Lexington cluster could not be brought into solution at even the one-third level.

The results of the run (#137) which brought all except the Ohio/Lexington cluster into solution were:

Depot Fixed Cost	83.1M
Depot Variable Cost	309.9M
Inbound Transportation	266.8M
Outbound Transportation	226.1M

Total System Cost $885.9M

Clusters in Solution	Percent of Cluster Fixed Cost
Northern California	67
Southern California	100
Virginia	100
Pennsylvania	100
Utah	33
Georgia/Florida	100
Texas	100
Oaklahoma City/Red River	100
Memphis/Anniston	67
Pueblo	100
Pearl Harbor	100
Cluster not in Solution	
Ohio/Lexington	33

The interpretation given to the above analysis was that for the 12-cluster structure, some part of every cluster was economically viable except the Ohio/Lexington cluster.

At a macro-level, the analysis to this point indicated that some reasonable combination of depots could be selected for each cluster, excluding Ohio/Lexington, which could handle the workload the model was assigning to the cluster, and which would cost no more in aggregate than that percentage of the total cluster fixed cost which the model was willing to pay for that cluster location in the trade-off against transportation costs. This was an extremely significant finding. Equally significant was that the model was putting through the three reduced-cost clusters almost exactly the same percentage of flow capacity as the partial fixed costs were of total cluster fixed cost:

	Percent of Total Cluster Fixed Cost	Percent of Total Cluster Weighted Throughput Capacity Used
Northern California	67	63
Utah	33	34
Memphis/Anniston	67	68

This was very convincing evidence that at least the four clusters initially closed by the model at their full fixed cost had excess depot weighted throughput capacity. The subsequent model runs further refined this emerging picture by putting some economically derived bounds on the magnitude of the excess capacity and cost.

However, as clearly as the general system picture was emerging, there was still uncertainty regarding the real economics of the problem in the central part of the country. It was known that the Ohio/Lexington cluster could not be brought into solution at one-third the total cluster fixed cost ($5.4 million), but it was also known that the fixed cost of the Lexington depot by itself was only $1.6 million. Further, it was unclear what was happening with the Memphis/Anniston cluster. It was known that the full value of both was too high to keep the cluster in solution, but it was not known if the cluster was being pulled into solution at the two-thirds level because of a generally favorable location relative to numerous customers or because of the large maintenance interface influence at Anniston. The cluster itself was showing overall weakness in terms of location economics, and it was concluded that the clustering of the two depots together, given their distance from each other (almost 300 miles), was possibly masking where the needed capacity should actually be.

b. Fifteen-Cluster Analysis

The 12-cluster analysis provided valuable insights into the shape the DODMDS should take for the future. However, as noted in the previous section, there was some uncertainty remaining about the location economics in the mid-section of the country. Further, it was recognized that some lack of realism was present in the 12-cluster analysis because every cluster was permitted to compete for the demand of every customer for every product. It was known that some clusters did not have the capability to handle certain products, primarily reparables. For example, Pueblo and Pearl Harbor had no capability for receiving, repairing, storing, and issuing tracked combat vehicles; Memphis/Anniston had no capability to handle aircraft engines; and the Texas cluster had no capability to handle heavy construction equipment.

Further refinement of the analysis beyond the 12-cluster stage to deal with the problems identified in the preceding paragraph required two steps. First, three clusters in the mid-section of the country were expanded to six. Because of the distances between them (over 300 miles), Oklahoma City ALC and Red River Army Depot were made separate clusters. The same was done with Defense Depot Memphis and Anniston Army Depot because of the distance between the two depots and because the 12-cluster analysis had indicated excess capacity in the original two-depot cluster. Finally, Lexington Army Depot was separated from the two Ohio depots (Dayton and Columbus) which were originally together as a three-depot cluster. This last step was taken not because of distance between Lexington and the two Ohio depots, but because of the fixed costs involved and the overall economic weakness shown in all previous model runs of the Ohio/Lexington cluster. The total fixed cost of the original three depot cluster was $16.3 million. When one-third of that ($5.4 million) was used in attempting to pull the cluster into solution in the 12-cluster runs, the reduced cluster still was not economically viable and was dropped. However, Lexington's contribution to the $16.3 million fixed charge for the three-depot cluster was only $1.6 million. It was posited that although the demand pattern in that section of the country was clearly very weak, the transportation savings might accrue to the extent of $1.6 million and, therefore, open the Lexington depot by itself.

There were two other clusters which had depots some distance apart but which were not divided any further. These were the Southern California cluster and the Georgia/Florida cluster. The reason for leaving these two original clusters intact when going to the 15-cluster structure was that both clusters had proven very strong in earlier model runs. The location economics being evaluated by the optimization model indicated heavy demand concentrations in both regions, and the capacities of all depots in each cluster were required to satisfy that demand. In sum, these two clusters showed no economic weakness; they did not pose a problem which had to be focused on at the next logical stage of macro-level analysis. It was recognized that at some later point in the analytical process, those two clusters would have to be looked at for potential support pattern assignments by depot.

Figure 5-2 contains a list of which depots were assigned to which clusters in the 15-cluster structure and a map showing the locations of the 15-clusters.

The second step in preparation for the next stage of the macro-analysis was the editing of certain product assignments to certain clusters. The 12-cluster analysis used a 100 percent dense problem structure; every product-bundle combination was allowed at every cluster. The editing process was merely recognition that such full range capability for all clusters was unreasonable because of existing depot configurations, especially maintenance capabilities. Of 405 (15-clusters X 27 bundles) possible cluster-bundle combinations in a full-dense 15-cluster structure, 108 cluster-bundle combinations were eliminated or not permitted in the model analysis. These eliminations were predominantly reparable products which were disallowed from clusters where no maintenance capability existed for such products. See Appendix E, Section 3, for a complete list of all cluster-bundle exclusions.

Before proceeding to the results of the 15-cluster modeling analysis, one further aspect of problem representation warrants discussion. The maintenance interface penalty was initially posited for 350 outbound links. For 350 depot-product-customer combinations, the maintenance interface penalty was invoked if the model chose to place one of the

Figure 5-2. <u>Fifteen Depot-Clusters</u>

Cluster Number	Depot Name	Cluster Number	Depot Name
1	Sacramento AD	6	Lexington DA*
	Sharpe AD		
	NAS Alameda	7	Anniston AD
	NSC Oakland		
	Sacramento ALC	8	NAS Jacksonville
	DDTC Tracy		Warner Robins ALC
			MCLSBLANT Albany
2	NAS North Island		
	NSC San Diego	9	Corpus Christi AD
	MCLSBPAC Barstow		San Antonio ALC
3	NAS Norfolk	10	Red River AD
	NSC Norfolk		
	MCAS Cherry Point	11	Pueblo DA*
	DGSC Richmond		
		12	NSC Pearl Harbor
4	Letterkenny AD		
	New Cumberland AD	13	DDMT Memphis
	Tobyhanna AD		
	DDMP Mechanicsburg	14	Oklahoma City ALC
5	Tooele AD	15	DCSC Columbus
	Ogden ALC		DESC Dayton
	DDOU Ogden		

*Depot Activities

selected products at a depot other than the historical maintenance site where the product had been carried. As the analysis progressed, two sets of changes were made to the number of link combinations carrying the maintenance interface penalty. The first change eliminated the penalty for 27 depot-product-customer combinations at Lexington, Pueblo and Sharpe Army depots. This was done in recognition of the elimination of certain maintenance missions at those three depots between the time the data were collected (FY 75) and the time the analysis was being done. It made no logistics sense to enforce a maintenance interface penalty for activities that no longer had certain maintenance missions. The second set of changes, made almost immediately after the first set, reduced the number of depot-product-customer combinations subject to the maintenance interface penalty from 323 to 206. The reason for this reduction was to constrain the effect of the maintenance interface penalty to only those reparable products for which the collocated maintenance activity had an assigned maintenance responsibility. For example, if a given collocated maintenance activity had a mission to repair aircraft engines but not a mission to repair other aircraft components, that depot was allowed the maintenance interface penalty only for the engines. See Appendix E, Section 1, for the listing of those 206 depot-product-customer combinations.

With the changes to the DODMDS problem representation described in the preceding paragraphs, 15-cluster model runs were initiated. Two basic strategies were executed: (1) all 15-clusters locked open, and (2) 15-cluster runs where the model could close clusters based on the transportation cost trade-off with depot fixed costs.

3. Fifteen-Cluster Results.

Some 150 optimization model runs had been completed at the point 15-cluster analysis began. Based on the cumulative insights and understanding of problem representations that had been gained through the earlier runs, convergence was accomplished very quickly with the 15-cluster structure. Stable results were achieved which held up under a wide range of conditions.

Table 5-4 shows the results of two optimization model runs compared to the modeling Baseline. The run (#179) in which all 15-clusters were locked into solution shows a reduction in cost of $75 million over the Baseline System. This reduction was attributable solely to materiel flow realignments from the Baseline since the full Baseline depot costs were borne. Consequently, the $75 million saving represents only transportation cost reductions. The run (#156) in which the clusters were eligible for closing by the model resulted in a total operating system cost of $890 million, $114 million below the modeling Baseline. The additional savings over the locked-open strategy were attributable to the fixed costs of the four clusters which the model closed (Ohio, Lexington, Pueblo and Memphis). This latter modeling result (Run #156) was defined to be the "Objective System" because it was to serve as a reference point for all further analysis.

In further explanation of Table 5-4, the Baseline column represents the wholesale materiel in terms of weighted throughput which went out of each cluster in the modeling Baseline. Weighted throughput (WTP), described fully in Appendix D-3, is a composite workload variable which incorporates lines, weight, cube, and dollar value of wholesale materiel issues. The remaining two columns in the table show what percentage of the base year throughput the model allocated through each cluster under the locked open case and the Objective System case. Because of the very large increases at Pearl Harbor and Anniston, it was anticipated that capacity problems might exist with the Objective System which would require further analysis to confirm and resolve.

Clarification is necessary regarding the apparent higher cost of the Objective System ($890 million) than the 12-cluster results discussed on page 173 ($886 million). The cluster-bundle exclusions (discussed in Appendix E, Section 3) were imposed at the time of transitioning to 15-cluster analysis.

Table 5-4. Fifteen Cluster Model Results - Weighted Throughput (WTP)

	WTP (Millions)	Percent of Baseline	
	Baseline	15 Locked Open	Objective
No. California	56.5	104	104
So. California	12.0	187	188
Virginia	31.6	148	150
Pennsylvania	50.7	100	105
Utah	37.4	45	47
Lexington	3.0	137	0
Anniston	9.1	162	259*
Georgia/Florida	14.5	145	148
Texas	20.6	78	78
Red River	11.3	148	179
Pueblo	2.8	139	0
Pearl Harbor	0.4	325	325*
Memphis	21.0	38	0
Oklahoma City	19.6	120	140
Ohio	19.4	26	0
Total	309.9		
Total System Cost	$1,004M	$929M	$890M

*Potential capacity problems; various options for handling. See "Load Balancing," page 5.59.

These initial exclusions increased system costs. To permit comparison, a 12-cluster run (#154) was made with the same set of exclusions imposed for the 15-cluster analysis. The total system cost was $893.5 million, $3.2 million higher than the Objective System.

Table 5-5 shows the comparison between the Objective System and the Baseline System in terms of how the potential savings were distributed.

Table 5-5. Cost Analysis ($ Millions)

Cost Elements	Baseline	Objective	Difference
Inbound Transportation.	242.9	258.8	+15.9
Outbound Transportation.	331.2	244.3	-86.9*
Depot Fixed/ Variable	430.3	387.2	-43.1
Total System	1004.4	890.4	-114.0

*Overstated by $15-20 million in model results because of reparable shifts and local delivery within clusters. See page 187.

The depot fixed costs shown in Table 5-5 were distributed in the Baseline and Objective Systems as follows:

Table 5-6. Depot Fixed Costs by Cluster Baseline Vs. Objective System

Cluster Number	Cluster Name	Baseline ($ Mil)	Objective System ($ Mil)
1	No. California	24.3	16.3
2	So. California	7.7	7.7
3	Virginia	14.2	14.2
4	Pennsylvania	14.8	14.8
5	Utah	14.8	4.9
6	Lexington	1.6	.0
7	Anniston	2.2	2.2
8	Georgia/Florida	6.3	6.3
9	Texas	3.3	3.3
10	Red River	4.2	4.2
11	Pueblo	1.8	.0
12	Pearl Harbor	.5	.5
13	Memphis	7.1	.0
14	Oklahoma City	2.9	2.9
15	Ohio	14.7	.0
	TOTAL	120.4	77.3

From Table 5-6 it can be seen how the Objective System achieved $43.1 million in depot fixed costs savings over the Baseline System. All of the depot costs in the four closed clusters were eliminated as were one-third of the baseline costs in Northern California and two-thirds of the baseline costs in Utah. As was true with the 12-cluster analysis, these two clusters had to be reduced in cost to be economically favorable, thus confirming the excess capacity found there in the 12-cluster analysis. Finally, Lexington did not enter the Objective System solution as a separate cluster with a fixed charge of only $1.6 million.

Having observed the overall materiel flow changes from the Baseline to the Objective System, the next step was to identify the changes by general type of materiel. To perform this analysis, three broad categories of materiel were defined, and the flow changes were classified into one of the three following categories:

- Reparable - All materiel in the 23 products coded as reparable.

- Personnel Support Consumable - Those products specifically oriented to personnel support versus hardware maintenance support. Included subsistence, DICOMSS, clothing, and medical products.

- Other Consumable - All other consumable coded product groups remaining after personnel consumables identified.

Table 5-7 shows the percentage increase or decrease in Weighted Throughput for each cluster between the Baseline and the Objective System. It also shows how that increase or decrease was distributed among the three materiel categories defined above.

Table 5-7. Objective System - Variations from Baseline by Materiel Type (Weighted Throughput)

Cluster	Total Millions Baseline	% Change Reparable	Pers Con	Other Con	Overall
No. California	56.6	+1.	-2.	+5.	+4.
So. California	12.0	+16.	+13.	+59.	+88.
Virginia	31.6	+11.	+38.	0.	+50.
Pennsylvania	50.7	+7.	-22.	+20.	+5.
Utah	37.4	-8.	-5.	-37.	-53.
Lexington	3.0	-77.	0.	-23.	-100.
Anniston	9.1	0.	+74.	+85.	+159.
Georgia/Florida	14.5	-8.	+23.	+45.	+48.
Texas	20.6	-2[illegible].	+5.	-3.	-22.
Red River	11.2	+40.	+10.	+28.	+79.
Peublo	2.8	-75.	0.	-25.	-100.
Pearl Harbor	0.4	+5.	-38.	+258.	+225.
Memphis	21.0	-4.	-47.	-49.	-100.
Oklahoma City	19.6	+5.	+7.	+28.	+40.
Ohio	19.4	-4.	-2.	-94.	-100.

From analysis of the flow changes shown in Table 5-7, two major insights were gained: (1) that the largest flow shifts were in the consumable categories, and (2) that further link constraints were necessary for reparable materiel. It was discovered, for example, that the model was assigning aircraft engine support for Air Force customers to clusters which did not perform Air Force engine repair. This accounted for the increase in reparable materiel assignments to the Southern California and Virginia clusters and the decrease in the Texas cluster. Because of product aggregation, the model had no way of identifying an Air Force engine from a Navy engine. Since both the Southern California and Virginia clusters had aircraft engine repair capability (Navy), those two clusters were permitted to supply aircraft engines in the initial editing described in the previous section. Air Force customers near these two clusters were assigned by the model to be supplied by these clusters. It was known, however, that in reality Air Force engine repair is performed in the Texas and Oklahoma City clusters.

Based on these insights from the macro-level analysis it was apparent that subsequent off-line analysis would be required to more realistically reflect reparable product assignments to clusters which actually have the repair capability for specific types of equipment.

4. The Objective System Vs. Macro-Criteria

The two tiers of criteria for evaluating any proposed DODMDS structure were described in Section B of this chapter. The generation and analysis of 156 model runs had resulted in an 11-cluster Objective System which was considered to be a very stable macro-level solution to the problem posed to the DODMDS study: What should the DODMDS of the future be? The remaining tasks for completing the macro-level analysis were to evaluate the Objective System against the macro-level criteria and to perform critical sensitivity analyses on the Objective System.

Figure 5-3 shows the results of evaluating the Objective System against the macro-level criteria, or "measures-of-merit."

Figure 5-3. Eleven-Cluster Objective System

Criteria	Evaluation
System Cost	Saves about $100 million annually over modeling Baseline System
Responsiveness	Improved
Storage Capacity	Adequate
Vulnerability	No change
Change Required	Asset positioning (consumables)

Against each criterion it can be seen that the Objective System measured up very well. While the system cost savings indicated by a comparison between the Baseline and Objective Systems were overstated by several million dollars due to problem representation and aggregation in the modeling process (discussed in paragraph E.6), there were clearly significant savings reflected in the Objective System. Further, it was estimated that energy consumption in the transportation system should decrease by about 10 percent, the level of savings in transportation costs achieved with the Objective System.

Materiel was being positioned closer to customers in the Objective System. If this would not improve customer service time, it certainly should not degrade it. However, evaluation of customer response was one of the major reasons for using the simulation model, and it will be dealt with explicitly in Section F of this chapter. The major point to be made here is that there was no reason whatever to conclude that customer responsiveness would not improve with the Objective System.

Relative to storage capacity, the Objective System was essentially sound. As Table 5-8 shows, there was more than adequate storage capacity to handle the materiel stockage requirements implied by the materiel assignments of the Objective System. Anniston and Red River did emerge here as potential problems to be dealt with in subsequent analysis. (Table 5-20, page 221, shows the results of this subsequent analysis.)

With respect to vulnerability to attack, civil disorder, strike, or natural disaster, the Objective System changed little from the Baseline System. Reparable materiel remained essentially where it was in the Baseline, and although there were fewer depots, most consumable materiel was distributed more widely among several depots than in the Baseline System. Vulnerability would be of greatest concern if substantial concentration of key materiel were suggested. This was not the case with the Objective System.

Table 5-8. Storage Capacity (000 Ft^3)

Clusters	Baseline Available*	Baseline % Used	Objective % Used
No. California	144,618	38	31
So. California	50,348	30	35
Virginia	108,026	24	36
Pennsylvania	138,698	48	34
Utah	74,187	89	20
Lexington	19,808	11	0
Anniston	21,428	40	111**
Georgia/Florida	60,542	23	25
Texas	34,277	44	26
Red River	19,669	81	109**
Pueblo	24,162	18	0
Pearl Harbor	5,559	5	32
Memphis	36,306	56	0
Oklahoma City	19,943	35	79
Ohio	27,663	37	0
TOTAL	785,234	32	37

*Source: Chapter 4, App D-3 (Baseline storage includes space for both wholesale and retail materiel.)
**Potential storage problem; various options to handle. See "Load Balancing," page 215.

Finally, in terms of system change, there clearly must be some change because of materiel support mission realignments. However, repositioning of materiel involves primarily consumable materiel of either a very general nature which any depot can handle, or of a nature similar to what suggested depots are already handling. Although joint stockage is not currently as widespread as the Objective System entails, there is considerable experience in the DODMDS with joint stockage. The Navy has carried DLA-managed materiel in its depots for 16 years, and the Army has recently moved in the same direction with DLA materiel at New Cumberland.

5. Sensitivity Analysis of the Eleven-Cluster Objective System

a. Background

Sensitivity analysis involved a series of model runs to test the sensitivity of the 11-cluster Objective System structure to several variables, i.e. demand shifts, changes to demand levels, wage rate differentials, transportation rate changes, shifts in sources of supply, and an evaluation of the mobilization workload projected by the mobilization workload factors. It was found, in each instance, the Objective System structure was not significantly altered as a result of substantial changes in these key variables.

b. Sensitivity Areas Examined

A synopsis of the major sensitivity scenarios tested follows:

(1) Scenario #1 - Demand Shift. Army's 2nd Infantry Division moved from South Korea to CONUS and all former Southeast Asia (SEA) customer demand (Foreign Military Sales, etc) shifted to Middle East.

(2) Scenario #2 - Demand Shift. Same as Scenario #1 but additionally shifted one-half of all US Forces in Northern Europe to CONUS.

(3) Scenario #3 - Transportation Rate Increase. Increased rates by 50 percent; tested impact of a much higher inflation in transportation costs than other costs.

(4) Scenario #4 - Transportation Rate Decrease. Reduced outbound transportation rates by 40 percent; tested for impact of Section 22 rates.

(5) Scenario #5 - Procurement Source Supply Shift. Moved on-half of new procurement availability from supply sources in the Northeast USA to Florida as a supply source.

(6) Scenario #6 - Mobilization. Mobilization workload factors by DODMDS product group applied to demand.

(7) Scenario #7 - Decrease in Demand. Demand, systemwide, reduced by 20 percent.

(8) Scenario #8 - Local Area Wage Rate Differentials. Adjusted standard variable costs to reflect wage differentials by geographic area for blue-collar workers.

(9) Scenario #9 - Revised Fixed Cost. Computed revised set of depot fixed costs to reflect different allocation assumptions.

(10) Scenario #10 - Maintenance Shifts. Moved demand and supply associated with selected maintenance depots to other depot maintenance locations.

c. Sensitivity Analysis Results

An overview of the results of sensitivity analysis scenarios tested against the eleven-cluster Objective System is shown in Figure 5-4. Succeeding paragraphs contain a scenario-by-scenario narrative analysis.

d. Demand Shifts (Scenarios #1 and 2)

(1) Scenario Objectives/Sources. The purpose of the "Demand Shift" sensitivity analysis runs was to test the sensitivity of the 11-cluster Objective System to several "What If" scenarios involving (1) US Force withdrawals from Korea and Northern Europe to CONUS and (2) shift in Security Assistance Program (SAP) from SEA customers to the Middle East. The proposed CONUS sites for relocated demand were based on a combination of "in-house" expertise of DODMDS study group representatives, interviews with Army Corps of Engineer (COE) personnel, and review of a three-volume COE Study (FOUO), dated February 1977, entitled: "Review of Division and Brigade Stationing." (A synopsis of 15 Army/ Congressional "What If" interrelated excursions encompassing 27 restationing propositions is contained in Figure 15, CONUS Restationing Prospects, page 40, Volume III of COE Study.)

Figure 5-4. Overview of Sensitivity Analysis Results

Sensitivity Scenario	Eleven-cluster Structure	Depot System Capacity
1	No Change	Adequate
2	No Change	Adequate
3	Two Clusters, Pueblo & Lexington, opened due to significance of transportation savings through serving local region customers	Excess
4	No Change	Adequate
5	No Change	Adequate
6	No Change	Adequate
7	No Change	Excess
8	No Change	Adequate
9	Two clusters, Pueblo & Lexington, opened due to the very slim margin of trade-off between fixed costs and transportation costs for these two clusters	Excess
10	No Change	Adequate

(2) Methodology for Demand Shift Scenarios Implementation. "Demand Shift" versions of the Mini-Shipment III File were created by shifting demands between customers across all quantitative fields (i.e., extended weight, price, cube, and number of shipments) by product, in support of Scenarios #1 and 2 as follows:

(a) Scenario #1 (Asia Shifts).

(1) Korea Army (Customer #531). All demands were shifted to Fort Bliss, Texas (Customer #378).

(2) China Sea, China Sea Army and SEA SAP (Customer Numbers 504, 532 and 604). All demands were shifted to Persian Gulf SAP (Customer #610).

(b) Scenario #2 (Above Asia Shifts plus Northern Europe Shift).

(1) Northern Europe Army (Customer #544). One-fourth of demand was shifted to Fort Benning, GA (Customer #334) and an additional one-fourth to Fort Irwin, CA (encompassed by MCLSBPAC, Customer #194).

(2) Northern Europe (Customer #501). One-fourth of demand was shifted to Eglin AFB, FL (Customer #234) and an additional one-fourth to Bergstrom AFB, TX (Customer #279).

(3) British Isles (Customer #502). One-half of demand was shifted to Langley AFB, VA (Customer #222).

(c) DICOMSS. As Product 895 (DICOMSS) is supplied by DODMDS depots to only overseas Army and Air Force customers, that portion of overseas demand for Product 895 eligible for movement to CONUS locations under above rules was eliminated during creation of the "Demand Shift" versions of the Mini-Shipment III File.

(d) Customer Return Shifts. Any shifts in demand location must be accompanied by corresponding shifts in non-procurement receipts to reflect new customer locations as sources of supply for materiel returns. Accordingly, "Customer Returns Shift" versions of the Supply Source Allocations File were created shifting supply source percentages, by product, between customer regions using the regions and rates expressed in subparagraphs (a) and (b) above for the two Demand Shift scenarios.

(3) Demand Shift Scenarios Results.

(a) Demand Shift Scenario #1 and Demand Shift Scenario #2 both resulted in no structural change to the 11-cluster Objective System solution. Workload shifts (in terms of hundredweight throughput) among the 11-clusters as a result of the Scenario #1 and Scenario #2 demand shifts are shown in Tables 5-9 and 5-10. (Overall system throughput decreases of 0.1 percent and 4.5 percent in Scenarios #1 and #2 respectively resulted from elimination of DICOMSS

Table 5-9. Demand Shift Sensitivity Analysis Scenario #1 (Run #161)

Cluster	Throughput (Millions/CWT) Objective System	Scenario #1	% Change
No. California	5.64	4.28	-24.1
So. California	1.91	1.83	- 4.2
Virginia	6.20	6.25	+ 0.8
Pennsylvania	5.02	6.05	+20.5
Utah	1.73	1.76	+ 1.7
Anniston	3.52	3.50	- 0.6
Georgia/Florida	1.33	1.34	+ 0.8
Texas	0.89	0.89	0
Red River	2.80	2.85	+ 1.8
Pearl Harbor	0.17	0.19	+11.8
Oklahoma City	1.83	2.06	+12.6
Total Throughput	31.04	31.00	- 0.1
System Cost	$890.4M	$870.9M	- 2.2%

Table 5-10. Demand Shift Sensitivity Analysis Scenario #2 (Run #162)

Cluster	Throughput (Millions/CWT) Objective System	Scenario #2	% Change
No. California	5.64	4.27	-24.3
So. California	1.91	2.08	+ 8.9
Virginia	6.20	4.89	-21.1
Pennsylvania	5.02	5.50	+ 9.6
Utah	1.73	1.76	+ 1.7
Anniston	3.52	3.82	+ 1.7
Georgia/Florida	1.33	1.40	+ 8.5
Texas	0.89	0.91	+ 2.2
Red River	2.80	2.74	- 2.1
Pearl Harbor	0.17	0.19	+11.8
Oklahoma City	1.83	2.07	+13.1
Total Throughput	31.04	29.63	- 4.5
System Cost	$890.4M	$836.4M	- 6.1%

support for overseas forces restationed in CONUS).

(b) Analysis of results of Demand Shift Scenarios #1 and 2 indicated a basic stability to the 11-cluster Objective System solution. Workload variances resulting from these scenarios were reasonably well balanced and did not dictate the need for inclusion/exclusion of additional clusters from the DODMDS Objective System solution.

e. Transportation Rate Changes (Scenarios #3 and #4)

(1) Scenario Objectives/Sources. The importance of transportation costs in the economic analysis of the DODMDS dictated sensitivity analyses of these costs. The necessity for sensitivity analyses was magnified by the increased rates predicted in the Commercial Transportation Forecast, Book 6, Section 5 and by the use of class rates in the development of transportation costs, as discussed in Book 6, Section 2.

(2) Methodology for Transportation Rate Change Scenarios.

(a) Scenario #3 (Transportation Rate Increases). Transportation rate increases were assumed for all modes of transportation. All rates produced by the computerized rate generator were factored up by 50 percent.

(b) Scenario #4 (Transportation Rate Decreases). The necessity for this scenario was recognized when class rates versus Section 22 rates were selected for modeling. This overstated transportation rates. The overstatement was projected at approximately 20 to 30 percent. In order to determine the effect of the overstatement, a 40 percent decrease was selected to determine if any impact would be noted. Since Section 22 is applicable to commercial surface modes, the 40 percent reduction was accomplished for the rates applicable to the first 15 freight conditions (Reference Book 6, Section 2). These included those freight conditions involved in truckload (TL), less than truckload (LTL) and rail (CL).

(3) Results of Transportation Rate Changes. The analyses of transportation rate decreases continued to verify the stable nature of the Objective System.

(a) Scenario #3 (Transportation Rate Increases).

(1) The 50 percent increase in all transportation rates confirmed the 11-cluster structure, but did open the Lexington and Pueblo clusters. An overall transportation cost increase of $246.5 million over the Objective System occurred. A total of 160 million pounds of throughput was allocated to the additional two clusters. Of this, 113.6 million pounds, distributed among 39 product groups, flowed through the Lexington cluster. The largest product group, in terms of weight, was 24.3 million pounds of subsistence. The customers' demand for subsistence supported by Lexington flowed to activities in Ohio, Indiana, Michigan, Minnesota, Missouri, and Kentucky. Pueblo throughput was 46.4 million pounds distributed among 12 product groups. As with Lexington, the largest single product group was subsistence (18.3 million pounds). Subsistence support from Pueblo flowed to activities in South Dakota, North Dakota, Wyoming, New Mexico and Colorado.

(2) Analysis of the results verified that the appearance of these two clusters was a result of the marginal trade-off of their fixed costs and transportation costs. During previous model analyses these facilities had consistently been on the margin of appearing in solutions. To determine the "regret" cost of not having Pueblo and Lexington as DODMDS wholesale depots if transportation costs should increase by 50 percent over other cost elements, an optimizer run was made with these two depots "locked out" of solution, thus conforming to the Objective System structure. The total system cost increased by only $1.3 million, .1 percent, over the sensitivity run (#158) where Pueblo and Lexington were in the solution set. The opening of these two new clusters resulted in excess capacity even in mobilization scenarios. For these reasons, the two locations were not presented in the alternatives. Future large increases in transportation costs, relative to other costs, could result in these locations becoming economically attractive to distribute certain products.

(b) Scenario #4 (Transportation Rate Decrease). The rate decrease scenario resulted in no change to the composition of the 11-cluster Objective System. Anniston and Pennsylvania throughput (CWT) increased by 10 and 7 percent respectively. Virginia and Pearl Harbor clusters exhibited minimal (less than 1 percent) changes in throughput (CWT). All others exhibited a decrease in throughput (CWT) which ranged from a low of 1 percent for the Red River cluster to a high of 13 percent for the Texas cluster. The total transportation cost reflected a 6 percent decrease.

f. Procurement Source Supply Shifts (Scenario #5)

(1) Scenario Objective. In this scenario the twofold objective was (1) to generally test sensitivity of the optimization model results in the 11-cluster Objective System to major shifts in procurement sources and (2) to specifically test the Pennsylvania and Georgia/Florida clusters for stability under conditions of significant procurement source shifts from Northeastern to Southeastern CONUS.

(2) Methodology for Implementation of Supply Shift Scenario. As depicted in Figure 3-7, page 80, of Chapter 3, 37 percent, 30.4 percent, and 34.5 percent of DOD procurement receipts by transaction, weight, and dollar value measures respectively, were obtained from procurement sources located in Postal ZIP Areas "0" and "1" in Northeastern CONUS. (These two regions encompassed 46 of the 142 procurement zones established under the materiel source aggregation strategy delineated in Appendix D-2.) For this scenario a "Procurement Source Supply Shift" version of the Supply Source Allocations File was created reducing procurement source availability for the 46 zones in Postal ZIP Areas "0" and "1" to 50 percent of previous values. The "withdrawn" procurement source availability was then reassigned within Postal ZIP Area "3" in Southeastern CONUS to the Miami, Florida procurement zone (3-digit Node ZIP 331).

(3) Procurement Source Supply Shift Scenario Results. The Supply Shift scenario resulted in no

structural change to the 11-cluster Objective System solution. Workload shifts among the 11-clusters as a result of the Supply Shift scenario run are shown in Table 5-11:

Table 5-11. Supply Shift Sensitivity Analysis Scenario #5 (Run #160)

Cluster	Throughput (Millions/CWT) Objective System	Scenario #5	% Change
No. California	5.64	5.64	0
So. California	1.91	1.91	0
Virginia	6.20	6.28	+ 1.3
Pennsylvania	5.02	4.72	- 6.0
Utah	1.73	1.71	- 1.2
Anniston	3.52	3.72	+ 5.7
Georgia/Florida	1.33	1.50	+12.8
Texas	0.89	0.91	+ 2.2
Red River	2.80	2.66	+ 5.0
Pearl Harbor	0.17	0.19	+11.8
Oklahoma City	1.83	1.80	- 1.6
Total Throughput	31.04	31.04	0
System Cost	$890.4M	$892.1M	+ 0.2%

(4) Analysis of Scenario Results. Results of this scenario indicated that the 11-cluster Objective System was basically stable and relatively insensitive to major shifts in procurement sources. As was the case for demand shifts, workload variances from this run were reasonably well-balanced and did not dictate the need for inclusion/exclusion of additional clusters from the 11-cluster Objective System solution.

g. Mobilization (Scenario #6)

(1) Mobilization Scenario Methodology. The method used to develop mobilization workload data is discussed in Volume II, Chapter 2. This rationale provided for the use of factors to represent estimated workload increase for each product group under

mobilization/wartime conditions. Using these factors, each customer-product-depot link in the Mini-Shipment III File was increased by the prescribed factor in all measures: extended weight, price, cube, and number of shipments. The resulting demands were used in the optimization model to determine whether depot workloads would change in an unbalanced way during mobilization/war. In other words, in the system proposed by the study group, would Depot A have a tenfold increase in workload during mobilization while Depot B had a twofold increase? If so, should consideration be given to realigning peacetime depot missions in order to support potential mobilization workload?

(2) Mobilization Scenario Results. The mobilization run resulted in an annualized system workload which was 352 percent of the Baseline System in weighted throughput. On a CWT basis, workload was 9.4 billion pounds, or 304 percent of baseline. On a cluster basis, workload increased by an amount between 161 percent and 278 percent. Stated another way, mobilization workload was roughly three to four times the peacetime workload in each cluster. Specific increases for each cluster in the 11-cluster Objective System were as follows in Table 5-12.

Table 5-12. Workload Increase In Mobilization (Run #168)

Cluster	Weighted Throughput Percentage Increase	Hundredweight Percentage Increase
No. California	261	223
So. California	236	211
Virginia	224	187
Pennsylvania	278	228
Utah	240	212
Anniston	275	197
Georgia/Florida	243	215
Texas	186	178
Red River	185	161
Pearl Harbor	208	200
Oklahoma City	208	211

(3) Analysis of Mobilization Scenario Results. The mobilization workload variance indicated by the optimization model was considered to be well balanced among the depot clusters of the Objective System and did not in itself dictate a need for an adjustment to depot loadings based solely on mobilization considerations. A determination of whether the Objective System could support mobilization issue requirements on a timely basis was tested by the simulation model. An analysis of simulation results is contained in Section F.3 of this chapter.

h. Decrease in Demand (Scenario #7)

(1) Scenario Objective. DOD customer demand on the DODMDS could decrease for several reasons. Should force reductions occur at some time in the future, less total demand would be expected than was experienced in the base year. Although such reductions are not anticipated, the impact they would have on the Objective System structure should be evaluated. Second, should DOD move to a distribution system policy of more direct delivery of materiel to customers, bypassing the depot system, the impact of that change should be estimated. Finally, if more materiel were to be supplied to DOD customers from local commercial sources than has been historically provided from such commercial sources, the effects on the depot system should also be evaluated.

(2) Methodology for Implementing Decreased Demand Scenario. The customer demand file was factored downward by 20 percent. The demand of each customer for each product was entered into the model at 80 percent of what it actually was in the base year in terms of hundredweight (CWT).

(3) Scenario Results. With 20 percent less demand placed on the Objective System, two of the eleven clusters did not remain in solution. The two clusters which dropped out were Virginia and Southern California. Since both were multiple depot clusters, it was assumed that the model would retain some portion of the two clusters at reduced fixed costs. This was in fact found to be the case. When the fixed

cost of each of the two clusters was reduced to 50 percent of their actual baseline value, both clusters were retained in the solution.

(4) Analysis of Scenario Results. With total system demand reduced by 20 percent, less system capacity was required to handle the workload than with the total baseline workload modeled in the Objective System. No cluster completely dropped out of the 11-cluster Objective System, but the Virginia and Southern California clusters had to be reduced in cost/capacity to remain in the solution. Since these two clusters had been retained in the Objective System at their full Baseline system fixed costs, it was not unexpected that a significant reduction in demand would result in their having excess capacity in economic terms. Both clusters still retained strong support patterns once their fixed costs/capacity were brought into line with the demand requirements. To determine the "regret" cost of retaining Virginia and Southern California clusters at their full fixed cost if system demand should decrease by 20 percent, an optimizer run (#255) was made with these two clusters "locked in" the solution, thus conforming to the Objective System Structure. The total system cost increased by only $1.2 million, .2 percent, over the sensitivity run (#157) where the Virginia and Southern California clusters were dropped from the solution set. The conclusion drawn from these findings was that if total system demand should, in fact, be decreased by as much as 20 percent at some point in the future, excess depot capacity would exist in these two clusters which would warrant considering closure of one depot in each cluster.

i. Local Area Wage Rate Differentials (Scenario #8)

(1) Scenario Objective. Depot costs resulting from staffing differences are in large part controllable by Service/DLA management policies. The use of standard depot variable cost for modeling analysis made the explicit assumption that there were no consistent, quantifiable differences in depot management efficiencies. This was a reasonable assumption given the diversity of commodity and mission assignments at individual depots in the DODMDS study base year.

However, there are quantifiable differences in depot costs related to wage grade pay scales for specific geographic locations which are beyond direct Service/DLA control. These differences may change over time as the nation's economy evolves, but it was assumed that the 1975 relative differences will persist through the DODMDS planning period.

(2) Methodology for Implementing Wage Grade Differential Scenario. To test the sensitivity of the Objective System structure and cost to wage grade differences, depot multipliers reflecting DOD Wage Fixing Authority rates for the 15 clusters were developed. See Appendix D-3, Wage Grade Index Multiplier.

The multipliers used for each cluster were as follows:

Table 5-13. Cluster Wage Grade Multipliers

No.	Name	Wage Grade Index Multiplier
1	No. California	1.07
2	So. California	1.01
3	Virginia	.97
4	Pennsylvania	.97
5	Utah	1.01
6	Lexington	.96
7	Anniston	.95
8	Georgia/Florida	.98
9	Texas	.98
10	Red River	.95
11	Pueblo	.99
12	Pearl Harbor	1.14
13	Memphis	.98
14	Oklahoma City	.99
15	Ohio	1.01

(3) Scenario Results. Differences ($ millions) in system cost by cost component between the Objective System using standard variable cost and a system reflecting wage grade index multipliers are summarized as follows:

	Depot Variable Cost	Depot Fixed Cost	Inbound Transp.	Outbound Transp.	Total System Cost
Objective System	309.9	77.3	258.8	244.3	890.3
Wage Grade Index Scenario	307.1	77.3	257.9	245.8	888.1
Difference	- 2.8	0	-.9	+ 1.5	- 2.2

With only NSC Pearl Harbor constrained in terms of capacity, and all clusters free to open or close, the optimizer exploited the lowest possible depot multipliers and produced a net savings of $2.2 million. Shifts of workload from the Objective System (OBJ) to the wage grade index (WGI) multiplier system were as follows:

Table 5-14. Workload Shifts from Objective System to Wage Grade Index System (Scenario #8) Throughput (Millions/CWT)

Cluster	OBJ	WGI	Change	% Change
1	5.6	5.1	- .5	- 9
2	1.9	2.1	+ .2	+11
3	6.2	6.2	0	0
4	5.0	5.0	0	0
5	1.7	1.8	+ .1	+ 8
6	0	0	-	-
7	3.5	3.7	+ .2	+ 6
8	1.3	1.2	- .1	- 8
9	.9	.9	0	0
10	2.8	3.2	+ .4	+14
11	0	0	-	-
12	.2	.2	0	0
13	0	0	-	-
14	1.8	1.5	- .3	-17
15	0	0	-	-

(4) Analysis of Scenario Results. As expected, the clusters which increased in throughput were those which had lower multipliers than the proximate clusters showing a decline. However, the shifts did not produce a structural change. The total system cost was only .2 percent lower with the wage grade differentials than the Objective System using standard variable costs. Once again, the Objective System structure was found to be stable within the tested range of an important input variable.

j. Revised Fixed Cost (Scenario #9)

(1) Scenario Objective and Methodology. Fixed costs used to derive the Objective System were based on Services/DLA reported installation services costs for each depot. As a result, the means for allocating installation services costs varied by Service/Agency and, in some cases, by depot. In order to test the sensitivity of the 11-cluster Objective System solution to variances in the methods of allocation, two components of fixed costs, viz., (facility and management services), were recomputed using DODMDS derived population ratios for each depot. See Appendix D-3, Section 2, for discussion of how the allocations were revised and Appendix D-3, Exhibit 2-3 for both the original costs and the DODMDS derived costs by function. The split of the latter costs between wholesale and retail is shown in Table 5-15.

(2) Scenario Results. The model results using DODMDS population-based fixed costs when compared to the Objective System were as follows ($ millions):

	Depot Variable Cost	Depot Fixed Cost	Transportation Cost	Total
Objective System	309.9	77.3	503.1	890.3
Revised FC Scenario	309.9	70.6	500.0	880.5
Difference	0	- 6.7	- 3.1	- 9.8

Table 5-15. Wholesale/Retail Split ($ Thousands)

(1) Depot #	(2) Depot	(3) Revised Total Fixed Cost	(4) Wholesale Line Items Shipped %	(5) Wholesale Fixed Cost Lines(3x4)	(6) Wholesale CWT Shipped %	(7) Wholesale Fixed Cost CWT (3x6)	(8) Avg of Cols 5 and 7
01	ANAD	3618	26	941	81	2931	1936
02	CCAD	1621	12	195	49	794	495
03	LEAD	4207	61	2566	74	3113	2840
04	LBDA	2815	54	1520	41	1154	1337
05	NCAD	4182	81	3387	84	3513	3450
06	PUDA	2235	43	961	81	1810	1386
07	RRAD	5840	74	3354	45	2040	2697
08	SAAD	4533	65	2946	60	2720	2833
09	SHAD	3073	59	1813	70	2151	1982
10	TOAD	3922	55	2157	63	2471	2314
11	TEAD	4437	52	2307	83	3683	2995
12	NASALA	2684	71	1906	76	2040	1973
13	NASJAX	1617	65	1051	50	809	930
14	NASNOR	1155	88	1016	81	936	976
15	NASNI	1437	80	1148	67	961	1055
16	NSCNOR	7215	77	5556	59	4257	4907
17	NSCOAK	7519	92	6917	88	6617	6767
18	NSCPH	2095	23	482	28	587	535
19	NSCSD	3303	21	694	55	1817	1256
20	MCASCP	1344	56	753	61	820	787
21	OCALC	5308	57	3026	62	3291	3159
22	OOALC	4728	44	2080	49	2790	2435
23	SMALC	4409	34	1499	49	2160	1830
24	SAALC	5101	59	3010	54	2755	2883
25	WRALC	4500	49	2205	57	2565	2385
26	MCLSBLANT	6762	34	2299	78	5274	3787
27	MCLSBPAC	5852	78	4565	87	5091	4828
28	DCSC	6921	100	6921	100	6921	6921
29	DDMP	3845	100	3845	100	3845	3845
30	DDMT	6061	100	6061	100	6061	6061
31	DDOU	7273	100	7273	100	7273	7273
32	DDTC	5735	100	5735	100	5735	5735
33	DESC	3987	100	3987	100	3987	3987
34	DGSC	4475	100	4475	100	4475	4475

Reductions in fixed costs for Lexington from $1.6 million to $1.3 million, and for Pueblo, from $1.8 million to $1.4 million, were sufficient to bring both depots into solution.

Subsequent modeling analysis revealed that Lexington and Pueblo came into solution at fixed costs as high as $1.5 million and $1.6 million respectively, which indicated that differences of approximately $.2 million in fixed costs produced structural changes for these two depots.

(3) Analysis of Scenario Results. Fixed costs for Lexington and Pueblo were so close to transportation differentials that very small changes in fixed costs brought them in and out of solution in a predictable way. The conclusion was that using a revised allocation method for computing depot fixed costs had no impact on system structure beyond the effects on Pueblo and Lexington. It was already known from the sensitivity analysis on increased transportation rates that the trade-offs between depot fixed costs and transportation differentials for these two clusters were on a thin margin. The sensitivity analysis on revised fixed cost allocation procedures merely reconfirmed this earlier finding.

k. Maintenance Shifts (Scenario #10)

(1) Scenario Objective. Throughout this report the importance of depot level maintenance on the wholesale distribution system is emphasized. The large amount of total demand imposed on the distribution system by maintenance activities, coupled with the reverse flows of repaired materiel back to the distribution facilities from maintenance, had a strong effect on the structure of the Objective System. This effect was accentuated by the maintenance interface penalty applied to the flows of reparable materiel between collocated maintenance and distribution depots. Because of the impact of depot maintenance on the structure of the wholesale distribution system, it was recognized that possible changes to depot maintenance missions should be evaluated. This evaluation took the form of a combined demand and supply shift sensitivity analysis.

It must be emphasized that the maintenance shift scenario was not based on any explicit analysis of maintenance missions by the DODMDS study group. Demand by, and repaired item returns from, certain collocated maintenance depots were arbitrarily moved to maintenance depots with similar missions in other geographic locations to evaluate the potential impact of such shifts.

(2) Methodology for Implementation of Maintenance Shift Scenario. Four collocated maintenance depots in three different clusters were selected for this analysis. The maintenance depots and their respective clusters were:

Collocated Maintenance Depot	Cluster
Corpus Christi Army Depot (CCAD)	Texas
Ogden Air Logistics Center (OOALC)	Utah
Naval Air Station, North Island (NASNI)	So. California
MCLSBPAC, Barstow (MCLSBPAC)	So. California

On the assumption that a future maintenance mission study resulted in relocation of depot level maintenance from these four sites, to other sites, what effect would such realignments have on the structure of the Objective System? To answer that question, other locations for performing the maintenance missions had to be selected. The following reassignments of maintenance missions were assumed:

Losing Maintenance Depot	Gaining Maintenance Depot	Gaining Cluster
CCAD	New Cumberland AD (NCAD)	Pennsylvania
OOALC	Sacramento ALC (SMALC) 1/3 Warner-Robins ALC (WRALC) 1/3 San Antonio ALC (SAALC) 1/3	No. California Georgia/Florida Texas
NASNI	Naval Air Station Alameda (NASAL)	No. California
MCLSBPAC	Anniston AD (ANAD) 1/2 Red River AD (RRAD) 1/2	Anniston Red River

Having selected the losing and gaining maintenance depots, the next step was to create special supply and demand files for processing by the optimization model. Demand by, and returns from, the losing maintenance customers were moved to the gaining maintenance depot locations. The historical cluster fixed costs and throughput capacities were used for all 15 clusters.

(3) Scenario Results. When the maintenance shift data were processed by the optimization model, the Objective System structure of 11 clusters was again confirmed. However, an adjustment had to be made to the fixed cost of the Southern California cluster to keep it in solution. In the first model run made, the historical fixed cost of $7.7 million for the entire Southern California cluster was used. With that level of fixed cost, and the reduced workload resulting from the maintenance shift, the Southern California cluster closed, leaving only ten clusters in solution. Therefore, a second model run was made which was identical to the first in all respects except that the fixed cost of the Southern California cluster was set at $3.0 million versus the original $7.7 million. The $3.0 million fixed cost level represented the sum of fixed costs for NSC San Diego and NAS North Island.

The wholesale distribution operations at MCLSBPAC were assumed to be eliminated with the maintenance shift, thus eliminating the MCLSBPAC portion of the Southern California cluster fixed costs.

With the reduced fixed cost for the Southern California cluster, the system structure was identical to the Objective System. However, the total system cost was 1 percent lower for the maintenance shift scenario than for the Objective System. Table 5-16 shows the comparative flows by cluster as well as the system cost differences.

Table 5-16. Comparison of Materiel Flows and System Costs for Maintenance Shift Scenario Vs. Objective System (Run #265)

Cluster Throughput (CWT/Millions)

Cluster	Objective System	Maint. Shift Scenario	% Change
1. No. California	5.64	6.13	+ 9
2. So. California	1.91	1.33	- 30
3. Virginia	6.20	6.18	0
4. Pennsylvania	5.02	5.09	+ 1
5. Utah	1.73	1.56	- 10
6. Lexington	0	0	--
7. Anniston	3.52	3.73	+ 6
8. Georgia/Florida	1.33	1.44	+ 8
9. Texas	0.89	0.85	- 4
10. Red River	2.80	2.73	- 3
11. Pueblo	0	0	--
12. Pearl Harbor	0.17	0.17	0
13. Memphis	0	0	--
14. Oklahoma City	1.83	1.83	0
15. Ohio	0	0	--
Total	31.04	31.04	0

System Costs ($ Millions)

	Objective System	Maint. Shift Scenario	% Change
Transportation	503.1	501.8	0
Facility	387.2	382.5	- 1
Total	890.3	884.3	- 1

(4) Analysis of Scenario Results. Although some adjustment in cluster fixed cost was required, the 11-cluster Objective System was found to be extremely stable where demand and supply patterns were changed to conform to a posited restructuring of the maintenance system.

Only the Southern California cluster required adjustment of its fixed cost level, and that adjustment still left two of the three original depots in the cluster. No new clusters entered solution. The total system cost decreased by $6 million from the Objective System, most of which was the $4.7 million fixed cost reduction in Southern California. Cluster throughput decreased, as expected, in those regions which lost maintenance missions, while cluster workload increased in gaining regions. However, only Southern California experienced a workload change from the Objective System of more than 10 percent.

On balance, the overall shifts in materiel flows were not extreme, nor was the 11-cluster structure altered, when hypothetical maintenance mission shifts were evaluated against the Objective System. The conclusion drawn from these results was that shifts which might occur in the future in depot level maintenance missions should have very little impact on the structure and cost of the Objective System. Should maintenance missions be realigned in the future, it is highly likely that gaining locations would be existing maintenance depots now performing similar types of maintenance. Since these are the very demand and supply locations which already exert substantial influence on the DODMDS, their influence would only be accentuated. Further, the locations of depots losing maintenance missions would appear to have sufficient residual demand from other customers in the area to sustain the wholesale distribution patterns implicit in the Objective System structure. Wholesale flows through the 11 clusters of the Objective System would be altered, but not by enough to change the basic 11-cluster structure itself.

6. SPLIT SYSTEM STRATEGY

a. Introduction

Although most of the DODMDS study group analysis focused on an integrated system strategy where consumable and reparable products could be jointly stocked in the same depot, a strategy was posited and tested with separate distribution system structures for consumables and reparables. To accomplish this, a series of optimization model runs was designed which permitted analysis of a separate system structure for consumable materiel.

This series of runs was predicated on the assumption that reparable materiel missions would remain unchanged from the Objective System, regardless of what was done with consumable materiel assignments. The objective was to determine if this separate system strategy yielded lower total system costs than the integrated system strategy.

b. Analytical Methodology

The analysis was divided into two phases. First, a series of four model runs was made in which those bundles containing only consumables were modeled. These consumable only bundles accounted for 1.9 billion pounds of the baseline total of 3.1 billion pounds, or about two-thirds of total weight in the base year. The consumable only bundles did not include all consumable products. About .2 billion pounds of weapon system related consumables (missile parts, aircraft parts, ship parts, etc.) which were in bundles with their parent reparable products were excluded. This set of runs was made at the discrete depot level with standard fixed costs of $1 million, $2 million, $3.5 million, and $5 million. Discrete depot analysis was done to determine if more than one depot would enter solution in any of the multiple depot clusters at a reasonable level of fixed costs. This provided a cross check on the magnitude of transportation cost distortions introduced by averaging transportation rates within clusters in the 15-cluster analyses. Standard fixed costs were used to get at the pure transportation economics with various levels of fixed costs which were not influenced by interdepot differences in fixed costs. In effect, the analytical approach asked: "Given the demands and supply sources for consumable products, how many depots and what locations are most economical at several levels of uniform fixed cost?"

By constructing the analysis this way, no geographic location was penalized in the transportation analysis just because the depot there happened to have had a relatively high fixed cost in the base year. However, by making the runs at successively higher levels of fixed cost, the model was forced to trade fixed costs against transportation costs. This first series of model runs was to provide specific locations where consumables should be located to achieve maximum transportation economies, given certain levels of fixed costs.

The second phase of the analysis was based on what was learned in the first phase about where consumables only should be located. It involved moving back into 15-cluster analysis with the full range of materiel, but allowing consumables to be stocked only at those locations identified in the first phase of the analysis. Comparing the results of this 15-cluster run with the Objective System permitted quantification of the differences between the separate system and integrated system strategies.

c. Results of the Analysis

(1) Phase One. Table 5-17 shows the locations of depots in solution for consumable only bundles at uniform fixed cost levels of $1 million, $2 million, $3.5 million, and $5 million.

Table 5-17. Optimization Model Results With Consumable Only Bundles Depot Locations in Solution

	Depot Fixed Cost			
	$1 Million	$2 Million	$3.5 Million	$5 Million
Anniston	Yes	Yes	No	No
Letterkenny	Yes	Yes	Yes	Yes
Red River	Yes	Yes	Yes	Yes
Tooele	Yes	Yes	No	No
Oakland	Yes	Yes	Yes	Yes
Jacksonville	Yes	No	No	No
San Diego	Yes	Yes	No	No
Norfolk	Yes	Yes	Yes	Yes
Pearl Harbor	Yes	No	No	No
Cherry Point	Yes	No	No	No
Oklahoma City	Yes	No	No	No
Sacramento ALC	Yes	No	No	No
San Antonio	Yes	No	No	No

At a fixed cost of $1 million, 13 depot locations were in solution. These conform precisely to the 11-clusters in the Objective System with the exception that the Northern California cluster had two locations represented (Sacramento and Oakland) and the Virginia cluster had two locations represented (Norfolk and Cherry Point). This meant that at a level of depot fixed costs of only $1 million, the model was discriminating among locations in those two clusters as a function of their distances from each other and their proximity to specific sets of customers.

However, at the $2 million depot fixed cost level, six of the locations present in the $1 million scenario dropped from solution, including Cherry Point and Sacramento. This provided a very good bound on the degree of distortion introduced into transportation costs by averaging rates within a cluster in the cluster analyses. In effect, the distortion in each of the two clusters in question (Virginia and Northern California) was less than $1 million. Otherwise, in the $2 million scenario, Cherry Point and Sacramento would have remained in solution to capitalize on the transportation economies that were being masked with cluster analysis. On this basis, it was estimated that overall transportation savings had been overstated by no more than $5 million by averaging rates within clusters in the cluster analysis.

At the $3.5 million depot fixed cost level, only four of the original thirteen depot locations remained in solution. This was significant in that $3.5 million was the average historical fixed cost for all 34 depots in the study. This meant that for general use consumable materiel, only four locations were economically viable at the average fixed cost of a DODMDS depot.

The results at the $5 million level were identical to the $3.5 million level, indicating that a somewhat stable point had been reached in the trade-off between transportation costs and depot fixed costs. It was these four locations, one West Coast (Oakland), one East Coast (Norfolk), one Northeast (Letterkenny), and one in the Central U.S. (Red River) that were used to enter the second phase of the analysis.

(2) Phase Two. In phase two, the consumable only bundles were allowed for stockage in the Virginia, Pennsylvania, Northern California, and Red River clusters. When the optimization model was run (#256) with this pattern of consumable stockage, but with all demand, including reparable materiel demand, the total system cost was $905 million. This cost exceeded the Objective System total cost by $15 million. The entire difference was accounted for by the higher transportation cost for consumable materiel when consumables were stocked only at the four locations derived from phase one results.

d. Conclusions

If the DODMDS consisted of only common-use consumable materiel, no more than four depot locations would be economically viable if those depots' fixed costs were as high as $3.5 million. Although these four locations did represent relatively large demand concentrations for consumable materiel, there was certainly consumable demand in other locations. The point is that the total consumable demand in DOD was not great enough to warrant additional depot locations closer to the demand when as much as $3.5 million fixed cost must be borne for a depot. Although marginal savings in transportation costs would accrue for every hundredweight of consumable materiel shipped from depots located closer to other demand concentrations than were the four identified from the first phase model analysis, the total number of hundredweights was not great enough, when multiplied by such marginal savings, to offset $3.5 million in fixed costs.

In essence, then, if DOD were starting from scratch, with no depots and the demand and supply represented in the DODMDS base year data, four depots would be the correct number so long as the fixed costs of each were in the $3.5 - $5 million range. This same conclusion would be true if DOD had depots, but such depots were capable of handling <u>only</u> reparable materiel to support maintenance functions. However, DOD already does have distribution depots, and most of those which directly support maintenance are capable of handling other than reparable materiel. In virtually every one of the eleven clusters in the Objective System, there is at least one depot which has the capability and excess capacity to handle the common-use consumable products. Since those depots which support maintenance missions would remain open to provide reparable product support, they should be used for the consumable missions as well. It was shown in the Results section above that following such an integrated stockage strategy costs $15 million less in annual transportation costs than a separate consumable stockage strategy.

7. <u>Unresolved Issues with Objective System</u>

Analysis of a system as complex as the DODMDS with a strategic model will never resolve every important issue. A strategic model can provide very reliable bounds on the structure the logistics system should take, but aggregation techniques and problem representation conventions preclude ever getting below the macro-level of analysis with the model alone. This aspect of modeling methodology was recognized from the inception of the study, and provisions were made early in the analysis phase to move to off-line analysis at a point it was believed such detailed analysis could be productive.

Several issues surfaced in the course of performing the macro-level analysis with the optimization model. Each of those issues has been touched upon at the places they were identified earlier in this chapter. They will be brought together here and focused upon as the critical tasks for micro-level analysis and resolution.

First, it was apparent that the optimization model found the depots at Pearl Harbor and Anniston to be economically desirable locations. The reasons were well understood by study group analysts. However, the materiel support assignments made by the optimization model were obviously loading those two depots beyond their reasonable capacities. Therefore, the issue of loading at these two depots was unresolved at the macro-level.

Further, as was pointed out in the earlier example of the Air Force jet engines being supplied from locations other than where they are repaired, product aggregation made some reparable flow assignments appear feasible where, in fact, upon closer off-line investigation, they were not feasible. The refinement of reparable materiel flows thus became another unresolved issue at the macro-level of analysis.

Finally, because of the above two issues, as well as the technique for handling intracluster transportation costs in the cluster analysis, it was known that transportation savings were overstated for the Objective System. It was estimated that this overstatement of savings was in the $15-20 million range. About $5 million of these overstated transportation savings was estimated to be a result of the technique used for generating cluster average transportation costs. The remaining $10-15 million could only be dealt with through micro-level analysis of the 11 cluster Objective System.

F. MICRO-ANALYSIS OF MACRO-LEVEL RESULTS

1. Objectives of Micro-Level Analysis

a. Objective System

The optimization model assigned customers to depots on a least-cost basis for each bundle without regard to Service identities or the total support pattern for an individual customer. As a consequence, the optimizer may have assigned each customer to several depots for the full range of supply support, although ideally, from the customer's point of view, all support should come from a single depc

b. Development of Refined System from Objective System

(1) Link Realignments. In order to rationalize customer support patterns and reduce the unrealistic anomalies resulting from the application of pure, least-cost depot-customer support links, a manual edit was performed of the 5535 links assigned in the 11-cluster Objective System solution. The following steps were taken to get from the Objective System to what was called the "Refined System."

(a) Service-Peculiar Link Cleanup. Customers were linked to Service depots most appropriate for supply of reparable commodities, (e.g., aircraft engines: for Air Force customers from Air Logistics centers, for Navy customers from Naval Air Stations, for Army customers from designated Army depots).

(b) Logistics Judgement Link Cleanup. Links which were not logical from a common sense logistics viewpoint were changed. For example, the model linked the Pearl Harbor Naval Shipyard to CONUS depots for support of commodities being supplied to other customers by the Pearl Harbor Naval Supply Center. Logically, if NSC Pearl Harbor was supplying a commodity to any off-base customer, it should also be supplying that commodity to customers located at the Pearl Harbor installation. NSC Pearl Harbor, therefore, was assigned responsibility for support of Pearl Harbor customers for those commodities carried by the Center.

(c) "Stray" Link Cleanup. Some least-cost links selected by the optimization model were not consistent with the overall support patterns of certain customers. Unless a compelling reason was known to keep the customer assigned to the least-cost depot, the customer was reassigned to a nearby depot already providing the preponderance of its support for other commodities.

Although the preceding effort was made to assign customers to "logical" depots for support of each product, it was not the study group intent nor desire to override optimizer selections when least cost links were reasonable or distributed among virtually equal alternatives. Many customers were located approximately equidistant among two or more depots, and the optimization model allocated commodity assignments among these equidistant depots based on differences in transportation rates as small as one cent per hundredweight. The number of depot assignments for an individual customer was not restricted in these cases. Ultimate support patterns decided upon by the Services/DLA will probably provide for a further rationalization and standardization of customer support, but resulting changes in total workload at each depot should be minimal. This is borne out by the various sensitivity analyses described earlier.

(2) Load Balancing. When simulator runs indicated capacity problems (inability to process assigned throughput) at selected depots, workload at these depots was reassigned to proximate depot clusters (within the 11-cluster Objective System structure) with excess capacity. As part of these "load-balancing" actions, an additional scenario was tested - support of customers through Defense Depot Memphis (Run #238). The Memphis depot (not part of the 11-cluster Objective System solution) was locked open to supply consumable commodities to customers in its geographic area. Also, Clothing/Textiles and Subsistence/DICOMSS for customers in the South/Central U.S. were linked to Memphis for support. This was done to evaluate the cost trade-offs involved in using Memphis to handle overflows from other depots in the 11-cluster Objective System structure. Results of this

run are shown in Table 5-18. This scenario resulted in excess system capacity and a system cost increase of $5.9 million annually when compared with the Refined System (Run #231).

Table 5-18. Refined System Vs Memphis

Cluster	Throughput (CWT/Millions) Refined System	Memphis	% Change
No. California	5.70	5.70	0
So. California	1.92	1.92	0
Virginia	2.89	2.89	0
Pennsylvania	8.50	8.22	- 3.3
Utah	1.97	1.96	- 0.5
Anniston	2.07	2.07	0
Georgia/Florida	2.57	1.93	-24.9
Texas	1.87	1.87	0
Red River	1.86	1.69	- 9.1
Pearl Harbor	0.12	0.12	0
Oklahoma City	1.57	1.53	- 2.5
Memphis	0	1.15	Not Applicable
Total Throughput	31.04	31.04	0
Total System Cost	$903.2M	$909.1M	+ 0.7%

(3) Additional Customer Support Pattern Tested. In addition to definition of "rational" support patterns, the following alternatives were tested on successive runs to determine comparative system costs and workloads of the following major support pattern shifts:

(a) DICOMSS/Subsistence Support for Transatlantic Customers. A major portion of the total workload assigned to East Coast depots was the movement of subsistence and DICOMSS to transatlantic customers (Europe, Mideast, etc.). The optimizer in most cases elected to route this workload through the Pennsylvania and Virginia clusters with the preponderance assigned to Virginia. In order to facilitate analysis of the comparative costs of using Virginia versus Pennsylvania for subsistence/DICOMSS support, separate runs were structured routing all transatlantic customers through either the Virginia cluster (Run #214) or the Pennsylvania cluster (Run #215). As shown in Table 5-19, routing through the Pennsylvania cluster resulted in a 0.2 percent increase ($2.2 million) in annual system costs. However, although the Virginia routing resulted in lower total system cost, simulation analysis of using the Virginia cluster to support transatlantic subsistence customers resulted in backlog problems due to the cluster's inability to handle the entire subsistence workload without investment in facilities. Because of the small system cost savings associated with subsistence mission relocation from the Pennsylvania cluster, where it is currently, the subsistence mission for transatlantic customers was retained in the Pennsylvania cluster in the Refined System. After final evolution of the Refined System (Run #231) routing of transatlantic customers through the Virginia cluster was retested (Run #236). Total system costs were $903.2 million for the Pennsylvania cluster subsistence option and $901.1 million for the Virginia cluster subsistence option, still only a 0.2 percent increase ($2.1 million) for retention of the transatlantic subsistence mission in the Pennsylvania cluster.

Table 5-19. Virginia Vs Pennsylvania Cluster Subsistence Runs

Cluster	VA Scenario	PA Scenario	% Change
	Throughput - All Products (Millions/CWT)		
No. California	5.77	5.77	0
So. California	1.92	1.92	0
Virginia	5.93	2.75	-53.6
Pennsylvania	5.49	8.67	+57.9
Utah	2.13	2.13	0
Anniston	3.11	3.11	0
Georgia/Florida	1.73	1.73	0
Texas	1.20	1.20	0
Red River	1.81	1.81	0
Pearl Harbor	0.03	0.03	0
Oklahoma City	1.92	1.92	0
Total Throughput	31.04	31.04	0
Total System Cost	$901.8M	$904.0M	+ 0.2

c. Synopsis of Relinking Actions

Figure 5-5 provides a synopsis of all of the above relinking actions taken during evolution from the Objective System to the Refined System. It shows (1) categories of relinking actions made to the 5,535-link Objective System structure, (2) the number of link changes by category, and (3) a comparison of Objective System and Refined System costs. As noted, adjustments to 23.3 percent of the 5,535 link system resulted in only a 1.4 percent increase in the total system cost.

Figure 5-5. Evolution of the Refined System

Relinking Actions Taken	Links Changed
• Link customers to Service depots for aviation reparables.	234
• Link other reparables to appropriate depots.	218
• Test subsistence/DICOMSS at Virginia versus Pennsylvania clusters.	33
• Eliminate "stray" links.	41
• Cluster load balancing actions:	
• Move selected Anniston links to Albany.	242
• Move selected Anniston links to Red River.	59
• Move selected Oklahoma City links to San Antonio.	88
• Move selected Mechanicsburg links to Norfolk.	50
• Move selected Mechanicsburg links to Albany.	21
• Move selected Red River links to San Antonio.	22
• Reduce/restructure Pearl Harbor workload.	84
	1,292

Total System Operating Costs (Millions)

Objective System	890.4
Refined System	903.2
Total Increase	12.8

2. Results of Micro-Level Analysis

a. The Refined System Structure

(1) Costs of Objective vs Refined System Structures.

(a) Objective System Annual Costs. Projected annual wholesale system operating costs of the 11-cluster Objective System structure were $890.4 million as compared to "Baseline" (base year) wholesale system operating costs of $1,004.3 million; a projected annual savings of $113.9 million in wholesale system costs.

(b) Refined System Annual Costs. Results of off-line analysis (e.g., link cleanup, load balancing, etc.) of the Objective System, when reinput to the optimization model as "locked" links, yielded the 11-cluster Refined System structure with projected annual wholesale system costs of $903.2 million; $12.8 million more than the Objective System but still a $101.2 million annual reduction from the Baseline System.

(2) Changes from the Objective System. As the same 11-cluster system holds in both the Objective and Refined System structures, cost differences between the two were attributable solely to (1) off-line actions taken to relink selected customers to selected depot clusters in a manner more suggestive of the "real-world" environment in which the system must operate; and (2) additional load-balancing actions taken to overcome throughput choke-points on lines or weight noted during processing of optimization model outputs through the simulation model. A synopsis of these changes was presented in Figure 5-5. The Anniston and Red River potential storage capacity problems noted in Table 5-8 were also alleviated in the Refined System as illustrated in Table 5-20.

(3) Customer Assignments to Clusters. In consonance with the actions to develop the Refined System structure, off-line analysis was performed on the 11-cluster Objective System to assign customers to clusters in a rational and logical manner, i.e., proximity of clusters to customers. These assignments

were confined to consumables since the relinking actions cited in Figure 5-5 provided for supply of reparables to all customers by specific clusters within the system. These cluster-customer support patterns are reflected in Appendix E, Section 4.

Table 5-20. Eleven-Cluster System Storage Capacity

Cluster	Available (000ft^3)	Objective System (% Used)	Refined System (% Used)
No. California	144,618	31	33
So. California	50,348	35	35
Virginia	108,026	36	31
Pennsylvania	138,698	34	37
Utah	74,187	20	24
Anniston	21,428	111	33
Georgia/Florida	60,542	25	44
Texas	34,277	26	48
Red River	19,669	109	72
Pearl Harbor	5,559	32	10
Oklahoma City	19,943	79	80
TOTAL	677,295	37	37

3. Operational Evaluation of the Refined System Structure

a. Introduction

Despite the micro-level and sensitivity analyses performed on the output of the optimization model, it was still unknown whether the Refined System would adequately function under dynamic conditions. Accordingly, three simulator runs which modeled 90 days of DODMDS operations were compared: (1) 90-Day Baseline System, (2) 90-Day Refined System - Peacetime, (3) 90-Day Refined System - Mobilization. A detailed discussion of the comparative analyses conducted can be found in Appendix E, Section 5.

b. Methodology

The basic methodology was to construct two sets of data for the Baseline System and the Refined System - Peacetime. One set was called the Customer Service Time (CST) data and was the sum of capacity delay time and transit time for each of the 205 DODMDS customers. The second data set was called the Measure of Performance (MOP) data and was constructed by multiplying the Customer Service Time for each customer by the number of lines of business for that customer during the 90-day simulation period. This latter measure was used in order to weight Customer Service Time by volume of business which placed greater emphasis on larger customers.

Using these data sets, system pairwise statistical tests were conducted using a t-test for the difference between means and an F-test (Analysis of Variance). The null hypothesis tested was Ho: There is no significant difference between the systems tested at a significance level of .05.

c. Results

A total of 150 null hypotheses were tested. In no instance, (by Issue Priority Group, Service, Agency, or CST/MOP measure), was the Baseline System statistically better than the Refined System for peacetime or mobilization. In many cases, the Refined System was significantly better than the Baseline System. A detailed display of the statistical results is contained in Appendix E, Section 5. Table 5-21 is a comparative summary of mean Customer Service Times.

d. Pipeline Inventory

Although the DODMDS study did not address inventory levels and value per se, the simulation technique did permit evaluation of the impact of the Refined System on pipeline inventory between depots and customers. The simulator processed orders on a daily basis and kept track of the amount of materiel, and its value, in transit to customers at any given time. Data were reported by the simulator on the value of materiel in transit at the end of 30, 60, and 90 days from the

Table 5-21. Comparative Summary for Mean Customer Service Times in Days

Service/Agency	Base Line IPG-1	Peace Time IPG-1	Mobilization IPG-1	Base Line IPG-2	Peace Time IPG-2	Mobilization IPG-2	Base Line IPG-3	Peace Time IPG-3	Mobilization IPG-3
CONUS System	3.15	2.24*	2.23	3.74	2.84*	2.82	6.66	5.39*	5.4
Total System	4.38	3.35*	3.3	6.01	4.98	4.8	12.98	10.77	10.77
Defense Logistics Agency	3.33	2.2*	2.1	2.66	2.33	2.43	4.56	4.41	4.46
U.S. Marine Corps	2.78	1.94*	1.86	3.79	2.39*	2.3	6.79	4.16*	4.16
U.S. Air Force	3.31	2.44*	2.43	3.99	3.23*	3.2	7.17	6.07*	6.06
U.S. Army	2.97	2.22*	2.25	3.72	2.75*	2.75	6.67	5.55*	5.56
U.S. Navy	3.0	2.05*	2.02	3.60	2.55*	2.54	6.23	4.66*	4.68
Overseas Atlantic	9.11	8.1	7.88	14.93	13.29	12.51	44.89	41.11	40.94
Overseas Pacific	11.49	9.31	9.11	18.61	17.01	15.88	42.65	33.37*	33.45

*Refined System--Peacetime is significantly better than the Baseline System.

time simulation began. The following table shows the value of inventory in transit for both the Baseline and Refined Systems at these 30 day intervals.

Table 5-22. Intransit Inventory From Depots to Customers ($ Millions)

End of	Baseline	Refined System	Difference
30 days	353.0	313.3	-39.7
60 days	378.7	345.3	-33.4
90 days	365.0	341.4	-23.6
Mean	365.6	333.3	-32.2

The results shown in Table 5-22 can be interpreted as follows: As a result of materiel, essentially consumable materiel, being located closer to customers in the Refined System than in the Baseline System, less materiel was intransit to customers at any given time with the Refined System. The average value of this reduction in pipeline inventory was $32.2 million. This means that a one time savings in inventory investment of about $32 million should be possible with implementation of the Refined System. If it is assumed that annual holding costs of inventory for DOD are 10 percent of the value of inventory, this $32 million reduction in pipeline inventory would provide an annual savings of $3.2 million in inventory holding costs.

e. Conclusions

(1) The DODMDS Refined System--Peacetime would be at least as good as the Baseline System and in some instances would be significantly better in Customer Service Times.

(2) The DODMDS Refined System would function equally well under peacetime and mobilization scenarios.

(3) The Refined System would provide a one-time savings in pipeline inventory of about $32 million and an annual savings of $3.2 million in inventory holding costs over the Baseline System.

G. NOMINAL DEPOT ANALYSIS

1. Introduction

A series of analyses was conducted to evaluate the DODMDS Refined System with unlimited capital investment in state-of-the-art materiel processing and storage facilities. These analyses provided insights into the systemwide potential annual savings and payback periods which could be anticipated with a large scale capital investment program in the "hands-on" depot receipt, storage and issue functions. These analyses were called the "nominal depot analysis".

2. Analytical Methodology

Nominal depot analysis was conducted using the engineered depot variable cost data described in Appendix E, Section 6. The engineered costs were developed from conceptually designed receipt, storage and issue functions.

The nominal depot analysis consisted of comparing the system costs using (1) historical depot variable cost and (2) nominal depot variable cost. This comparison provided an estimate of the potential savings under ideal materiel handling and storage conditions. This analysis used the same link structure and parameters (except depot variable cost) as the Refined System.

Nominal depot variable costs were initially developed reflecting labor and supplies (L&S) cost at two levels: a maximum and a minimum economy-of-scale. A "most likely" level of economy-of-scale nominal variable cost was then computed based on the volume of workload per cluster in the Refined System. It was assumed that a linear relationship existed between the minimum and maximum economy-of-scale. The minimum, maximum and "most likely" variable cost rates were then used to evaluate the Refined System. For discussion purposes in this chapter, only the "most likely" nominal cost is used. Appendix E, Section 6, contains a discussion of the Refined System using the maximum and minimum nominal variable cost.

The Refined System structure was priced out using nominal depot variable cost data. This pricing out of the Refined System was not an optimization analysis but used the optimization model as an accounting tool since all links were fixed. The nominal cost analysis of the Refined System was conducted using different combinations of clusters with nominal depot variable costs and historical depot variable costs. The four scenarios were:

a. All 11-clusters of the Refined System with nominal depot variable cost rates.

b. Six clusters (Northern California, Southern California, Virginia, Georgia/Florida, Pennsylvania, and Oklahoma City) with nominal depot variable cost rates and the other five clusters with historical standard variable cost rates.

c. Five clusters (those in paragraph 2.b. above except Georgia/Florida) with nominal depot variable rates and the other six clusters with historical standard variable cost rates.

d. Three clusters (Northern California, Virginia and Oklahoma City) with nominal depot variable cost rates and the other eight clusters with historical standard variable cost rates.

3. Results of the Analysis

Table 5-23 displays the system depot variable cost, annual savings (as compared to the Refined System with historical variable cost), estimated one-time capital investments and payback period in years for each of the above scenarios.

Table 5-23. Nominal-Historical Depot Combinations: Refined System

Scenarios	(1) Number of Clusters With Historical Cost	(2) Number of Clusters With Nominal Cost	(3) System Variable Cost ($) (Millions)	(4) Annual System Savings ($) (Millions)	(5) One-Time Capital Investment ($)Millions	(6) Payback In Years Col 5 ÷ Col 4
1	0	11	237	73	3170	43
2	5	6	252	58	2256	39
3	6	5	260	50	1961	39
4	8	3	278	32	1062	33

4. Conclusions

As can be seen from Table 5-23, a system of 11 clusters with nominal depots produced the largest annual savings ($73 million) and an estimated $3.2 billion in one-time investment cost. By reducing the number of nonimal depots (number of clusters with nominal variable costs), and increasing the number of locations with historical variable costs, the amount of annual savings and one-time investment cost were progressively reduced. However, when the number of clusters with nominal variable costs was reduced from six to three, the payback period did not change appreciably. With the volume of business in the DODMDS, a large scale investment program in the distribution system facilities, even under ideal conditions would not appear to produce an attractive return on investment. Building only three such state-of-the-art facilities in areas of high demand concentration would require an investimat of $1.062 billion. Because of the relatively low volume of peacetime workload in DOD, annual savings over the Refined System with historical cost data would be only $32 million. At this rate of savings, return on the $1.062 billion investment it would require 33 years to pay off the investment.

H. SUPER-DEPOT FOR CONSUMABLE PRODUCTS STRATEGY

1. Introduction

The DODMDS product groups consist of two basic types of commodities: (1) reparable items which are subject to depot level maintenance; and (2) consumable items which are consumed by the user or discarded when in unserviceable condition. Consumables generally have similar handling and storage requirements. It was postulated that consumable items could possibly benefit from consolidation at "super-depots" having favorable economies of scale and lower unit costs in processing. The concept of super-depots was evaluated by determining if the DODMDS commodity sources and customer demand patterns would economically support the concentration of consumable materiel at a few locations, each of which possessed an economy-of-scale advantage. The analysis used the historical depot fixed costs and transportation rates, while depot variable costs were based on nominal depot data.

2. Analytical Methodology

For this analysis DODMDS product groups were split into consumables and non-consumables. Non-consumables consisted of the 22 reparable product groups plus larger aircraft parts, ground support equipment, tires, medium sized shop and industrial items, small construction materiel, and large office equipment. The remaining 40 product groups were classified as consumables. Table 5-24 provides a specific breakdown of the products classified as consumable and non-consumable.

Three locations were posited as sites for super-depots, one on each coast and one in central CONUS. Specific clusters selected as locations for potential super-depots were Northern California, Oklahoma City, and Virginia.

Depot variable costs for this analysis were the nominal standard rates ($/CWT) by product group at two economy-of-scale levels. (Reference Chapter 4, Appendix D-3, Section 3 for explanation of methodology for development of nominal variable cost rates.) Consumable product variable cost rates ($/CWT) for Northern California, Oklahoma City, and Virginia (the super-depot sites) were at the nominal, three-depot economy of scale level. The variable cost rates for the non-consumable products at the super-depot sites were at the nominal 20-depot economy-of-scale level. For all other clusters, the variable cost rates for all products were at the nominal 20-depot economy-of-scale level. The three-depot economy-of-scale assumes that one-third of the wholesale consumable product workload would be processed at each of the super-depot locations, while the 20-depot level assumes one-twentieth the total DODMDS throughput. The 20-depot economy-of-scale level was selected by determining from the Objective System structure the number of depots (excluding the 11 depots which comprise Northern California, Oklahoma City and Virginia clusters) to remain in the DODMDS. With this mixture of product-specific variable cost rates, it could be determined if the Objective System structure would change significantly with consumable product depots being provided lower variable cost rates.

3. Results Of The Analysis

Optimization model results, using the nominal depot variable costs in a 15-cluster analysis, are presented in Tables 5-25, 5-26, and 5-27. The cluster workload changed very little compared to the Objective System. The volume of workload for the three super-depots increased by a maximum of 3.8 percent, and the total system transportation cost was virtually unchanged. The 3.8 percent increase in consumable workload at Oklahoma City resulted in that cluster having only 6 percent of the total system consumable workload, considerably below the 33 percent required to realize the three-depot economy-of-scale.

DODMDS system costs generated for the super-depot scenario were based on two levels of nominal depot variable costs. For this reason, the total system costs generated were not comparable to the Objective System total costs. Therefore, cost data were not included in the tables. The intent of this analysis was to determine whether the system structure would change significantly from the Objective System by employing a super-depot concept. No such change occurred.

4. Conclusions

The total throughput volume of wholesale materiel classified as consumable in this analysis was 19.5 million CWT. From Table 5-25, the model positioned only 56 percent of the total consumable throughput at the super-depot clusters. Further, this consumable workload (10.9 million CWT) was only 3 percent above the 10.6 million CWT of consumables assigned to the Northern California, Virginia, and Oklahoma City clusters in the Objective System. From these findings it was concluded that DODMDS commodity sources and customer demand patterns, coupled with transportation costs, do not support the concept of creating super-depots for distribution of consumable materiel. The economies of scale for such materiel do not generate sufficient cost per unit savings in depot processing to warrant the additional transportation cost or required capital investment.

Table 5-24. Consumable & Non-Consumable Product Classification

DODMDS Product Number	Description	Classification for this Analyses	DODMDS Product Number	Description	Classification for this Analyses
101	Guns < 75MM	NC	491	Shop Eq < 50 lbs	NC
102	Guns 75MM+	NC	492	Shop Eq > 50 lbs	NC
104	Guns & FC	C	494	Shop 10-50 lbs	NC
121	Fire Contr	NC	495	Shop > 50 lbs	C
141	Missile < 50 lbs	NC	496	Shop 1-10 lbs	C
142	Missile > 50 lbs	NC	497	Shop < 1 lbs	C
144	Msl Pts < 50 lbs	C	534	Hardwre > 10 lbs	C
145	Msl Pts > 50 lbs	C	536	Hardwre 1-10 lbs	C
151	Acft Fxd Wg	NC	537	Hardwre < 1 lb	C
152	Acft Rtr Wg	NC	544	Const Mat < 50 lbs	NC
153	Acft Comps	NC	545	Const Mat > 50 lbs	C
154	Acft Pts 10-50 lbs	C	581	Com Elec Equip	NC
155	Acft Pts > 50 lbs	NC	584	Com Pts > 10 lbs	C
156	Acft Pts 1-10 lbs	C	586	Com Pts 1-10 lbs	C
157	Acft Pts < 1 lb	C	587	Com pts < 1 lbs	C
161	Acft Eng < 50 lbs	NC	611	Elec Eq > 50 lbs	NC
162	Acft Eng > 50 lbs	NC	614	Elec 10-50 lbs	C
171	Gnd Spt	NC	616	Elec 1-10 lbs	C
174	Gnd Spt Pts	NC	617	Elec < 1 lbs	C
191	Ships & Boats	NC	615	Batt & F Cell	C
204	Ship Equip	C	671	Photo Equip	NC
221	Rail Equip	NC	674	Photo Sup	C
224	Rail Mat	C	651	Med Equip	C
231	Veh Wheeled	NC	654	Med Sup < 50 lbs	C
232	Veh Trk Cmbt	NC	655	Med Sup > 50 lbs	C
241	Const Eq > 50 lbs	NC	684	Chem < 50 lbs	C
244	Const Eq < 50 lbs	C	685	Chem > 50 lbs	C
264	Tires Auto	NC	714	Ofc Sup < 50 lbs	C
265	Tires Acft	NC	715	Ofc Sup > 50 lbs	NC
281	Auto Eng	NC	844	Clo & Tex < 50 lbs	C
294	Auto Pts 10-50 lbs	C	845	Clo & Tex > 50 lbs	C
295	Auto Pts > 50 lbs	C	894	Subsistence	C
296	Auto Pts 1-10 lbs	C	895	DICOMSS	C
297	Auto Pts < 1 lbs	C	990	Misc < 50 lbs	C
			995	Misc > 50 lbs	C

C - Consumables
NC - Non-Consumables

Table 5-25. Consumable Item Super-Depot System Vs. Objective System - Workload

Cluster Number/Name	(1) Objective System (Million CWT)	(2) Super-Depot Concept** Nominal Cost (Million CWT)	(3) % Change (Col. 2 Vs Col. 1)
1 No. California*	5.64	5.66	+ .4
2 So. California	1.91	1.91	-0-
3 Virginia*	6.21	6.25	+ .6
4 Pennsylvania	5.02	5.01	- .2
5 Utah	1.73	1.71	- 1.2
6 Lexington	-0-	-0-	---
7 Anniston	3.52	3.47	- 1.4
8 Georgia/Florida	1.33	1.30	- 2.3
9 Texas	.88	.88	-0-
10 Red River	2.80	2.78	- .7
11 Pueblo	-0-	-0-	---
12 Pearl Harbor	.17	.17	-0-
13 Memphis	-0-	-0-	---
14 Oklahoma City*	1.83	1.90	+ 3.8
15 Ohio	-0-	-0-	---
Total	31.04	31.04	

* Super-Depot Candidates.
**Depot variable cost rates ($/CWT) input to the model included the nominal direct variable labor and supplies cost plus nominal indirect variable cost.

Table 5-26. Super-Depot Concept: Consumable/Non-Consumable Workload (Millions of CWT)

Cluster Number/Name	Consumable	Non-Consumable
1. No. California	4.15	1.51
3. Virginia	5.61	0.64
14. Oklahoma City	1.15	0.75
Total	10.91	2.90

Table 5-27. Consumable Item Super-Depot System Vs. Objective System - Transportation Cost

	(1) Objective System (Millions)	(2) Super-Depot Concept-L&S VC (Millions)	(3) % Change (Col. 2 Vs Col 1.)
Inbound Transp. Cost	259	259	-0-
Outbound Transp. Cost	244	244	-0-
Total Transp. Cost	503	503	-0-

I. SUMMARY

1. Introduction

This chapter has presented the progression of the DODMDS analysis from the initial discrete depot model runs through the development of a Refined System consisting of 11 clusters of depots. The nature and results of a wide range of analyses were covered. The types of analysis included use of the two DODMDS study models to structure and evaluate system alternatives, and off-line analysis of model results to further refine materiel allocations made by the optimization model. This section recaps the major findings from the analysis at the cluster level.

2. Summary of Findings

Following initial optimization model resolution runs, using discrete depot locations and costs, a decision was made to perform the analysis of the fundamental location economics of the total system using clusters of depots. This approach had several advantages. One major advantage was the much greater latitude afforded study group analysts in framing alternative system structures within an overall location-economics context.

It became clear early in the 12-cluster analysis that the existing DODMDS has excess depot capacity and, consequently, excess depot cost. It was also apparent that materiel support patterns were not aligned to take best advantage of potential transportation economies. Through further 12-cluster (and subsequently 15-cluster) analysis, the geographic locations of excess depot capacity were identified, and the estimated transportation cost savings were related to specific cluster-product-customer support patterns.

An Objective System was defined which consisted of 11 of the original 15 clusters. This Objective System became the reference point for all further analysis. Recognizing that the Objective System had certain flow and materiel assignment characteristics which were not practical because of modeling and data aggregation techniques, intensive off-line analysis was performed on the Objective System to derive a Refined System. This Refined System was comprised of the same 11 clusters as the Objective System, but cluster mission assignments were modified to reflect the realities of unique Service logistics operations, as well as the aggregate capabilities of the depots which made up each cluster. Table 5-28 provides a summary of the materiel flows and system costs by cluster for the Baseline, Objective, and Refined Systems.

Table 5-28. Summary of Materiel Flows and System Costs for Baseline, Objective, and Refined Systems Depot Throughput (CWT/Millions)

Cluster	Baseline	Objective System	Refined System
No. California	6.22	5.64	5.70
So. California	1.24	1.91	1.92
Virginia	3.18	6.20	2.89
Pennsylvania	7.85	5.02	8.49
Utah	2.51	1.73	1.98
Lexington	0.13	0	0
Anniston	2.11	3.52	2.07
Georgia/Florida	0.78	1.33	2.57
Texas	0.82	0.89	1.87
Red River	1.54	2.80	1.86
Pueblo	0.33	0	0
Pearl Harbor	0.12	0.17	0.12
Memphis	2.85	0	0
Oklahoma City	0.65	1.83	1.57
Ohio	0.71	0	0
Total	31.04	31.04	31.04

System Costs ($ Millions)

Cost Component	Baseline	Objective System	Refined System
Inbound Transp.	242.9	258.8	262.7
Outbound Transp.	331.1	244.3	253.3
Facility	430.3	387.2	387.2
Total	1,004.3	890.3	903.2

At the macro-level, the estimated system operations cost reduction possible by moving from the Baseline to the Refined System would be about $100 million per year in the long-term. These potential savings would accrue from elimination of excess depot capacity (about $43 million) and from transportation economies (about $57 million) possible with materiel positioned closer to customer concentrations of demand. The outbound transportation cost reduction of $77 million was offset by an increase in inbound transportation costs of $20 million required to position the materiel at clusters closer to the customer demand. The realignment of materiel flows and cluster missions required to move from the Objective System to the Refined System increased the system cost over the Objective System by $13 million, or 1 percent.

The Objective System was subjected to a series of sensitivity analyses to evaluate its stability under a wide range of changes to the driving variables in the DODMDS. The Objective System structure was consistently stable under conditions of extreme variation in demand patterns, supply source patterns, and transportation rates. This stability was also apparent with changes in depot fixed and variable costs which reflected regional wage rate differentials, alternate fixed cost allocation procedures, and investment programs designed to achieve economies of scale in depot processing.

With respect to DODMDS responsiveness to customer demand, service levels with the Refined System were found to be consistently better than the Baseline System for both peacetime conditions and under mobilization. The mobilization demand, roughly three times greater than the peacetime demand level, could be processed within the physical capacity limits of the Refined System. Further, pipeline inventory requirements for materiel in-transit from depots to customers were reduced by approximately $32 million for the Refined System versus the Baseline System. At an assumed inventory holding cost rate of 10 percent, this would translate to an annual holding cost savings of $3.2 million.

Although most of the analysis focused on an integrated distribution system strategy with joint stockage of reparable and consumable materiel (specifically mandated by the DODMDS Study Charter), a strategy was posited and tested in which separate distribution subsystems for consumable and reparable materiel would exist. The effect of following this separate system strategy was found to be an increase in total system cost of $15 million per year compared to the integrated strategy implict in the Refined System. Further, it could be expected that system responsiveness would deteriorate compared to the Refined System since consumable materiel would be positioned in fewer places, and thus not as close to some major customer concentrations, than in the Refined System. Although not analyzed specifically, an integrated system strategy should also decrease retail inventory levels at some depots in the Refined System which are collocated with concentrations of customer demand. In the past, many of the collocated depots were not wholesale suppliers of consumable products and, therefore, maintained retail stock levels of such products to support local demand. The placement of wholesale stocks at these depots should eliminate the requirement for a separate retail level of those consumable products involved.

The analysis of separate distribution systems for consumable and reparable materiel was carried one step further to determine if having a few "super-depots" for consumable materiel would result in large enough volumes of business through those few depots to generate significant economies of scale in depot processing. The hypothesis was that if such economies of scale for consumable products could be exploited, resulting in substantially lower depot variable costs in three super-depot locations, higher transportation costs would be more than offset by savings in depot processing costs. Such savings would, of course, have to be great enough to pay back the investment required in the super-depots within an acceptable number of years. It was found that the economies of scale possible for consumable materiel were not significant enough to overcome transportation costs. Consumable materiel flows by commodity-cluster combination were almost unchanged between the Objective System and the hypothetical system.

Finally, analysis was performed to determine if large scale investment in nominal depots having state-of-the-art facilities and equipment would be warranted, given the DODMDS materiel flow and assets-in-storage characteristics. This analysis considered all materiel in the DODMDS study, not just consumable materiel. It was found that the flow volumes, coupled with the large amount of dead inventory which characterized the DODMDS, would not support major investment in super-depot facilities. The most favorable investment payback period of the alternative nominal depot configurations analyzed was 33 years.

3. Unresolved Issues

Although the analysis discussed in Chapter 5 dealt with all major DODMDS structural and performance issues at the cluster level, there remained the critical issue of identifying alternative combinations of depots within clusters of the Refined System which could satisfy the capacity and cost characteristics dictated by the Refined System. There was a further issue which required analysis at a more discrete level than the cluster: What effect would significantly higher levels of throughput over the base year for some clusters have on the fixed costs of depots in those clusters? It is these key issues which are discussed in Chapter 6.

CHAPTER 6
OPTIONS

A. INTRODUCTION

One of the basic goals of the DODMDS study group was to examine and recommend alternatives to integrate, consolidate and/or standardize the DODMDS facilities. To achieve that goal it was necessary for the study group to develop an "objective" system. The analysis described in the preceding chapter provided an overall system structure which can serve as the target DODMDS. Chapter 5 dealt with the DODMDS in terms of clusters of depots and determined the volume of each commodity which should be processed by each cluster on an annual basis. Each of the clusters of depots was composed of one to six individual depot facilities.

The overall purpose of this chapter is to formulate alternatives to achieve the long range DODMDS structure (Refined System) by considering the potential contribution of each individual depot to that structure. These alternatives were formulated by considering various qualitative and quantitative characteristics of each of the individual depots within the clusters. There was also a need to formulate some alternatives which involved trade-offs between certain clusters. The necessity for this further intercluster analysis emerged from the process of link editing and depot load balancing of the Objective System, which created new economic capacity trade-offs across two clusters in the Refined System. This chapter concludes with a display of the various trade-offs within each cluster and between some clusters which must be considered and dealt with to achieve a long range DODMDS structure.

B. PURPOSE OF TRADE-OFF ANALYSIS

The specific purpose of developing trade-offs within each cluster (intracluster analysis) and between certain clusters (intercluster analysis) was twofold: (1) to formulate options where more than one feasible alternative existed and (2) to outline the individual depot commodity stockage patterns. To formulate the feasible options, it was necessary to (a) isolate and describe the impact of each option on collocated customers, special distribution missions, and organic capabilities; (b) estimate the annual savings/costs and one-time costs associated with each option and; (c) assess the impact of the option on the capacity of the cluster. To develop commodity stockage patterns, the cluster throughput by commodity developed in the macro-analysis was allocated to specific depots within clusters by commodity groupings. The recommended volumes by commodity groupings within each cluster could then provide guidelines for inventory management.

C. FORMULATION OF OPTIONS

In some multidepot clusters, the throughput assigned to the cluster could be processed by several combinations of depots within that cluster. The initial step in formulating options for each cluster was to determine which combinations of depots should be subjected to further evaluation. The macro-analysis indicated that two clusters, Northern California and Utah, required a reduction in fixed cost. In those clusters the rule-of-thumb for selecting combinations of depots was that the fixed cost of the combination should approximate the fixed cost of the cluster indicated by the macro-analysis. It should be recalled that the macro-analysis concentrated on determining the economic balance between cluster fixed cost and transportation costs. The balance point in the macro-analysis for cluster fixed cost was an approximation to an upper bound for each cluster. If, in the optimization process, a cluster stayed in solution with an upper bound to fixed cost, the cluster would stay in solution at all values less than the upper bound. For some clusters there were combinations of depots in which the sum of fixed costs was less than the upper bound required by the macro-analysis. The options formulated as possible alternatives did not attempt to minimize the depot fixed cost but attempted to achieve a balance of fixed cost for each cluster commensurate with the allocation of workload proposed for that cluster in the macro-analysis. (In all clusters, the sufficiency of processing and storage capacities and transportation capabilities of the cluster were assessed on an aggregated and annual basis.)

In formulating alternatives, the following qualitative and quantitative characteristics of each depot were used:

1. Estimated Annual Savings in Operating Costs

The annual savings of each option were the depot fixed costs minus the maintenance interface penalty costs. The method used to determine these estimates is contained in Book 8, Appendix F, Section 1. The estimated savings shown are gross savings which may be offset by increases in fixed cost at other depots within each cluster. The estimated savings are, however, indicative of the relative differences in savings associated with the options shown. Estimated annual savings are subject to change due to inventory management decisions which are made concerning asset positioning during implementation.

2. One-Time Costs of Personnel Turbulence

The one-time costs consist of estimates of severance pay, relocation costs etc. The methodology for these cost estimates is shown in Book 8, Appendix F, Section 2.

3. One-Time Costs of Relocating Materiel

Costs were estimated for assets for which there was no demand in the DODMDS base year. It was assumed that these were representative of the inactive assets that could not be liquidated by attrition. The methodology for these estimates is shown in Book 8, Appendix F, Section 3.

4. On-Base Customer Interfaces

The supply interface with on-base collocated customers was analyzed and is described in Book 8, Appendix F, Section 4.

5. Maintenance Interface

The supply interface with major collocated maintenance activities is described in Appendix F, Section 4. The maintenance interface penalty for separation of reparables from their historical maintenance facilities (see Book 5, Appendix D-3) was used in this analysis.

6. Condition Of Facilities

The condition of facilities was categorized as marginal, adequate, and very good. This evaluation was based on the information provided in response to the DODMDS Data Call and on visits by study group personnel to all facilities. "Marginal" refers to facilities which have deteriorated and, in general, will require upgrading or selective replacement to maintain satisfactory capacities and standards. "Adequate" indicates that the physical condition of the facilities is satisfactory to meet the proposed mission requirements, including surges. "Very Good" refers to facilities in good physical condition which have also made strides in automating several phases of materiel processing. These facility condition designations are subjective and do not supersede any planned requirement for each Service/DLA to continue with facility renovation or replacement.

7. Special Distribution Missions

Each option considered the impact on any special distribution mission of the individual depots. Special distribution missions were considered to be:

a. Consolidation/Containerization Point (CCP)

An activity responsible for consolidation of materiel, preparation of documentation, and distribution of materiel to overseas Army customers.

b. Direct Commissary Support System (DICOMSS)

The storage and container stuffing associated with overseas commissary stores of the Army and Air Force (DICOMSS).

c. Manifested Water Cargo (MWC)

Container stuffing and break bulk cargo processing associated with manifested water cargo under the auspices of Military Traffic Management Command (MTMC).

8. Increased Fixed Cost

Where the Refined System weighted throughput of a cluster exceeded the cluster historical weighted throughput by more than 25 percent, an increase in fixed cost was computed. One technique used for determining the increase in average fixed cost is the cost estimating relationship described in Book 8, Appendix F, Section 5.

9. Organic (DOD Operated) Capabilities of Each Depot

The following organic capabilities are discussed in Appendix F, Section 7:

a. Airlift Capability in the form of an aerodrome capable of serving C-5 aircraft.

b. Military Airlift Command Aerial Port (MAC APOE).

c. Water port facilities capable of receiving deep-draft ships where deep-draft is considered to be water depth of 30 feet or more alongside the pier.

10. Annual Throughput Capacity

The annual capacity measured in lines and CWT was computed on the basis of 251 working days with one eight-hour shift. In some cases the Refined System volume was slightly greater than the volume which could be obtained on the basis of 251 working days, and it was assumed in those cases that additional shifts or work days would be employed, as necessary. See Appendix D-3, Section 4.

11. Storage Capacity

Storage capacity, measured in available cubic feet, as described in Appendix D-3, Section 4.

12. Transportation Capabilities

Although not an integral part of the analysis of individual depots within a cluster, reviews were conducted of organic and commercial transportation capabilities available at and to the individual depots to insure that sufficient capability existed to support the alternatives. The transportation capabilities analysis is contained in Appendix F, Section 7.

D. LIMITATIONS

The following subject areas were not assessed in the formulation of options:

1. Changes in transportation costs due to changes in intracluster support patterns resulting from phasedown or closure of wholesale missions at specific depots having local and on-base customer supply interfaces. However, it was estimated (in Chapter 5) that intracluster transportation costs were understated by no more than $5 million systemwide due to the technique for handling local delivery within clusters.

2. Possible increases in fixed costs at specific depots due to apportionment of workload within clusters whose Refined System workload, measured in weighted throughput, declined or remained equivalent to the baseline.

3. Savings in retail inventory levels which should accrue through positioning of wholesale assets at depots having historically large retail demand.

E. ANALYSIS OF INDIVIDUAL CLUSTERS

The analyses of individual clusters are divided into four groups: (a) multidepot clusters which required a reduction of fixed cost in the macro-analysis; (b) clusters which did not require a reduction of fixed cost in the macro-analysis; (c) intercluster trade-offs; (d) clusters where the wholesale mission was discontinued in the Refined System. In the analysis of individual clusters, all dollar figures are presented in constant FY 1975 dollars. Recommendations regarding the options formulated in conjunction with the analyses are contained in Chapter 7.

1. Multidepot Clusters Requiring Reduction of Fixed Cost

Two clusters - Northern California and Utah - had more capacity than was required to support the Refined System. Examination of these clusters was conducted outside the framework of the macro-analysis by focusing on the quantitative and qualitative factors listed above. The result of these analyses was a series of options which reduced the fixed cost within each cluster and matched the annualized processing and storage capability to the requirements of the Refined System. The magnitude of necessary reduction in fixed cost for each of these clusters was indicated in the macro-analysis.

a. Northern California Cluster

(1) Facilities. Sacramento Army Depot (SAAD); Sharpe Army Depot (SHAD); Naval Air Station Alameda (NASAL); Naval Supply Center Oakland (NSCOAK); Sacramento Air Logistics Center (SMALC); and Defense Depot Tracy (DDTC).

(2) Discussion. The macro-analysis indicated that the throughput volume of this cluster would not support the total fixed cost of all depots in this cluster. It would support a fixed cost of $16.3 million as compared to the Baseline fixed cost of $24.3 million; requiring a reduction of $8.0 million in fixed cost. That magnitude of fixed cost savings could be achieved through closure of the wholesale mission at some combination of two of the six depots in the cluster.

(3) Cluster Data.

	Baseline Capacity	Refined System Workload
Annual CWT	16.9M	5.7M
Annual Lines	10.9M	5.3M
Storage (cu ft)	144.6M	48.3M

The Refined System change in workload in this cluster over the baseline is shown in the following commodity groups:[1]

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	1.2M	1.1M
Personnel Consumables	2.2M	2.1M
Other Consumables	2.8M	2.5M
Total	6.2M	5.7M

This cluster has the largest number of depots of any cluster; four of them have distinct local customer supply interfaces; three possess organic capabilities; three have special distribution missions involving container stuffing; and there is considerable diversity in facility condition.

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[1]These groupings of DODMDS commodities (see Table 4-1, Appendix C, Section 4 for individual product group identification) are used throughout this chapter. Components of each group are listed below:

- Reparables consist of Product Groups 101, 102, 121, 141, 142, 151, 152, 153, 161, 162, 171, 191, 221, 231, 232, 241, 281, 491, 492, 581, 611, 651, and 671;
- Personnel Consumables consist of Product Groups 654, 655, 844, 845, 894 and 895; and
- Other Consumables consist of the remaining 40 Product Groups.

(4) Depot Data.

	SAAD	SHAD	NASAL	NSCOAK	SMALC	DDTC
Collocated Customers:						
Operational Units	No	No	Yes	Yes	Yes	No
Depot Maintenance	Yes	*	Yes	Yes	Yes	No
IPE[1]	No	No	No	No	No	Yes
Special Distribution Missions	No	CCP	No	MWC	No	DICOMSS
Organic Capability:						
Water Port	No	No	Yes	Yes	No	No
C-5 Airport	No	No	Yes	Yes	Yes	No
Facility Condition	Adequate	Marginal	Marginal	Adequate	Very Good	Adequate
Throughput Capacity:						
Annual CWT	0.8M	4.7M	0.3M	3.6M	2.8M	4.7M
Annual Lines	0.7M	0.9M	0.6M	3.4M	3.5M	1.8M
Storage Capacity (cu ft)	13.8M	10.9M	13.8M	44.6M	19.6M	41.9M
Fixed Cost ($)	3.2M	2.5M	1.9M	7.7M	1.7M	7.3M
Maintenance Interface Penalty (Potential) ($)	1.9M	*	0.6M	0.1M	2.8M	0

[1]Industrial Plant Equipment (IPE)

* Depot Maintenance mission at SHAD has been phased out since the DODMDS base year.

(5) Principal Options.[1]

Option	SAAD	SHAD	NASAL	NSCOAK	SMALC	DDTC	Annual Savings	Estimated One-Time Costs Personnel	Materiel Relocation
1		X		X			$10.0M	$ 9.9M	$15.8M
2		X				X	$ 9.7M	$11.9M	$10.8M
3			X	X			$ 8.9M	$ 9.7M	$ 6.9M
4	X			X			$ 8.9M	$11.5M	$ 8.1M
5			X			X	$ 8.6M	$11.7M	$ 1.8M
6	X					X	$ 8.6M	$13.5M	$ 3.1M
7				X	X		$ 6.6M	$11.4M	$ 7.6M
8					X	X	$ 6.2M	$13.4M	$ 2.5M

(6) Option Description.

About the Options: In reducing cluster fixed cost to $16.3 million the range of annual savings and one-time expenses was very small. The last two options can be distinguished on the basis that their potential annual savings were less than could be achieved by the closure of either NSC Oakland or DDTC alone. All of the options reduced cluster fixed costs by at least $8.0 million per year. None of the options, except number seven, require capital investment in order to maintain satisfactory system response.

Each of the options proposed above would entail closure of the wholesale mission at either NSCOAK or DDTC. These two activities can be described as large consumable wholesalers.

Each option involving closure of NSCOAK would separate the wholesale stocks currently at NSCOAK from both deep-water port and airlift capabilities. Closure of both NASAL and NSCOAK would incur a potential negative impact on existing supply interfaces.

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[1] In all principal option charts in this chapter, depots marked with "X" are those whose wholesale distribution mission is closed in the specific option.

DDTC had neither significant local customers nor organic capabilities. Closure of DDTC would entail relocation of a special mission in the form of container stuffing associated with DICOMSS. Both SHAD and NSCOAK currently have container stuffing missions.

Since the DODMDS study base year, the SHAD depot maintenance mission has been phased out. The base year wholesale distribution fixed costs understate the current fixed cost for SHAD due to having both distribution and maintenance missions over which to distribute these costs in the base year. To partially compensate for this change, the maintenance interface penalty for SHAD was set at zero in computing annual savings.

Facility conditions at SHAD and NASAL were rated as marginal and would require one-time capital investments to upgrade or replace MHE and warehouses to maintain existing capabilities. No cost for replacement was estimated.

Option 1: Closure of SHAD and NSCOAK: In addition to the impacts discussed above relative to NSCOAK, closure of SHAD requires the relocation of the special mission (CCP) to one of the remaining depots in the cluster. DDTC presently performs container stuffing for DICOMSS and could absorb the CCP function. SAAD and SMALC could also absorb this mission. The distribution workload of SHAD has been substantially increased in the last three years as a result of DARCOM's stockage realignment to the DSS/CCP concept. However, the maintenance mission at SHAD has been eliminated. The Army boat storage function at Rough and Ready Island can be satellited from another depot in the cluster.

The throughput capacity of the remaining depots compared to the Refined System workload for the cluster is as follows:

	SAAD, NASAL SMALC, DDTC Capacity	Refined System Workload
Annual CWT	8.6M	5.7M
Annual Lines	6.6M	5.3M

The combined throughput capacity of SAAD, NASAL, SMALC and DDTC exceeds the Refined System workload by 25 percent. Storage capacity of these four depots is 89.1 million cubic feet, or 84 percent above the required cube.

Option 2: The closure of SHAD and DDTC results in no impact on local customer supply interface or generation of maintenance interface penalty costs. This option requires the absorption by the remaining depots of two special distribution missions (CCP and DICOMSS). There is no adverse impact on the proximity of wholesale stocks to the organic airlift and water port capabilities of the cluster. The throughput capacity of the remaining depots compared to the Refined System workload for the cluster is as follows:

	SAAD, NASAL NACOAK, SMALC Capacity	Refined System Workload
Annual CWT	7.5M	5.7M
Annual Lines	8.2M	5.3M

The combined throughput capacity of SAAD, NASAL, NSCOAK and SMALC exceeds the Refined System workload by 32 percent. Closure of DDTC and SHAD reduces the storage capability of the cluster by 52.8 million cubic feet. The storage capacity at the remaining four depots is 91.8 million cubic feet.

Option 3: Closure of both NASAL and NSCOAK would substantially impact on local customer supply interfaces in the Bay area. Both activities have missions in support of collocated operational units and depot maintenance. This option separates the wholesale stocks at NSCOAK and NASAL from deep-water port facilities, as well as one of the two organic C-5 airfields in the cluster.

Throughput capacity of the remaining depots compared to the Refined System workload for the cluster is as follows:

	SAAD, SHAD SMALC, DDTC Capacity	Refined System Workload
Annual CWT	13.0M	5.7M
Annual Lines	6.9M	5.3M

With the closure of NASAL and NSCOAK, the cluster throughput capacity is reduced by 3.9 million CWT and 4.0 million lines, but remains 30 percent above the Refined System requirement. Storage capacity is reduced to 86.2 million cubic feet, or 37.9 million cubic feet above the 48.3 million cubic feet required.

Option 4: Closure of SAAD and NSCOAK. In addition to the NSCOAK impacts discussed above, SAAD closure incurs a $1.9 million maintenance interface penalty. Support to depot maintenance at SAAD could be accomplished from SMALC which is across the city.

Discontinuation of the wholesale mission at SAAD and NSCOAK reduces the cluster throughput capacity and compares to the Refined System workload as follows:

	SHAD, NASAL SMALC, DDTC Capacity	Refined System Workload
Annual CWT	12.5M	5.7M
Annual Lines	6.8M	5.3M

The combined throughput capacity of this four depot cluster exceeds the Refined System requirement by 28 percent. This option results in a 40 percent reduction in storage capacity, but still exceeds the required storage capacity by 37.9 million cubic feet.

Option 5: Closure of DDTC and NASAL. The local customer supply interface at NASAL could be absorbed by NSCOAK. This option incurs a small maintenance interface penalty at NASAL. The DICOMSS special distribution mission at DDTC could be accomplished at any of the remaining depots. This option maintains the NASAL wholesale stocks in close proximity to airlift and deep-water port capabilities at NSCOAK. NSCOAK could provide support to depot maintenance at NASAL.

A comparison of the throughput capacity of SAAD, SHAD, NSCOAK and SMALC and the Refined System cluster workload is as follows:

	SAAD, SHAD NSCOAK, SMALC Capacity	Refined System Workload
Annual CWT	11.9M	5.7M
Annual Lines	8.5M	5.3M

The combined throughput capacity of the option exceeds the Refined System workload by 60 percent. Storage capacity is 88.9 million cubic feet, or 84 percent above the Refined System requirement.

Option 6: Closure of SAAD and DDTC. This differs from Option 5 in that there is no impact on the proximity of wholesale stocks to airlift or water port capabilities within the cluster. However, a $1.9 million maintenance interface penalty is incurred. Support of depot maintenance at SAAD could be accomplished from nearby SMALC. There is no separation of wholesale stocks from organic capabilities and the DICOMSS special distribution mission at DDTC could be absorbed by one or more of the remaining depots in the cluster.

A comparison of the throughput capacity of SHAD, NASAL, NSCOAK and SMALC and the Refined System cluster workload is as follows:

	SHAD, NASAL NSCOAK, SMALC Capacity	Refined System Workload
Annual CWT	11.4M	5.7M
Annual Lines	8.4M	5.3M

The closure of SAAD and DDTC reduces the cluster throughput capacity by 33 percent, but the remaining capacity is above the Refined System workload. Storage capacity decreases to 88.9 million cubic feet, well above the 48.3 million cubic feet of storage space required.

Options 7 & 8: The last two options again present the trade-off between NSCOAK and DDTC. However, both call for closure of SMALC which has the largest impact on support to a depot maintenance activity within the cluster and generates an estimated annual $2.8 million maintenance interface penalty cost for processing unserviceable reparables at the collocated maintenance site. SMALC also has local customer supply interface responsibilities for operational units at McClellan AFB. SMALC possesses airlift capability on-base and has recently undergone extensive modernization.

The throughput and storage capacity of the four depots in both Options 7 and 8 compared to the Refined System workload for the cluster are as follows:

	Option 7 SAAD, SHAD NASAL, DDTC Capacity	Option 8 SAAD, SHAD NASAL, NSCOAK Capacity	Refined System Workload
Annual CWT	10.5M	9.4M	5.7M
Annual Lines	4.0M	5.6M	5.3M

In terms of throughput capacity in CWT and storage capacity the remaining depots in each option could handle the Refined System requirement. The storage capacity under Option 7 and 8 is 80.4M and 83.1M cubic feet respectively. To overcome the 1.3 million shortfall in line item capacity in Option 7, an estimated $3.6 million capital investment in MHE and processing space will be required at DDTC.

(7) Summary. Each option involves the discontinuation of the wholesale distribution mission at NSCOAK or the closure of DDTC. Closure of NSCOAK has the potential to degrade existing supply interfaces with local operational units and will remove some of the wholesale stocks from collocated organic deep-water port capability. Closing DDTC requires relocation of the special distribution mission, DICOMSS.

Options 1 and 2, which close SHAD and NSCOAK and SHAD and DDTC respectively, generate the highest annual savings. Relocation of the CCP mission could be accommodated at SAAD. Impact on customer supply interfaces would be minimal. Closing SHAD would eliminate the need to replace or upgrade SHAD's marginal distribution facilities to maintain existing capability.

Discontinuance of the wholesale mission at NASAL (Options 3 and 5) incurs a $0.6 million maintenance interface penalty cost and when coupled with closure of NSCOAK has a potential negative impact on support to local operational units, namely eight squadrons comprising approximately 200 aircraft. Unless positioned at NSCOAK, wholesale aviation materiel would be separated from the local customers as well as from organic airlift and deep-water port capabilities. Closing NASAL would eliminate a near term one-time cost requirement to upgrade marginal facilities.

Options 4 and 6, closing SAAD, incur a $1.9 million maintenance interface penalty cost. Wholesale support could be provided by nearby SMALC.

Phasing out the wholesale mission at SMALC (Options 7 and 8) would generate a disruption of the local customer supply interface, including a "new" $2.8 million annual maintenance interface penalty for separating unserviceable reparables from the maintenance activity. Option 7 further creates a substantial shortfall in existing line item throughput capacity requiring an estimated $3.6 million one-time capital investment to handle the cluster workload.

b. Utah Cluster

(1) Facilities. Tooele Army Depot (TEAD); Ogden Air Logistics Center (OOALC); and Defense Depot Ogden (DDOU).

(2) Discussion. The macro-analysis prescribed a significantly lower workload for this cluster than the combined Baseline capacity of the three depots in the cluster. The macro-analysis supported a fixed cost of

one-third the Baseline fixed cost of $14.8 million, thus indicating a reduction of $9.9 million.

(3) Cluster Data.

	Baseline Capacity	Refined System Workload
Annual CWT	13.8M	2.0M
Annual Lines	9.0M	1.4M
Storage (cu ft)	74.2M	17.8M

The Refined System reduction in workload is shown in the following generalized commodity groups:

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	1.3M	1.3M
Personnel Consumables	0.3M	0.2M
Other Consumables	0.9M	0.5M
Total	2.5M	2.0M

(4) Depot Data.

	TEAD	OOALC	DDOU
Collocated Customers:			
Operational Units	No	Yes	No
Depot Maintenance	Yes	Yes	No
IPE	No	No	No
Special Distribution Missions	No	No	No
Organic Capability:			
Water Port	No	No	No
C-5 Airport	No	Yes	No
Facility Condition	Adequate	Very Good	Very Good
Throughput Capacity:			
Annual CWT	10.9M	1.8M	1.1M
Annual Lines	1.0M	3.3M	4.7M

	TEAD	OOALC	DDOU
Storage Capacity (cu ft)	12.1M	13.4M	48.7M
Fixed Cost ($)	4.0M	2.2M	8.5M
Maintenance Interface Penalty (Potential) ($)	3.2M	2.2M	0

(5) Principal Options.

Option	TEAD	OOALC	DDOU	Annual Savings	Estimated One-Time Costs: Personnel	Estimated One-Time Costs: Materiel Relocation
1			X	$8.5M	$11.3M	$3.4M
2	X	X		$0.8M	$ 9.6M	$9.4M

(6) Option Description.

Option 1: Close DDOU. Closure of DDOU achieves the largest annual savings in the cluster. DDOU is not collocated with a major depot maintenance activity and therefore does not incur a maintenance interface penalty. Throughput capacity of the cluster compared to Refined System workload is as follows:

	TEAD OOALC Capacity	Refined System Workload
Annual CWT	12.7M	2.0M
Annual Lines	4.3M	1.4M

The combined throughput capacity of TEAD and OOALC is over 200 percent above the Refined System in both CWT and lines. Storage capacity of this option is 25.4 million cubic feet or an excess of 7.6 million cubic feet.

Option 2: This option closes the wholesale mission at both TEAD and OOALC. The annual savings are almost netted out by the maintenance interface penalty costs associated with TEAD and OOALC. DDOU storage capacity is more than adequate for the Refined System storage requirement. The throughput capacity of this option, compared to the Refined System workload is as follows:

	DDOU Capacity	Refined System Workload
Annual CWT	1.1M	2.0M
Annual Lines	4.7M	1.4M

The DDOU capacity while more than enough in lines, was only 55 percent of the Refined System requirement in CWT. Finally, this option has a potential negative impact on the operational units at Hill AFB and a combined maintenance interface penalty at both maintenance sites of $5.4 million.

(7) Summary. Option 1 is feasible in terms of both reducing fixed cost and retaining sufficient processing and storage capacity. Further, this option has no potential negative impact on maintenance and operating unit support relationships in the cluster. Option 2 was formulated to illustrate the limited annual savings and shortfall in capacity associated with closure of the wholesale distribution missions at TEAD and OOALC.

2. Clusters Not Requiring Reductions in Fixed Cost

Five clusters (Virginia, Pennsylvania, Texas, Southern California, and Pearl Harbor) in the Refined System had sufficient workload volume to support the full fixed cost of the cluster. However, the Virginia cluster offers some opportunity for economic trade-offs. Although the economic balance of the Pennsylvania and Texas clusters is based on the continuation of existing depot level maintenance missions, options are framed for these clusters for future consideration. The Southern California cluster poses a unique problem which will be addressed. Finally, Pearl Harbor presents no alternatives.

a. Virginia Cluster

(1) Facilities. Naval Air Station Norfolk (NASNOR); Naval Supply Center Norfolk (NSCNOR); Marine

Corps Air Station Cherry Point (MCASCP); and Defense General Supply Center Richmond (DGSC).

(2) Discussion. The macro-analysis indicated that the throughput volume of this cluster would support the total depot fixed cost of the cluster. However, the Refined System prescribed a cluster workload which was less than the collective baseline capacity, indicating that potential savings were possible by elimination of the wholesale distribution mission at one or more of the four depots.

(3) Cluster data.

	Baseline Capacity	Refined System Workload
Annual CWT	6.4M	2.9M
Annual Lines	7.2M	4.5M
Storage (cu ft)	108.1M	33.0M

The Refined System increased reparable workload but decreased the total workload in this cluster compared to the Baseline as shown in the following generalized commodity groupings:

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	0.2M	0.3M
Personnel Consumables	1.1M	1.1M
Other Consumables	1.9M	1.5M
Total	3.2M	2.9M

(4) Depot Data.

	NASNOR	NSCNOR	MCASCP	DGSC
Collocated customers:				
Operational Units	Yes	Yes	Yes	No
Depot Maintenance	Yes	Yes	Yes	No
IPE	No	No	No	No
Special Distribution Missions	No	MAC	No	No
Organic Capability:				
Water Port	Yes	Yes	No	No
C-5 Airport	Yes MAC APOE	Yes MAC APOE	Yes	No
Facility Condition	Marginal	Adequate	Marginal	Adequate
Throughput Capacity:				
Annual CWT	0.4M	3.4M	0.4M	2.2M
Annual Lines	0.7M	4.3M	0.8M	1.4M
Storage Capacity (cu ft)	8.5M	41.7M	3.9M	54.0M
Fixed Cost ($)	1.4M	5.6M	1.3M	5.8M
Maintenance Interface Penalty (Potential) ($)	0.4M	*	0.4M	0

* Less than $0.05M.

(e) Principal Options.

Option	NASNOR	NSCNOR	MCASCP	DGSC	Annual Savings	Estimated One-Time Costs: Personnel	Estimated One-Time Costs: Materiel Relocation
1	X			X	$6.9M	$9.2M	$1.6M
2			X	X	$6.8M	$7.9M	$1.3M
3				X	$5.8M	$6.3M	$0.9M
4		X			$5.6M	$7.1M	$2.0M
5	X				$1.0M	$2.9M	$0.7M
6			X		$0.9M	$1.6M	$0.4M

(6) Option Descriptions.

Option 1: Close NASNOR and DGSC. The NSCNOR wholesale distribution mission can be expanded to include all consumables for the geographical area. The supply interface with depot maintenance at NASNOR would be accomplished by NSCNOR. The remaining depots' capacity compared to the Refined System workload is as follows:

	MCASCP NSCNOR Capacity	Refined System Workload
Annual CWT	3.8M	2.9M
Annual Lines	5.1M	4.5M
Storage (cu ft)	45.6M	33.0M

The collective throughput and storage capacities are sufficient to handle the proposed throughput and to accommodate the proposed storage requirements. Facility conditions MCASCP are marginal and an investment will be required in the near future to upgrade or replace existing facilities in order to maintain capacity.

Option 2: Close MCASCP and DGSC. The NSCNOR wholesale distribution mission can be expanded to absorb the DGSC workload. The supply interface with depot maintenance and 13 aircraft squadrons is disrupted at MCASCP. The remaining depots' capacity compared to the Refined System workload is as follows:

	NASNOR NSCNOR Capacity	Refined System Workload
Annaul CWT	3.8M	2.9M
Annual Lines	5.0M	4.5M
Storage (cu ft)	50.2M	33.0M

The collective throughput and storage capacities of NSCNOR and NASNOR are sufficient to handle the proposed throughput and to accommodate the proposed storage requirements. Facility conditions at NASNOR are marginal and an investment will be required in the near future to upgrade or replace existing facilities in order to maintain capacity.

Option 3: Close DGSC. This option presents minimum disruption to supply interfaces with maintenance and operational units collocated with the other wholesale supply activities. The remaining depots' throughput capacity, compared to the Refined System workload for the cluster is as follows:

	NASNOR NSCNOR MCASCP Capacity	Refined System Workload
Annual CWT	4.2M	2.9M
Annual Lines	5.8M	4.5M
Storage (cu ft)	54.1M	33.0M

NASNOR, NSCNOR and MCASCP collectively possess a margin in throughput capacity in both CWT and lines to handle the proposed workload. The combined storage capacity of these three depots is 54.1 million cubic feet and of sufficient magnitude to accommodate the proposed storage requirement (33.0 million cubic feet). Facility conditions at NASNOR and MCASCP are marginal and will require one-time investments for upgrading or replacement within the near future to maintain required capacities. The future mission of NASNOR and MCASCP in this option should be wholesale distribution of aviation reparables and related products.

Option 4: Reduce NSC Norfolk to a retail mission. Wholesale distribution of ship's parts and boats should be retained in the Norfolk area and could be accomplished by NASNOR. The potential negative impact on local customer supply interface patterns with operating units is greatest with this option. The major wholesale supply activity (DGSC) would be separated from a deep-water port with break-bulk capability and from a C-5 capable aerial port by 100 miles. The capacity of the remaining depots compared to the Refined System workload for the cluster is as follows:

	NASNOR MCASCP DGSC Capacity	Refined System Workload
Annual CWT	3.0M	2.9M
Annual Lines	2.9M	4.5M
Storage (cu ft)	66.4M	33.0M

In terms of CWT, the combined capacity of NASNOR, MCASCP and DGSC is capable of handling the proposed workload. Throughput capacity in Lines is 36 percent below the proposed demand and would require an estimated $5.6 million investment at DGSC in MHE and facilities to satisfy the requirement. Storage capacity of this option is 66.4 million cubic feet or twice the proposed requirement. The marginal facilities at NASNOR and MCASCP will require one-time investments for upgrading or replacement to maintain required capabilites, within the near future.

Option 5: Close NASNOR wholesale mission. Marginal savings are associated with this option. The supply interface of depot maintenance and 18 aircraft squadrons would be shifted to NSCNOR.

NSCNOR, MCASCP and DGSC's throughput capacity compares to the Refined System workload for this cluster as follows:

	NSCNOR MCASCP DGSC Capacity	Refined System Workload
Annual CWT	6.0M	2.9M
Annual Lines	6.5M	4.5M
Storage (cu ft)	99.6M	33.0M

Throughput capacity would exceed the Refined System workload by 44 percent. Storage capacity is reduced to 99.6 million cubic feet, which is 66.6 million cubic feet greater than the storage demand. One-time capital investment would be required to upgrade marginal facilities at MCASCP, within the near future, in order to retain existing capabilities.

Option 6: Close MCASCP wholesale mission. Marginal savings are associated with disruption to the supply interface of depot maintenance and 13 aircraft squadrons.

The remaining throughput capacity compared to the Refined System workload for this cluster is as follows:

	NASNOR NSCNOR DGSC Capacity	Refined System Workload
Annual CWT	6.0M	2.9M
Annual Lines	6.4M	4.5M
Storage (cu ft)	104.2M	33.0M

Excess capacity would remain in the proposed system with this option, since only 70 percent of the capacity of the remaining three depots is being used.

This option would produce an estimated $0.4 million in "new" cost to the DODMDS for processing unserviceable reparables at MCASCP, the collocated depot maintenance site. Potential negative impact on local customer supply interface would also be associated with the separation of wholesale stocks from the operational aircraft units at MCASCP. The marginal facility condition at NASNOR will require one-time investment in MHE and warehouses, within the near future, to maintain required capabilities.

(7) Summary. Storage capacity at either NSCNOR or at DGSC alone is sufficient for the Refined System workload. Wholesale distribution mission closure at DGSC and one of the air stations produces the highest annual savings in fixed costs to DOD. Limiting the closure to DGSC produces the next highest annual savings with no adverse impact on customer supply interfaces. Near term one-time investments to upgrade facilities at NASNOR and MCASCP would be required to maintain existing and needed capabilities.

The phase-down of the wholesale distribution mission at NSCNOR produces a substantial shortfall in line item throughput capacity. A potential negative impact on customer supply interface would result from separation of the NSCNOR wholesale stocks from local customers. Immediate proximity of the NSCNOR wholesale stock to an organic deep-water port and airlift capability will be lost. One-time capital investments to increase the throughput capacity at DGSC is required to support the Refined System workload. The investment at NASNOR and MCASCP would still be required.

Phasing out the wholesale distribution missions at NASNOR or MCASCP contributes little to reducing excess capacity. Phasing out MCASCP produces a potential negative impact on customer supply interface patterns with local depot maintenance and operational units.

b. Pennsylvania Cluster

(1) Facilities. Letterkenny Army Depot (LEAD); New Cumberland Army Depot (NCAD); Tobyhanna Army Depot (TOAD); and Defense Depot Mechanicsburg (DDMP).

(2) Discussion. Workload in the Pennsylvania cluster is characterized by the largest volume in CWT of personnel consumables of any cluster in the Refined System. Almost 50 percent of the volume of this cluster in the Refined System is personnel related consumables, with 25 percent being reparables and 25 percent being other consumables. The macro-analysis indicated that the throughput volume would support the total depot fixed cost of this cluster. Retaining the two largest depots (DDMP & NCAD) creates no impact on the special mission distribution assignments.

(3) Cluster Data.

	Baseline Capacity	Refined System Workload
Annual CWT	14.6M	8.5M
Annual Lines	5.0M	5.5M
Storage (cu ft)	138.7M	51.7M

The annual volume of workload in the Refined System is greater than the annual cluster capacity in lines when capacity is computed on the basis of 251 eight-hour working days per year. Processing of Refined System workload would require that the depots in this cluster operate 276 eight-hour working days annually. This excess of Refined System workload is only in terms of lines and may be due to selection of the highest quarter of transaction data from the data base for simulation modeling. The Refined System changes in the workload over the Baseline are shown in the following commodity groupings:

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	1.7M	2.0M
Personnel Consumables	4.0M	4.2M
Other Consumables	2.2M	2.3M
Total	7.9M	8.5M

(4) Depot Data.

	LEAD	NCAD	TOAD	DDMP
Collocated Customers:				
Operational Units	No	No	No	No
Depot Maintenance	Yes	Yes	Yes	No
IPE	No	No	Yes	Yes
Special Distribution Missions	No	CCP	No	DICOMSS
Organic Capability:				
Water Port	No	No	No	No
C-5 Airport	No	No	No	No
Facility Condition	Adequate	Very Good	Very Good	Adequate
Throughput Capacity:				
Annual - CWT	1.8M	5.8M	.6M	6.4M
Annual - Lines	.5M	2.0M	.2M	2.3M
Storage Capacity (cu ft)	11.7M	29.1M	26.2M	71.7M
Fixed Cost ($)	3.0M	4.3M	3.1M	4.4M
Maintenance Interface Penalty (Potential) ($)	2.8M	1.9M	1.8M	0

(5) Principal Options.

Option	LEAD	NCAD	TOAD	DDMP	Annual Savings	Estimated One-Time Cost: Personnel	Estimated One-Time Cost: Material Relocation
1			X		$1.3M	$2.8M	$1.8M
2	X				$0.2M	$4.7M	$2.1M
3					0	0	0

(6) Option Description.

Option 1: Close TOAD wholesale distribution mission. This option would generate a disruption in the supply interface with an Army maintenance activity. With the current maintenance mission at this depot, the savings in this option are marginal. Alteration of the maintenance mission at TOAD in the future should generate a reassessment of the need for this depot as a DODMDS distribution facility. The throughput capacity in CWT and storage capacity in cubic feet of LEAD, NCAD, and DDMP as compared to the proposed system are:

	LEAD, NCAD DDMP Capacity	Refined System Workload
Annual CWT	14.0M	8.5M
Storage Space (cu ft)	112.5M	51.7M

This option would require that the three remaining depots operate 288 eight-hour work days, per year in order to process the Refined System line item workload.

Option 2: Close LEAD wholesale distribution mission. Closing the LEAD wholesale distribution mission would generate the largest maintenance interface penalty of all options in this cluster. The net savings associated with this option are very marginal within the context of the historical maintenance mission. Should the historical maintenance mission change, then larger savings could be generated. The capacity of the other three depots exceeds the Refined System workload by 50 percent in CWT and 145 percent in storage capacity. This option would require that the three remaining depots operate 306 eight-hour working days per year, in order to process the Refined System line item workload.

Option 3: Close no depots. This option represents no disruption of supply interface associated with Army maintenance activities and represents no savings or additional cost as compared to the Baseline. The wholesale materiel stockage of TOAD and LEAD should include only wholesale reparable materiel required for the depot level maintenance program at each of those depots.

(7) Summary. The phase out of the wholesale distribution mission at TOAD would produce a net savings with no significant impact on the overall capacity of this cluster. However, significant disruption to the TOAD maintenance mission would occur. Closure of the wholesale distribution mission at LEAD produces marginal savings with significant disruption to the LEAD maintenance mission. The requirement for both TOAD and LEAD as DOD wholesale distribution facilities is predicated on the continuance of the maintenance mission at each depot. NCAD and DDMP were not considered viable depots for closure because of their existing capacities. Closure of either depot would cause a major shortfall in required capability within this cluster.

c. Texas Cluster

(1) Facilities. Corpus Christi Army Depot (CCAD) and San Antonio Air Logistics Center (SAALC).

(2) Discussion. The macro-analysis supported the total fixed cost of this cluster. The influence of depot level maintenance in this cluster made it viable in the overall system structure. In the Refined System, however, this cluster assumes more of a geographical area support responsibility than in the past, particularly in the distribution of personnel and other consumable commodities.

(3) Cluster Data.

	Baseline Capacity	Refined System Workload
Annual CWT	4.2M	1.9M
Annual Lines	3.8M	2.0M
Storage (cu ft)	34.3M	16.4M

The change in depot workload in the Refined System as opposed to the Baseline is shown in the following general commodity groups:

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	0.6M	0.7M
Personnel Consumables	*	0.4M
Other Consumables	0.2M	0.8M
Total	0.8M	1.9M

* Less than 2000 CWT.

(4) Depot Data.

	CCAD	SAALC
Collocated Customers:		
Operational Units	No	Yes
Depot Maintenance	Yes	Yes
IPE	No	No
Special Distribution Missions	No	No
Organic Capability:		
Water Port	No	No
C-5 Airport	Yes	Yes
Facility Condition	Very Good	Very Good
Throughput Capacity:		
Annual CWT	1.1M	3.1M
Annual Lines	0.4M	3.4M

	CCAD	SAALC
Storage Capacity (cu ft)	4.3M	30.0M
Fixed Cost ($)	0.7M	2.7M
Maintenance Interface Penalty (Potential) ($)	2.2M	3.3M

(5) Principal Options.

Option	CCAD	SAALC	Annual Cost Increase	Estimated One-Time Cost: Personnel	Estimated One-Time Cost: Material Relocation
1	X		$1.5M	$0.7M	*
2			0	0	0

*$29,000.

(6) Option Description.

Option 1: Close wholesale distribution mission at CCAD. With the current depot level maintenance mission at CCAD, the savings associated with this option are negative, i.e., to support the depot level maintenance requirements for unserviceables from an alternate site would generate a net increase in cost to DOD. Should the CCAD depot level maintenance mission change in the future this option will create additional savings. The CWT and lines processing and storage capacity at SAALC is more than adequate to accommodate the total volume of this cluster.

Option 2: Close no depots. This option represents no disruption in the established supply interface associated with the two maintenance activities in this cluster and represents no savings or additional costs when compared to the Baseline. The wholesale distribution mission at CCAD should be restricted to wholesale reparables necessary to support the depot level maintenance at that location. This option was viable given the current depot level maintenance missions at both CCAD and SAALC.

(7) Summary. With the current depot level maintenance functions in this cluster there was no economic reason for altering the number of depots in this cluster or their mission.

d. Southern California Cluster

(1) Facilities. Naval Air Station North Island (NASNI); Naval Supply Center San Diego (NSCSD); and Marine Corps Logistic Support Base, Pacific (MCLSCBPAC).

(2) Discussion. In the macro-analysis the capacity constraint at each cluster was set at 25 percent over the historical wholesale weighted throughput (WTP) of the depots comprising each cluster. It was assumed that up to the 25 percent increase in WTP there would be no change in the fixed cost of a cluster, and that increases over 25 percent would require an increase in fixed cost. An 8 percent violation of the weighted throughput capacity limit in this cluster indicated that an increase of fixed costs was required. The fixed cost of this cluster was increased by $1.0 million and was subjected to an optimization analysis with no impact on the Refined System. The $1.0 million in increased fixed cost for this cluster was arbitrarily selected as a value greater than a linear extrapolation of fixed cost and was used to test the economic threshold in the optimization process. The capacity of this cluster in CWT exceeds the proposed workload but a large portion of the cluster capacity is at MCLSBPAC which is approximately 140 miles from the San Diego naval complex. The lines capacity of this cluster approximately equals the proposed workload. The Southern California cluster is characterized by a large concentration of customers, both operational units and maintenance facilities, in the San Diego naval complex and a large depot capacity at MCLSBPAC, including specialized equipment for handling and storing combat and non-combat vehicles.

	Baseline Capacity	Refined System Workload
Annual CWT	6.7M	1.9M
Annual Lines	2.5M	2.5M
Storage (cu ft)	50.4M	17.4M

(3) Cluster Data. The Refined System throughput for the cluster differed from the Baseline workload composition in that the volume of both personnel and other consumable commodities significantly increased:

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	0.6M	0.6M
Personnel Consumables	0.3M	0.6M
Other Consumables	0.3M	0.7M
Total	1.2M	1.9M

(4) Depot Data.

	NASNI	NSCSD	MCLSBPAC
Collocated Customers:			
Operational Units	Yes	Yes	No
Depot Maintenance	Yes	Yes	Yes
IPE	No	No	No
Special Distribution Missions	No	MWC	No
Organic Capability:			
Water Port	Yes	Yes	No
C-5 Airport	Yes	No	No
Facility Condition	Adequate	Adequate	Adequate
Throughput Capacity:			
Annual CWT	0.7M	0.8M	5.2M
Annual Lines	0.8M	0.4M	1.3M
Storage Capacity (cu ft)	18.1M	6.1M	26.2M
Fixed Cost ($)	1.7M	1.3M	4.8M
Maintenance Interface Penalty (Potential)($)	0.85M	0.14M	0.14M

All depots open. In this cluster there is a need to have a depot in the proximity of depot maintenance and operational units in the San Diego complex since these are the largest customers supported. The vehicle depot maintenance mission also requires direct support of a distribution facility. Therefore, the course of action indicated for the immediate future would be to process all reparables, other than vehicle reparables, at the San Diego naval complex, and all vehicle reparables at MCLSBPAC. The maximum possible amount of consumables should be processed at the San Diego complex and the overflow at MCLSBPAC. In the future, with improved facilities at the San Diego complex,[1] MCLSBPAC could be phased down to processing of vehicle reparables and the associated consumables and support of customers in the immediate vicinity.

e. Pearl Harbor Cluster

(1) Facility. NSC Pearl Harbor (NSCPH).

(2) Discussion. The throughput of this cluster was managerially limited during the macro-analysis. The composition of the workload in the Refined System does not differ significantly from the Baseline. There is no major issue with this cluster.

(3) Cluster Data.

	Baseline Capacity	Refined System Workload
Annual CWT	0.4M	0.1M
Annual Lines	0.2M	0.2M
Storage (cu ft)	5.6M	0.5M

[1]The Navy has approved funding of $7.2 million in MILCON funds to replace aging storage and processing facilities.

The changes of workload volume between the baseline and the Refined System by generalized commodity category are reflected below:

	Baseline Workload (CWT)	Refined System Workload (CWT)
Reparables	0.002M	0.001M
Personnel Consumables	0.107M	0.090M
Other Consumables	0.007M	0.027M
Total	0.116M	0.118M

The current processing capacity of this depot is adequate to meet the depot workload volume of the Refined System.

(4) Depot Data.

	NSCPH
Collocated Customers:	
Operational Units	Yes
Depot Maintenance	Yes
IPE	No
Special Distribution Mission	No
Organic Capability:	
Water Port	Yes
C-5 Airport	No
Facility Condition	Adequate
Throughput Capacity:	
Annual CWT	0.4M
Annual Lines	0.2M
Storage Capacity (cu ft)	5.6M
Fixed Cost ($)	0.54M
Maintenance Interface (Penalty (Potential) ($)	0.002M

3. Intercluster Analysis

a. Discussion

The purpose of the macro-analysis described in Chapter 5 was to produce an Objective System structure using the trade-offs between depot fixed costs and transportation costs. After the Objective System was established a link editing process was undertaken to match the Objective System workload allocation to the physical capacity - both throughput and storage - of the clusters remaining in solution. This process produced the Refined System, which was subjected to intracluster analysis.

The purpose of this intracluster analysis was to explore the potential contribution of individual depots within each cluster to the Refined System. The means for doing this analysis was to assess the ability of selected combinations of individual depots within clusters to match the Refined System requirements, measured in existing physical throughput and storage capacity, and potential costs/savings. This process was called option formulation.

The application of these processes to the clusters in the southeastern CONUS (including, for this discussion, ANAD, RRAD, OCALC, DDMT and the depots in the Georgia/Florida cluster) produced a situation where a structural decision, viz, closure of DDMT, arrived at through macro-analysis, must be reassessed in light of the option formulation process. The following discussion describes the formulation of alternatives for processing the workload in the Southeastern CONUS:

During the link editing process to achieve the Refined System, certain customer-commodity combinations were removed from ANAD and RRAD due to physical capacity limitations at those facilities. Since both the Georgia/Florida and Oklahoma City clusters had large amounts of physical capacity which were available in the Objective System, these clusters were managerially given substantially increased workload. While physical throughput and storage capacities were not exceeded in this process, the increase in workload over the baseline was substantial enough to require an assessment of the potential increase in fixed cost of these two clusters.

In the macro-analysis with the optimization model the capacity constraint at each cluster was set at 25 percent over the historical wholesale weighted throughput (WTP) of the depots comprising each cluster. It was assumed for up to the 25 percent increase in WTP, there would be no change in the fixed cost of a cluster, and that increases over 25 percent would result in an economic capacity violation requiring an increase in fixed cost. This assumption appears to be reasonable in view of the absence of empirical evidence as to the actual behavior of depot fixed cost at extreme increases in depot workload. In order to bridge the empirical evidence gap concerning the relationship between depot fixed cost and workload, the analysis in Appendix F, Section 5 was conducted to provide estimates of fixed cost associated with various levels of depot workload. The fixed cost projection technique in Appendix F, Section 5 must be viewed as an estimating technique developed for study purposes. The actual fixed cost increases at a given depot will be dependent upon specific physical conditions at each depot and the level of retail activity, not included in this analysis.

The weighted throughput of the Georgia/Florida cluster increased from 17.9 million in the base year to 32.1 million in the Refined System, or an increase of 79 percent. Capacity of the cluster measured in WTP was 22.4 million (17.9 million X 1.25). This value represents the level of WTP for which historical fixed cost was assumed to apply. The Refined System increased WTP 43 percent over the WTP capacity limit. The individual depot contributions to the cluster WTP capacity and fixed cost are shown below:

Depot	WTP Capacity	Historical Fixed Cost
NASJAX	2.9M	$1.0M
WRALC	15.3M	$2.2M
MCLSBLANT	4.2M	$3.2M
Total	22.4M	$6.4M

Appendix F, Section 5, contains the technique used for estimating increases in depot fixed cost. For a postulated level of depot workload measured in WTP, the estimating relationship provides an estimated value of fixed cost. By extrapolating the estimating relationship to 32.1 million in WTP, the estimate of the minimum fixed cost required for the Georgia/Florida cluster is $5.8 million. Since this level of fixed cost would only apply for a single depot and since no one depot in the cluster has the capacity in both the CWT and Lines to handle the requirements of the Refined System, the workload must be apportioned among the depots. However, the technique in Appendix F, Section 5 can be applied only to NASJAX and WRALC. Since MCLSBLANT does not fit the sample used to devise the estimating relationship, either no change in WTP and fixed cost for MCLSBLANT can be made or a separate means must be employed for projecting increases to its fixed cost.

One alternative would absorb the entire increase in WTP for the cluster at WRALC, leaving both NASJAX and MCSLBLANT at their historic WTP and fixed cost. The projected fixed cost for the cluster under that condition was computed as follows (Case 1):

Case 1

Depot	Increase in WTP	Revised WTP	Projected FC
NASJAX	0	2.9M	1.0M
WRALC	9.7M	25.0M	5.3M
MCLSBLANT	0	4.2M	3.2M
Total	9.7M	32.1M	$9.5M

This represents an estimated increase of $3.1 million over the baseline fixed cost for the cluster.

A second alternative would be to assume a linear relationship between increases in WTP and fixed cost at MCLSBLANT. For this case, both WTP and fixed cost increase by 43 percent and produce projected fixed cost as follows (Case 2):

Case 2

Depot	Increase in WTP	Revised WTP	Projected FC
NASJAX	0	2.9M	$ 1.0M
WRALC	7.9M	23.2M	5.1M
MCLSBLANT	1.8M	6.0M	4.6M
Total	9.7M	32.1M	$10.7M

This represents an estimated increase of $4.3 million over the baseline fixed cost for the cluster.

Therefore, the estimated range of how much fixed cost could increase for this cluster, was $3.1 million to $4.3 million.

The weighted throughput of the Oklahoma City cluster increased from 19.1 million in the base year to 28.4 million in the Refined System, an increase of 49 percent. Capacity of the cluster measured in WTP was 23.9 million (19.1 X 1.25). This value represents the level of WTP for which historical fixed cost was assumed to apply. However, WTP in the Refined System increased 19 percent over WTP capacity. Using the estimating relationship in Appendix F, Section 5, the increase in WTP resulting from the Refined System could increase the fixed cost of this cluster from $2.9 million (historical) to as much as $5.3 million.

The $2.4 million estimated increase in fixed cost for the Oklahoma City cluster, coupled with the $3.1 million estimated increase for Georgia/Florida, produce an overall increase in fixed cost for the southeastern CONUS of $5.5 million. This increase in fixed cost had to be weighed against the DDMT historic fixed cost of $7.1 million to determine if the economic capacity violation at the two clusters was of sufficient magnitude to reinstate DDMT. Further, the magnitude of increase in fixed cost in the Georgia/Florida and Oklahoma City clusters had to be weighed against DDMT at some lower level of fixed cost than the historic fixed cost to determine if a trade-off between the three clusters could be established.

Increasing the fixed cost in the Georgia/Florida and Oklahoma City clusters by $3.1 million and $2.4 million respectively, and conducting an optimization analysis holding all other parameters of the Objective System constant resulted in no change to the system structure, that is, the Memphis cluster did not open with a fixed cost of $7.1 million. Therefore, the estimated value of the economic capacity violation of the Georgia/Florida and Oklahoma City clusters was not of sufficient magnitude to reinstate the Memphis cluster and close either of the other clusters. Decreasing the fixed cost of Memphis from $7.1 million to $2.0 million while holding the Georgia/Florida and Oklahoma City cluster fixed costs at historic levels of $6.4 million and $2.9 million respectively, and restricting the workload volume of ANAD brought DDMT into solution. However, increasing DDMT fixed cost to $3.0 million under the same model conditions did not open DDMT, i.e., DDMT was in solution at a fixed cost, $2.0 million but not at $3.0 million. Thus, the estimated increased cost associated with the economic capacity violations in Georgia/Florida and Oklahoma City could be avoided only if the DDMT fixed cost could be reduced to the unrealistic level of $2.0 million. The impact of retaining DDMT is that the depot workload overflow at the Georgia/Florida and Oklahoma City cluster can be absorbed by DDMT thereby foregoing the economic capacity violations at those two clusters.

The economics of closing DDMT, thereby absorbing increases in workload at the two clusters (Georgia/Florida and Oklahoma City) having the required physical capacity, could be equivalent to the economics of retaining DDMT as a stock point. The economic equivalence between retaining and closing Memphis in the system structure is contingent upon the accuracy of the estimates of increasing fixed cost due to increasing workload. If the estimates of increase in fixed costs are higher than actual values, then the viability of Memphis in the system structure is reduced, i.e., additional workload can be absorbed by the Georgia/ Florida and Oklahoma City clusters for a lower total cost than by opening Memphis. If the estimates of increase in fixed costs are lower than the actual values, then the viability of Memphis in the system structure is increased.

With no overwhelming economic advantage associated with retention or closure of DDMT, the disposition of DDMT rests on the impact that the DDMT closure or retention has on the other depots/clusters in Southeastern CONUS. For purposes of formulating options in the Southeastern CONUS, the following scenarios involving the Memphis cluster were used:

(1) Scenario 1 is the Refined System with DDMT closed. It may be recalled from Chapter 5 that the Refined System imposed link editing on ANAD and RRAD clusters to prevent exceeding the physical capacity constraints at those two depots. This produced economic capacity limit violations at Georgia/Florida and Oklahoma City clusters of 43 and 19 percent respectively.

(2) Scenario 2 is a Modified Refined System with DDMT Open. This scenario imposed link editing on ANAD and RRAD but permitted DDMT to absorb the excess workload from those two depots, thereby reducing the economic capacity violation at Georgia/Florida and Oklahoma City clusters to 1 and 10 percent respectively.

The physical and economic capacity characteristics of DDMT permit this depot to absorb the depot workload of Scenario 2. The depot workload for DDMT under Scenario 2 is 2.4 million CWT as compared to a baseline capacity of 4.0 million CWT.

Since the depot workload volume for the Georgia/Florida cluster was dependent upon the disposition of DDMT, two sets of options were framed for this cluster. What follows is a description of the cluster capabilities and options under Scenario 1, DDMT closed, and Scenario 2, DDMT open.

b. Georgia/Florida Cluster

(1) Facilities. Naval Air Station Jacksonville (NASJAX); Warner-Robins Air Logistics Center (WRALC); Marine Corps Logistics Support Base Atlantic (MCLSBLANT).

(2) Discussion. The workload in this cluster Scenario 1 is substantially different than in Scenario 2 with DDMT open. In Scenario 1, the WTP of the cluster exceeded the WTP capacity limit by 43 percent. Such a large increase in WTP could cause fixed cost to increase by an estimated $3.1 million.[1]

Under Scenario 2, the WTP of the cluster exceeds the WTP capacity of the cluster by 1 percent. These two scenarios produce different frameworks for formulation of options in the Georgia/Florida cluster, the first requiring an increase in fixed costs, the second permitting annual savings to be posited.

(3) Cluster Data.

	Baseline Capacity	Scenario 1 Workload	Scenario 2 Workload
Annual CWT	7.7M	2.6M	1.5M
Annual Lines	5.6M	3.6M	2.7M
Storage (cu ft)	60.5M	26.9M	16.6M

Scenarios 1 and 2 increase the workload in this cluster over the baseline as shown in the following generalized commodity groupings:

	Baseline Workload (CWT)	Scenario 1 Workload (CWT)	Scenario 2 Workload (CWT)
Reparables	0.6M	0.6M	0.5M
Personnel Consumables	*	0.9M	0.4M
Other Consumables	0.2M	1.1M	0.6M
Total	0.8M	2.6M	1.5M

* Less than 8000 CWT

[1]The actual increase in fixed cost is dependent upon the amount of substitution of wholesale stock for retail stock. The minimum increase in fixed cost would be zero under the assumption of total substitution of wholesale for retail.

(4) Depot Data.

	NASJAX	WRALC	MCLSBLANT
Collocated Customers:			
Operational Units	Yes	Yes	No
Depot Maintenance	Yes	Yes	Yes
IPE	No	No	No
Special Distribution Missions	No	No	No
Organic Capability:			
Water Port	No	No	No
C-5 Airport	Yes	Yes	No
Facility Condition	Ade-quate	Very Good	Ade-quate
Throughput Capacity:			
Annual CWT	0.2M	2.4M	5.1M
Annual Lines	0.4M	3.7M	1.5M
Storage Capacity (cu ft)	7.8M	18.6M	34.1M
Fixed Cost ($)	1.0M	2.2M	3.2M
Maintenance Interface Penalty (Potential) ($)	0.3M	3.6M	0.2M

(5) Principal Options.

(a) Under Scenario 1.

Option	NASJAX	WRALC	MCLSB-LANT	Increased Cost	Estimated One-Time Cost Personnel	Estimated One-Time Cost Materiel
1	X			$2.6M	$1.8M	$0.4M
2				$3.1M	0	0

(1) About the Scenario 1 Options. The throughput capacity of WRALC is required to process the line item workload for this cluster under Scenario 1. The storage capacity of MCLSBLANT is required to match the storage requirements for the increase in personnel support and other consumable products for the cluster under Scenario 1. The technique for estimating the increases in fixed costs is that described in case one.

(2) Scenario 1 Option Description. Option 1: Closure of the wholesale mission at NASJAX produces a maintenance interface penalty cost . $0.3 million. The physical throughput and storage capacity of the remaining depots is more than adequate to match the Refined System workload requirements.

	WRALC MCLSBLANT Capacity	Scenario 1 Workload
Annual CWT	7.5M	2.6M
Annual Lines	5.2M	3.6M
Storage (cu ft)	52.7M	26.9M

This option entails separation of the wholesale stocks at NASJAX from the C-5 airfield on base. Further it has a potential negative impact associated with separating wholesale stocks from local customers, namely, depot maintenance and 17 aircraft squadrons.

The following table shows the impact of the increased WTP on the fixed costs associated with this option:

	WTP Capacity	Historical Fixed Cost	Increased WTP	Revised WTP	Estimated Fixed Cost
NASJAX	2.9M	1.0M	0	0	0
WRALC	15.3M	2.2M	12.6M	27.9M*	5.5M
MCLSBLANT	4.2M	3.2M	0	4.2M**	3.2M
Total	22.4M	6.4M	12.6M	32.1M	8.7M

* Includes 2.9 million in WTP capacity from NASJAX.
** Historical Capacity

This option apportions the increase in workload for this cluster primarily to WRALC. The option assumes that a portion of the WTP capacity and storage capacity of MCLSBLANT can be used for processing slow moving bulk personnel and other consumable materiel for the cluster.

The estimated cluster fixed cost of this option is $8.7 million, an increase of $2.3 million over the baseline. The maintenance interface penalty of $0.3 million at NASJAX brings the total increase in costs of this option to $2.6 million.

Option 2: Retain all wholesale distribution facilities. This option incurs no maintenance interface penalty costs and involves no potential negative impact on local supply interfaces. The cluster is left with an excess of physical throughput capacity of almost 200 percent in CWT and 60 percent in lines. Storage capacity of the three combined is over twice the Refined System requirement. This option could result in an increase in costs of $3.1 million to $4.3 million described in Case one and Case two due to the substantial increase in workload over the baseline. The physical capacity of the depots compared to the scenario and workload is as follows:

	Baseline Capacity	Scenario 1 Workload
Annual CWT	7.7M	2.6M
Annual Lines	5.6M	3.6M
Storage (cu ft)	60.5M	26.9M

(3) Summary of Scenario 1 Options. With no wholesale mission closures, this cluster requires an estimated increase in fixed cost of $3.1 million. The estimated fixed cost increase for the cluster may be slightly reduced by discontinuation of the wholesale mission at NASJAX. The estimated cost avoidance achieved through closure of NASJAX is only $.5 million different from the option which closes none of the wholesale distribution functions in the cluster ($3.1 million - 2.6 million = $0.5 million). When weighed against the potential negative impact on local customer

supply interfaces at NASJAX, this may be regarded as insignificant.

MCLSBLANT's role in the future under Scenario 1 expands from support of depot maintenance to an increased mission of processing and storage of bulk personnel and other consumable commodities for the geographic area. An increased mission assumes that the high historic fixed cost at MCLSBLANT represents underutilized capability both in facilities and personnel.

(b) Under Scenario 2.

Option	NASJAX	WRALC	MCLSB-LANT	Annual Savings	Estimated One-Time Cost Personnel	Estimated One-Time Cost Materiel
1			X	$3.0M	$1.9M	$5.1M
2	X			$0.7M	$1.8M	$0.4M
3		X		0	$6.3M	$1.7M
4				0	0	0

(1) Scenario 2 Option Description.

Option 1: Closure of the wholesale mission at MCLSBLANT produces the smallest maintenance interface penalty and the highest annual savings of the four options. The capacity of the remaining depots compares to the Scenario 2 workload for the cluster as follows:

	NASJAX WRALC Capacity	Scenario 2 Workload
Annual CWT	2.6M	1.5M
Annual Lines	4.1M	2.7M
Storage (cu ft)	26.4M	16.6M

The combined capacity of NASJAX and WRALC exceeds the Scenario 2 requirements in both throughput and storage.

This option would remove the wholesale distribution mission from MCLSBLANT with the exception of storing repaired end items prior to shipment. The small maintenance interface penalty indicates that unserviceable reparables can be stored at another site with little economic impact on the potential annual savings to the proposed DODMDS. This option would impact the Marine Corps unique storage and associated care-in-storage of PWRS, weapons systems, and equipment/spares in support of active/reserve forces. If MCLSBLANT is retained, alteration of the depot maintenance mission at MCLSBLANT in the future should generate a reassessment of the need for this depot as a DODMDS facility.

Option 2: Closure of the wholesale mission at NASJAX produces a small maintenance interface penalty and less than $1 million in annual savings. The throughput and storage capacity of the remaining depots is more than enough to match the proposed system workload requirements.

	WRALC MCLSBLANT Capacity	Scenario 2 Workload
Annual CWT	7.5M	1.5M
Annual Lines	5.2M	2.7M
Storage (cu ft)	52.7M	16.6M

This option entails separation of the wholesale stocks at NASJAX from the C-5 airfield on base. Further it has a potential negative impact associated with separating wholesale stocks from local customers, namely, depot maintenance and 17 aircraft squadrons.

Option 3: Closure of the wholesale mission at WRALC produces the highest maintenance interface penalty and as a result no potential annual savings, since the penalty cost exceeds the depot fixed cost at WRALC.

Throughput capacity of the remaining depots compares to the proposed system workload for the cluster as follows:

	NASJAX MCLSBLANT Capacity	Scenario 2 Workload
Annual CWT	5.3M	1.5M
Annual Lines	1.9M	2.7M
Storage (cu ft)	41.9M	16.6M

In terms of CWT, the combined throughput capacity of NASJAX and MCLSBLANT exceeds the workload requirement for the cluster. This combination, however, produces a shortfall in throughput capacity measured in line items. Storage capacity of MCLSBLANT alone is sufficient for the proposed system workload. This option separates wholesale stocks at WRALC from on-base airlift capability.

This option would produce an estimated $3.6 million in cost to the DODMDS in the form of processing unserviceable reparables at the collocated maintenance sites. It would also produce a potential negative impact on existing customer support patterns at WRALC.

Option 4: This option does not close the wholesale mission at any of the three depots. It, therefore, incurs no maintenance interface penalty costs and involves no potential negative impact on local supply interfaces. The cluster is left with an excess of throughput capacity. Storage capacity of the three combined is almost four times the Refined System requirement.

(2) Summary of Scenario 2 Options. The closure of the wholesale distribution mission at MCLSBLANT produces a $3.2 million savings in fixed cost to the proposed DODMDS, with minimum impact on other customer support patterns in the cluster or proximity of wholesale stocks to airlift capability. Disposition of reparable workload at MCLSBLANT requires some offset to potential annual savings.

Discontinuing the wholesale distribution mission at NASJAX produces marginal (less than $1 million) annual savings and a potential negative impact on customer support at NASJAX.

Closure of the wholesale mission at WRALC produces a shortfall in throughput capacity measured in line items, a large maintenance interface penalty, no annual savings, and a potential negative impact on local customer supply interface patterns at WRALC.

The depot data for the single depot clusters in Southeastern CONUS is shown in Table 6-1. The single depot clusters include: Anniston Army Depot (ANAD); Red River Army Depot (RRAD); Oklahoma City Air Logistics Center (OCALC); and Defense Depot Memphis (DDMT).

Table 6-1. Depot Data for Single Depot Clusters

	ANAD	RRAD	OCALC	DDMT
Collocated Customers:				
Operational Units	No	No	Yes	No
Depot Maintenance	Yes	Yes	Yes	No
IPE	No	No	No	No
Special Distribution Missions	No	CCP	No	No
Organic Capability:				
Water Port	No	No	No	No
C-5 Airport	No	No	Yes MAC APOE	No
Facility Condition	Adequate	Adequate	Very Good	Adequate
Throughput Capacity:				
Annual CWT	4.3M	3.9M	2.7M	4.0M
Annual Lines	0.2M	1.1M	3.7M	3.9M
Storage Capacity (cu ft)	21.4M	19.7M	19.9M	36.3M
Fixed Cost ($)	2.2M	4.2M	2.9M	7.1M
Maintenance Interface Penalty (Potential)($)	3.7M	2.0M	6.7M	0

c. Oklahoma City Cluster

(1) Facility. Oklahoma City ALC (OCALC).

(2) Discussion. The workload for this cluster in both Scenarios 1 and 2 is greater than the Baseline. However, the existing facilities are capable of processing the increased workload. The major change in the composition of throughput between the baseline and Scenarios 1 and 2 is the addition of personnel consumables and an increase in other consumables. The overflow of WTP capacity at OCALC under Scenario 2 is less than 10 percent, in contrast to the 19 percent economic capacity overflow in Scenario 1. Using the estimating relationship in Appendix F, Section 5, the estimated average value of fixed cost is $5.3 million under either scenario.[1] The magnitude of actual increase in fixed cost at this depot is dependent upon the physical conditions as well as the amount of substitution of wholesale stock for retail stocks resulting from the changes in commodity mix and volume of workload.

(3) Cluster Data.

	Baseline Capacity	Scenario 1 Workload	Scenario 2 Workload
Annual CWT	2.7M	1.6M	1.7M
Annual Lines	3.7M	1.7M	1.7M
Storage (cu ft)	19.9M	16.0M	14.4M

The change in workload volume between the Baseline and Scenarios 1 and 2 is shown below by general commodity group:

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[1]The minimum increase in fixed cost would be zero under the assumption of total substitution of wholesale stock for retail stock.

	Baseline Workload (CWT)	Scenario 1 Workload (CWT)	Scenario 2 Workload (CWT)
Reparables	0.6M	0.9M	0.7M**
Personnel Consumables	*	0.2M	0.2M
Other Consumables	0.1M	0.5M	0.8M
	0.7M	1.6M	1.7M

* Less than 1000 CWT.
** Implementation of Scenario 2 will require the imposition of link editing in order to position workload at Oklahoma City according to the link constraints for reparable materiel discussed in Chapter 5.

d. Anniston Cluster

(1) Facility. Anniston Army Depot (ANAD).

(2) Discussion. The throughput of Scenarios 1 and 2 of this cluster differ only slightly from the Baseline. The Anniston cluster required the imposition of link editing of the customer-commodity assignments in order to avoid exceeding the physical capacity limitation of ANAD. The link editing was accomplished as part of the development of the Refined System (Scenario 1) and was assumed to be equally applicable to the workload for ANAD in Scenario 2.

(3) Cluster Data.

	Baseline Capacity	Scenarios 1 & 2 Workload
Annual CWT	4.3M	2.1M
Annual Lines	0.2M	0.2M
Storage (cu ft)	21.4M	7.2M

Comparison of the baseline workload to the workload in Scenarios 1 and 2 is shown below by general commodity group:

	Baseline Workload (CWT)	Scenarios 1 & 2 Workload (CWT)
Reparables	2.0M	1.9M
Personnel Consumables	*	0
Other Consumables	0.1M	0.2M
Total	2.1M	2.1M

* Less than 1000 CWT.

(4) The condition of the facilities at this depot are adequate to perform the Refined System mission.

e. Red River Cluster

(1) Facility. Red River Army Depot (RRAD).

(2) Discussion. The throughput of this depot in Scenarios 1 and 2 differs from the Baseline in that personnel consumables increase while reparables decrease. The Red River cluster required the imposition of link editing of the customer commodity assignments in order to avoid exceeding the physical capacity limits of RRAD. The requisite link editing was accomplished as part of the development of the Refined System (Scenario 1) and was assumed to be equally applicable to the workload for RRAD determined in Scenario 2.

(3) Cluster Data.

	Baseline Capacity	Scenarios 1 & 2 Workload (CWT)
Annual CWT	3.9M	1.9M
Annual Lines	1.1M	0.9M
Storage (cu ft)	19.7M	14.2M

Comparison of the Baseline workload to the workload in Scenarios 1 and 2 is shown below by general commodity group:

	Baseline Capacity	Scenarios 1 & 2 Workload (CWT)
Reparables	1.1M	0.9M
Personnel Consumables	*	0.3M
Other Consumables	0.5M	0.7M
Total 1.9M	1.6M	1.9M

* Less than 1000 CWT.

(4) The condition of the facilities at this depot are adequate to perform the Refined System mission.

f. Intercluster Analysis Summary

The results of the analysis described above can be summarized as a choice between; (1) closing DDMT and incurring increases in workload at the Georgia/Florida and Oklahoma City clusters, and, (2) retaining DDMT and incurring small increases in workload at those same two clusters. The former choice permits limited options in the Georgia/Florida cluster. The latter could generate savings associated with the closure of the wholesale mission at MCLSBLANT. The necessity for the load-balancing actions for ANAD and RRAD in the Refined System would not change whether DDMT is retained or closed.

Closing DDMT and absorbing increases in workload at Oklahoma City and Georgia/Florida may require some additional fixed cost at each of those clusters. The actual magnitude of increased fixed cost, if any, cannot be determined at this time and is dependent upon the substitution of wholesale stock for retail stock in both the Oklahoma City and Georgia/Florida clusters.

The analysis of the Southeastern CONUS clusters does not suggest a clear cut decision vis-a-vis closure or retention of DDMT. Because of the lack of clarity in this regard, action to close DDMT should be deferred pending a more detailed on site assessment of the economic impact of workload increases in the Georgia/Florida cluster.

4. Clusters Recommended for Closure

The macro-analysis indicated that the wholesale distribution mission at four clusters -- Ohio, Memphis, Lexington, and Pueblo -- should be discontinued. Termination of the wholesale distribution mission at these four clusters will result in annual savings and one-time costs as reflected in Table 6-2.

Table 6-2. Cost Impact of Cluster Closures ($ in Millions)

	Fixed Cost	Potential Maintenance Interface Penalty	Estimated Annual Savings	Estimated One-Time Costs: Personnel	Estimated One-Time Costs: Materiel Relocation
DCSC	9.1M	0	9.1M	8.8M	1.3M
DDMT	7.1M	0	7.1M	12.8M	2.6M
DESC	5.6M	0	5.6M	4.8M	0.3M
LBDA	1.6M	0*	1.6M	2.2M	1.1M
PUDA	1.8M	0.8M	1.0M	1.5M	3.8M
Total			24.4M	30.1M	9.1M

*Army closed the maintenance facility at LBDA in 1976 and the maintenance interface penalty for reparable items does not apply.

Book 8, Appendix F, Section 6 contains the depot data charts for DCSC, DESC, LBDA and PUDA.

F. SUMMARY

In the formulation of the options, each was viewed as a mutually exclusive event. In the process of implementing this study these options may not be mutually independent but interrelated. The factors and data elements considered in the formulation of the options are those described in paragraph C and the appendices to this chapter. There may be qualitative factors other than the ones presented in the analysis which decision makers will want to consider before accepting the prescribed options.

The DODMDS Baseline System is composed of 15 clusters of depots and 34 individual depot facilities. The long range DODMDS structure as proposed by the DODMDS study group would consist of 11 clusters of depots. The economic balance of the system (transportation versus depot fixed cost) suggests that the future DODMDS be composed of a lesser number of individual depot facilities. Restructuring of the Baseline System can be achieved by discontinuing the wholesale distribution mission at specific depots, and consolidation or merger of others. Deciding which of the individual wholesale missions should be discontinued was the reason for formulating various alternatives.

In evolving to a future DODMDS there are seven clusters of depots (Northern California, Utah, Virginia, Georgia/Florida, Southern California, Pennsylvania, and Texas) which have options decision makers will want to consider particularly if changes in the assumptions of the study are anticipated in the future. Eight clusters offer no alternatives, given that the Refined System is accepted.

G. DEPOT-COMMODITY ASSIGNMENTS

The second purpose of intracluster analysis was to develop commodity stockage patterns at each depot within a cluster. Locating wholesale materiel at a depot for subsequent use by a consumer is an inventory management decision. The asset positioning decision process is executed by the inventory manager on an NSN by NSN basis and reflects discrete elements of data such as historical and projected demand rates, inventory costs and war reserve requirements. The analysis in Chapter 5 indicated the annual volume in CWT of throughput for each cluster. The DODMDS economic analysis resulted in a determination of the total depot workload for each cluster given the parameters and variables of the DODMDS problem set. The decision by an inventory manager to position materiel at one location versus another location is not based on the historical workload of a depot or capability of a depot in terms of a commodity type, but on data available only to the inventory manager on an item by item basis. However, the DODMDS macro-analysis can be used as a guideline for inventory managers in determining whether a particular type of commodity should be located in one DODMDS cluster versus another and where within a cluster. Based on the volume per commodity for each cluster, the historic capabilities of each depot and the specific posited option for each cluster, recommended material location guidelines (Book 8, Appendix F, Section 8) were developed for inventory managers in locating materiel at specific depots within each cluster. The tables in Appendix F, Section 8 are indicative of one group of options among the many which could be selected.

CHAPTER 7
FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This chapter summarizes the salient results of the extensive analytical effort of the DODMDS study. These analyses established that excess capacity exists within the DODMDS, that most facilities are in satisfactory or better condition, and that a proposed structure of 23 distribution centers could satisfy the peacetime and mobilization/wartime distribution requirements.

The chapter is organized in the following manner: First, a discussion of the findings and conclusions is presented. The next section proposes a specific DODMDS structure based on the findings. This is followed by a section dealing with management considerations. The last section discusses other related issues, followed by some concluding comments.

B. FINDINGS AND CONCLUSIONS

1. Location of Demand

As a general observation, customer demand in terms of weight alone may be categorized as follows: one-third came from overseas (to include FMS/SAP actions), one-third from customers collocated with or in very close proximity to wholesale distribution centers, and one-third from all other customer locations. Further, nearly three-fourths of the total customer demand (allowing air and waterport gateways to represent overseas demand) was concentrated in areas where the DOD wholesale distribution centers were located (within 300 miles). The implication is that most of the wholesale distribution centers are located near concentrations of customers. Figure 7-1 illustrates this point.

2. System Capacity

The DODMDS base year capacity exceeded system demand as indicated below:

(1) Throughput:

	Daily Capacity	Daily Demand
CWT (000)	349	85[1]
Line Items (000)	237	75

(2) Storage:

	Available	Required For Wholesale
Cubic Feet (million)	785[2]	249[3]

The study concluded that additional facilities should not be constructed, except for replacement or modernization where economically justified by operational workload on a location by location basis. By using the DOD-wide economies as a pivot for future investment decisions, it should be possible to take advantage of appropriate equipment/labor trade-offs in the most cost beneficial regions for any proposed construction (see discussion under construction and investment consideration, paragraph E).

3. Transportation Costs

The different support patterns resulting from the DODMDS alternatives resulted in higher inbound (to the depot) transportation costs and reduced outbound (to the customer) transportation costs. This was a result of positioning materiel closer to the customer and to the CONUS ports of embarkation. The trade-offs between inbound and outbound transportation costs resulted in reduced transportation costs overall from

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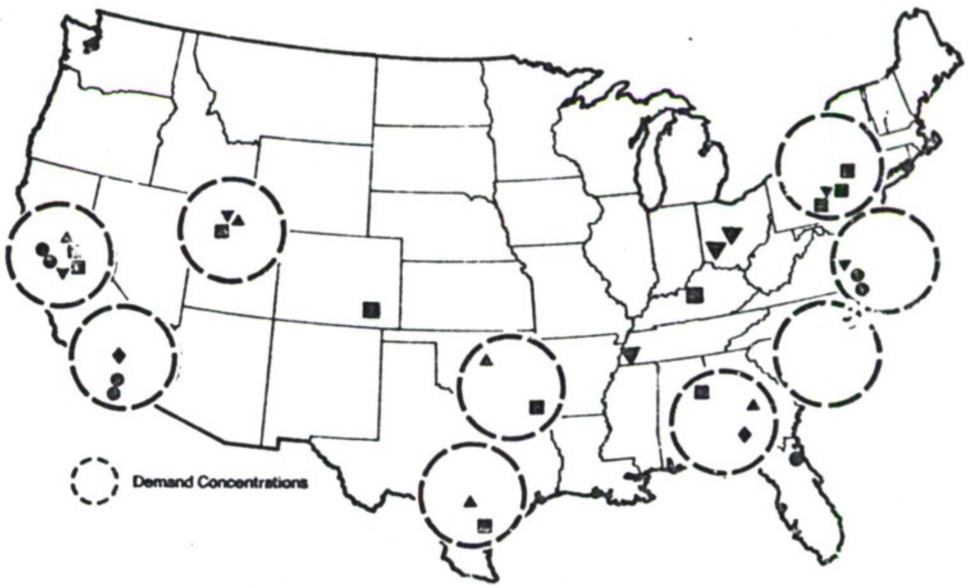
[1] Based on 365 days per year.
[2] Includes space used for retail stocks.
[3] See Appendix D-3, Section 4 for derivation procedure.

Figure 7-1. Demand Concentration



Note: Each circle represents 3 percent or more of the total weight demanded, and 2 percent or more of the total lines demanded within that area (300 mile diameter). These areas represent nearly three-fourths of the total demand based on weight and issue transactions (includes CONUS air and waterport gateways for overseas demand).

Source: DODMDS Data Base.

the base year due to the greater savings on the outbound links. Other factors also influenced transportation costs, particularly the decrease in ton mile costs for longer distances when the most efficient links and modes are used, i.e., using less costly truckload/carload modes for the larger shipments from procurement sources. The net result was a reduction in transportation costs through greater reliance upon the most efficient links and modes.

4. Multimission Facilities

By definition, multimission facilities are those having more than one functional mission activity. In a strict sense, nearly all of the 34 distribution activities included in the study can be considered as being within multimission complexes. Of importance to the DODMDS study were those facilities which had activities that generated significant customer demand. There are several measures by which a facility can be evaluated as to its degree of multimission activity, i.e., number of issues to local customers, by weight, by dollar value, etc. One measure, local customer demand (issue transactions) on the wholesale distribution system, as shown in Table 7-1, can be used to illustrate the point. Weight and dollar value rankings would generally follow the same trend.

The location of wholesale distribution activities on multimission facilities was found to have the following specific impacts on the DODMDS structure:

a. The cost that distribution incurs for installation support (composed of facility services, management services, base transportation, and ADP) tends to decrease as installation population increases. Thus, wholesale supply depots located on large multimission installations incurred lower installation support cost per unit of throughput than did wholesale supply depots located on a small installation or installations existing primarily to house a supply depot. Consequently, the study concluded that the benefit of overhead sharing is

Table 7-1 Local Customer Annual Demands on the Wholesale Distribution System (Issue Transactions)

Wholesale Distribution Locations	Local Customer Demand
1. Norfolk	1,180,795[1]
2. San Diego	1,020,445[1]
3. Tinker AFB (OCALC)	571,388
4. McClellan AFB (SMALC)	569,640
5. Kelly AFB (SAALC)	552,035
6. Oakland	528,192[1]
7. Robins AFB (WRALC)	521,477
8. Hill AFB (OOALC)	402,334
9. Jacksonville	328,405
10. Cherry Point	252,130
11. Corpus Christi	192,493[2]
12. Letterkenny	178,318
13. Anniston	178,309
14. New Cumberland	124,880
15. Red River	111,571
16. Barstow	110,827
17. Tooele	106,785
18. Albany	87,499
19. Tobyhanna	71,277
20. Lexington	69,361
21. Sharpe	54,531
22. Sacramento	47,221
23. Memphis	47,001
24. Pueblo	43,974
25. Richmond	38,726
26. Mechanicsburg	9,708
27. Tracy	7,961
28. Ogden	4,140
29. Dayton	See footnote 3
30. Columbus	See footnote 3

[1] Naval Facilities combined to reflect consolidated local customer demand, including fleet support.

[2] Includes the Army depot maintenance activity and the NAS.

[3] Issues to local on-base customers not shown separately due to small level of activity; customer issues combined with nearby Air Force facilities at Wright-Patterson and Rickenbacker AFB's.

another valid reason for locating wholesale supply depots on large multimission installations.

b. The study found that the system cost of the DODMDS can be reduced if materiel is positioned near concentrations of demand. The modeling and off-line analysis determined how much of each DODMDS product should be positioned in each cluster to minimize the sum of transportation costs and depot fixed costs. This geographical allocation of materiel provided a basis for determining the requirements for depot facilities in each cluster and a basis for selecting the depots to meet the requirements.

c. The study found that collocation of wholesale supply distribution missions with maintenance missions produces economies. The collocation economies result from the fact that the maintenance mission at collocated depots does not need separate receipt, storage and issue capabilities because these are performed by the wholesale supply depot as an integral part of the materiel distribution process. The cost to perform the supply interface is integrated into the cost of operating a supply depot.

5. Integrated Stockage of Consumables and Reparables

The study found that the total demand for consumables in DOD was not large enough to warrant separate systems of depots for handling consumables. An analysis was made to determine whether concentrating the distribution of consumables in a few depots would be advantageo s. The results showed that a separate system for consumables would produce a net increase in the system cost. This concept was further tested by providing three clusters with lower variable cost rates for consumable products, thus favoring possible consolidation of consumables. Again, the 11-cluster system structure remained unchanged. As all DODMDS depots have the capability to process consumables, the study found that integrated stockage of consumables and reparables would be more economical than separated stockage.

6. Economies of Scale

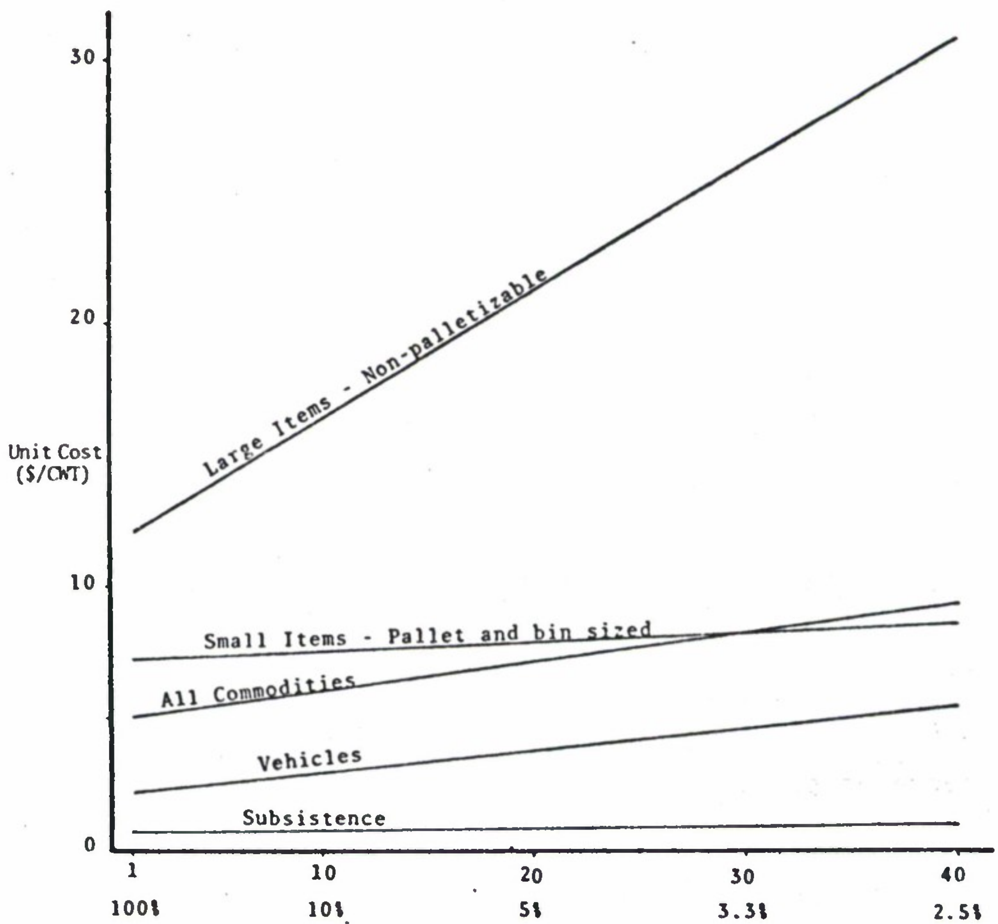
The study found that significant economies of scale are achieved in handling large and non-palletizeable items and that economies of scale are much less pronounced in handling smaller, pallet and bin sized materiel.

a. The historical variable costs used for modeling the DODMDS did not reflect economies of scale. Nominal depot variable costs considered unit cost differences among throughput levels by commodity groupings and were used as a basis for examining opportunities for achieving economies of scale in depot materiel processing. "Hands on" receipt, storage and issue functions were expressed as a unit cost ($/CWT of throughput) and included the cost of labor, supplies, and annualized investment in required MHE and buildings. These unit costs were based on current (1976) state-of-the-art technologies and 1986 forecast technologies and costs. (See Appendix D-3)

b. Figure 7-2 displays the state-of-the-art unit cost at various increments of the DODMDS wholesale throughput for four principal materiel categories, and a weighted average representing all commodities. Large items and vehicles present the greatest potential savings through consolidation, permitting better utilization of labor, equipment and space. Subsistence, and small items generally, use more conventional handling and storage concepts, and, therefore, incur lower initial costs at low throughput levels. Substantial labor savings through mechanization were not found to exist for either subsistence or small items categories, even at the higher levels of DODMDS throughput.

c. Economy of scale ratios for the commodity categories are shown in Table 7-2.

Figure 7-2. State-of-the-Art Unit Cost vs. Volume of Throughput by Materiel Category*



DODMDS Throughput (CWT) Expressed as Number of Distribution Centers (1 Depot to 40 Depots) and % of Total Wholesale Throughput

*Aircraft engines, tires, small arms, and specialized materiel (requiring cold, hazardous or security storage) are excluded from Large and Small categories.

Table 7-2. Economy-of-Scale Ratios* by Commodity Category

Commodity Category	State-of-the-Art Technology (1976)
Vehicles	2.53
Subsistence	1.47
Large Items	2.55
Small Items (Pallet Size)	1.20
All Commodities	1.88

*Unit Cost ($/CWT) at 100 percent or total DODMDS wholesale throughput divided by the unit cost at 2.5 percent of the total DODMDS throughput. (See Book 5, Appendix D-3, Section 6)

d. Between FY 76 and FY 86, all areas of depot costs are expected to increase significantly. Labor and construction costs will increase more than equipment. Increases in depot supply operations costs are forecast as follows:

	Predicted Increase* 1976-1986 (Percent)
Labor	90
Construction (space)	84
Equipment	70
Supplies	58

*Reference Appendix D-3, Section 5.

7. Responsiveness

The DODMDS study Refined System indicated that responsiveness would be improved due to movement of materiel closer to the consumer. These results offer a one-time potential reduction in pipeline inventory of $32 million and reduced inventory holding costs of approximately $3.2 million annually.

C. RECOMMENDED STRUCTURE OF THE DODMDS

These findings served as the basis for the following specific proposals for restructuring the DODMDS. In the course of evaluating the mass of data and variety of options which confronted the study group during the analysis phase, certain of the depot clusters revealed only marginal advantage or desirability among the different wholesale distribution facilities. In some cases, slight cost advantages were offset by competing facilities' mission characteristics such as local customer interface, condition of facilities, and the like. The study group preferences concerning those facilities where the margins of difference were slight are separately identified from those preferences which were more obvious and well substantiated by the data and model results.

1. Study group preferences clearly supported during all phases of analysis:

a. In Hawaii, Naval Supply Center Pearl Harbor remain with basically the historical mission and volume of throughput.

b. In Utah, the volume of throughput be decreased from the baseline and the wholesale mission at DDOU be discontinued. The Utah location is not transportation cost favorable for many customer regions supplied from there in the base year. The remaining depots in this cluster (OOALC and TEAD) have sufficient processing and storage capacity to handle the reduced cluster throughput.

c. In Southern Texas, the volume of throughput be increased over the baseline by increasing the proportion of consumables supplied to regional customers. Most of the increased workload would be absorbed by SAALC. CCAD would continue its primary mission of supporting the collocated aircraft maintenance depot.

d. In East Texas, the throughput at RRAD remain essentially unchanged from the baseline.

e. In Oklahoma, the volume of throughput at OCALC be increased over the baseyear and the workload at OCALC increased accordingly. The additional throughput consists primarily of personnel support items and other consumables.

f. In Ohio, the wholesale mission at DCSC and DESC be discontinued since there is not enough proximate demand to justify wholesale supply depots in these locations.

g. In Pennsylvania, the throughput remain essentially unchanged from the base year, and LEAD, NCAD, TOAD, and DDMP continue their wholesale distribution missions.

h. In Alabama, the throughput of ANAD remain essentially unchanged from the baseline.

i. In Georgia/Florida, the volume of throughput be increased over the base year. The additional throughput consists primarily of personnel support items and other consumables. The large bulky consumables would move to MCLSBLANT with the high volume line item oriented materiel moving to WRALC.

2. Study group preferred options supported by extensive analyses, but where decision makers might attribute greater importance to qualitative factors not explicitly addressed by the study group:

a. In Northern California, the volume and composition of throughput remain essentially the same as in the base year, and that the wholesale distribution mission be discontinued at two depots, one of which should be a large consumables—oriented depot at either NSCOAK or DDTC. Specifically, the study group proposes the discontinuance of the wholesale mission at (1) DDTC because this would cause no disruption of local customer support relationship, would not separate the stock from the prime port facilities, and would permit consolidation of Navy wholesale distribution facilities in the Oakland area; and (2) Sharpe Army Depot, because the impact on customer supply interfaces would be minimal, and the need to upgrade SHAD's marginal facilities would be eliminated. NASAL, SMALC, SAAD and NSCOAK would absorb the cluster workload from the two discontinued depots. NASAL and NSCOAK should be administratively merged (see Section E below).

b. In Southern California, the volume of throughput be increased over the baseline, and its composition changed by increasing the proportion of personnel and other consumables. All depots in the cluster (NASNI, NSCSD and MCLSBPAC) remain open and absorb additional workload. NASNI and NSCSD should be administratively merged (see Section E below).

c. In Colorado, the wholesale mission (other than ammunition) of PUDA be discontinued since there is not quite enough proximate demand to justify a wholesale supply depot in this location. The depot's capacity is not required by the DODMDS.

d. In Kentucky, the wholesale mission (other than ammunition) be discontinued at LBDA since there is not quite enough proximate demand to justify a wholesale depot at this location. The depot's capacity is not required by the DODMDS.

e. In Virginia/North Carolina, the cluster throughput remain essentially unchanged from the base year but, in view of the existing excess capacity, the wholesale mission be discontinued at one large general depot (NSCNOR or DGSC). Specifically, the study group proposes the discontinuation of the wholesale mission at DGSC. NSCNOR is preferred over DGSC because of its close proximity to customers, port and organic airlift capabilities, and because DGSC is not capable of processing the recommended throughput without capital investment. NASNOR and NSCNOR should be administratively merged (see Section E below).

3. Study group preferences where the marginal differences with other options appear to be very small:

a. Memphis, the study finding was that the wholesale distribution mission at Memphis should be eliminated. However, this was based on the assumption that the fixed costs in the Georgia/Florida cluster would not increase over the base year. This assumption could be incorrect because of the substantially increased workload assigned to the Georgia/Florida cluster. To determine whether or not the assumption is correct, on-site analysis should be conducted at the Georgia/Florida depots. If the on-site analysis confirms the assumption of little or no increase in annual fixed costs, the basic study would be supported. However, if the additional workload in the Georgia/Florida cluster can only be handled with an increase in annual depot fixed costs of $5 million or more, it would be equally cost effective to retain Memphis as a wholesale distribution center. It is therefore recommended that the decision to eliminate the wholesale distribution mission at Memphis be deferred until the on-site analysis of depots in the Georgia/Florida cluster, as described above, is completed.

Table 7-3 summarizes the recommended DODMDS structure based on the study group preferences.

D. <u>MANAGEMENT CONSIDERATIONS</u>

1. <u>Introduction</u>

a. In the initial stages of the study a broad range of alternative structures was considered. These ranged from more depots to a very small number of large "super-depot" complexes, optimally located. This broad range of potential options gave rise to concerns regarding management options. Certainly three or four high-rise wholesale distribution complexes would not require five management systems. Had the super-depot concept emerged from the analysis, it would have reinforced the potential for implementation of one recommendation of the Blue Ribbon Defense Panel's "Report to the President and the Secretary of Defense on the Department of Defense", dated 1 July 1970. This panel recommended the establishment of a unified logistics command that would encompass supply, distribution, maintenance and transportation services into a single command.

b. While the LSPC LOGPLAN stated, "There will not be a single logistics command, as proposed by the Blue Ribbon Panel," the unified command had to be considered as a distinct possibility. As the analyses continued, however, certain factors became apparent.

Table 7-3. Summary of Recommended DODMDS Structure

Region	Change in Throughput From The Base Year	Wholesale Distribution Mission Retained	Wholesale Distribution Mission Closed	Change in Annual Costs[1]	One-time Costs Personnel	One-time Costs Materiel
Hawaii	No significant change	NSCPH	--	0	0	0
Utah	Personnel consumables decreased by 1/2	TEAD OOALC	DDOU	-$8.5M	$11.3M	$3.4M
Southern Texas	Personnel consumables added other consumables increased four times	CCAD SAALC	--	0	0	0
East Texas	Reparables decreased by 1/5; consumables doubled.	RRAD	--	0	0	0
Oklahoma	Personnel consumables added; other consumables increased five times; reparables increased by 1/2	OCALC[2]	--	0	0	0
Ohio		--	DCSC DESC	-$14.7M	$13.5M	$1.6M
Pennsylvania	No significant change	LEAD NCAD TOAD DDMP	--	0	0	0
Alabama	No significant change	ANAD	--	0	0	0

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[1] No anticipated increase in annual costs if increased workload is within 125 percent of existing throughput capability.

[2] Fixed costs for OCALC could increase because of the substantially higher workload assigned to that depot. The minimum increase in fixed cost would be zero, assuming total substitution of wholesale for retail stocks. It was estimated that fixed costs for OCALC could increase by up to $2.4 million.

Table 7-3. (Cont.) Summary of Recommended DODMDS Structure

Region	Change in Throughput From The Base Year	Wholesale Distribution Mission Retained	Wholesale Distribution Mission Closed	Change[1] in Annual Costs	--One-time Costs-- Personnel	--One-time Costs-- Materiel
No. California	No significant change	SAAD NASAL[2] NSCOAK[2] SMALC	DDTC SHAD	-$9.7M	$11.9M	$10.8M
So. California	Personnel and other consumables doubled	NASNI[2] NSCSD[2] MCLSBPAC	--	0	0	0
Colorado		--	PUDA	-$1.0M	$1.5M	$3.8M
Kentucky		--	LBDA	-$1.6M	$2.2M	$1.1M
Virginia	No significant change	NASNOR[2] NSCNOR[2] MCASCP	DGSC	-$5.8M	$6.3M	$0.9M
Tennessee			DDMT[3]	-$7.1M	$12.8M	$2.6M
Georgia/Florida	Personnel Consumables added;[4] other consumables increased five times	NASJAX WRALC MCLSBLANT		0	0	0
Total		25[5] depots	9 depots	-$48.4M	$59.6M	$24.2M

[1]No anticipated increase in annual costs if increased workload is within 125 percent of existing throughput capability.

[2]Recommended for administrative merger. See Section E.

[3]Final decision on closure of DDMT should be deferred until impact of substantially increased workload in Georgia/Florida on fixed costs of depots in that cluster have been determined. If such fixed costs should increase by $5 million or more, DDMT would become a cost favorable depot.

[4]The workload increase for Georgia/Florida is based on the assumption this cluster's fixed cost would not increase by $5 million or more, thus making DDMT a cost favorable depot. With DDMT as a DODMDS depot, the Georgia/Florida cluster workload would increase over the base year, but by a much smaller amount. See Footnote 3 above.

[5]Reduces to 22 with merger of NAS and NSC at Oakland, San Diego, Norfolk.

The scope of the study did not nclude the total DOD Logistics System. The actual scope was the wholesale distribution (warehousing and transportation) system. Outside of the scope of the study were critical areas such as maintenance, procurement, and inventory management. So it was recognized that what was under study was merely a portion of the unified command envisioned by the Blue Ribbon Panel's Report. Similarly, the Blue Ribbon Defense Panel Report recommendation was developed in consonance with other recommendations which envisioned submerging Service-unique considerations within mission oriented commands (i.e., a Strategic Command, a Tactical Command and a Logistics Command).

2. Materiel Ownership and Management

The issue of materiel ownership and management was a relatively straight forward one in the context of the study. All wholesale materiel, by definition, is owned by and visible to the Service/Agency (ICP) which is its sponsor. As changes in sponsorship take place, so does ownership. This procedure should continue. Further, the inventory control function as well as requirements determination, which are integral parts of the management aspects of wholesale materiel, were outside the scope of the study. Materiel issued from the wholesale level to a retail account carries with it the transfer of ownership. Because retail materiel management and ownership were also outside the scope of the DODMDS study, no changes were proposed in this area.

3. Facility Management

a. The DODMDS study group did not pursue any management considerations that would involve a unified logistical command within DOD or any larger management element such as a federal or national supply system. One of the approved assumptions guiding the DODMDS study effort states: "Each military Service/DOD Agency will continue to have a major role in the management of DOD logistics." Any option calling for a unified logistics command would, of necessity, require full and complete interaction and participation of the DOD components in its development and management. Consequently, the following discussion is limited to general alternatives for consideration of the future management of wholesale materiel distribution in the DOD. The general alternatives are three:

(1) Unified Distribution Facilities Command.

(2) Regional Distribution Facilities Commands.

(3) Continuation of the status quo.

b. One alternative for management of the future DODMDS is a unified distribution facilities command which would exercise operational control of the wholesale distribution facilities in the DOD. This alternative would require uniformity of regulations, procedures and reporting systems to be imposed on the diverse distribution functions presently performed by the Services/DLA. It would also entail consideration of the many interfaces between wholesale distribution and the other major logistics functions, i.e., depot maintenance, materiel management, procurement, and specialized distribution activities such as ammunition, perishable subsistence, and fleet ballistic missile support centers. Detailed analysis of the concept of a unified distribution command would require a separate in-depth study of the justification for establishing a separate command structure to manage only one function of the complete logistics process.

c. A second alternative for the management of the future DODMDS is that of regional distribution facilities commands similar to the structure employed by the Federal Supply Service. As an example, the depots in Northern California could be placed under a "Northern California Distribution Region," with the commander of the region having management control and budgeting responsibility for wholesale distribution of materiel within the region. One advantage of this concept is the possible reduction in distribution staff elements at each of the individual distribution facilities in a region. However, this concept has the potential for additional layering in management to pull together the regional requirements for transmission to higher headquarters. This alternative, like the first, would require significant coordination in establishing working interfaces between distribution managed at a regional level and the other elements of the logistics process managed through Service/Agency chains of command.

d. The current management is primarily independent, that is, the Services and DLA administer their own facilities. Decisions on facility characteristics, operational policies, budgeting and missions are made by the component involved. The advantages of the current arrangement are the ability of the Services/DLA to respond to unique mission and military readiness requirements, and the capacity to give tailored support to local customers, including major industrial customers. Further, the current management permits the incorporation of the mission as part and parcel of the complete range of logistics processes managed by the Services and DLA. The disadvantage of the current management system is the existence of five separate and possibly competing distribution staff elements with responsibility for managing the future DODMDS.

e. For the near term, the current management structure is recommended. The DODMDS study group analyses identified the overall structure of the future DOD wholesale distribution system, at least in terms of location. The potential for a small number of high rise distribution complexes did not, in fact, materialize. The options presented did not necessitate major structural changes. Although the options envisioned a geographical redistribution of consumables and increased joint stockage, from the DOD (or JLC) perspective, no major physical structural changes are proposed which require changes to present management structures. Joint stockage and inter-service support are not revolutionary. Emphasis on increased use of such practices has been evident since the early 1960's, and was one of the reasons behind the growth of Military Standard Systems (MILS) (i.e., MILSTRIP, MILSTAMP, etc.). In addition, during the data development and research stages of the study, other DOD groups were found to be in the process of developing more closely integrated procedures and systems e.g., Defense Automated Data Systems (DADS), Defense Intransit Item Visibility System (DIVS).

f. In summary, the study scope was limited when viewed from the perspective of the total logistics system, and therefore, any major management changes would be based on less than a complete systems approach. The options recommended propose no revolutionary structural changes. A nucleus of standard, integrated DOD procedures exists through the MILS for necessary communication of supply and transportation information under increased use of joint stockage. Other working group efforts to solve existing operational problems and improve overall procedures can be incorporated into the recommended physical structure of the future DODMDS with the existing management structure.

E. ADMINISTRATIVE MERGER OF NAVY FACILITIES

The review of management relationships also led to a closer examination of the Navy complexes in the Norfolk, San Diego and Oakland areas. Within each complex there are two separately administered distribution facilities, one associated with a supply center and the other with an air station. Separate command and funding channels exist for each of these facilities. Although the two distribution facilities within each of the three Navy complexes were in close proximity or nearly contiguous to one another, no coordinated effort regarding site renovation or facility modernization was evident. It was not coincidental, therefore, that in spite of the large concentration of customer demand within these areas, some storage and processing facilities were found to be marginal while others were good. The study group recommends the merger of the Navy distribution facilities within each of the Navy complexes at San Diego, Oakland, and Norfolk.

F. OTHER IMPORTANT ISSUES

1. Construction and Investment Considerations

The recommended future DODMDS is capable of satisfying the projected workload; hence, no construction or investment projects are proposed. Some DODMDS facilities have already taken advantage of high cube, well constructed and configured buildings by installing mechanized materials handling and storage systems to improve depot capabilities. Many of the other DODMDS facilities located near demand concentrations also have buildings which exhibit this adaptability to modern material handling and processing systems. There are some storage facilities which are considered marginal and will require replacement or renovation within the near future. Funding of MILCON or major renovation projects should be based on economic analysis of payback potential on a location-by-location basis.

2. Mobilization Criteria

Little information or guidance regarding the impact of mobilization of the DODMDS was readily known or available. As a consequence, considerable effort and study were required to develop a set of mobilization factors for use with the DODMDS developed 69 product groups. As addressed in Chapter 4, these 69 product groups were developed based on detailed rationale, and resulted in the grouping of thousands of DOD commodities into one of 69 product groups based on their relative homogeneity. This grouping thus lends itself to many of the types of analysis often required in mobilization/contingency planning. It would appear that JCS/Services planning could be aided by the use of the 69 product commodity approach.

3. Maintenance

The charter of the DODMDS study did not provide for an analysis of the maintenance function nor allow recommendations for changes in depot maintenance missions. However, maintenance does have a significant influence on the DODMDS, as both a source of materiel and as a consumer. Because of this influence, a combined demand and supply shift sensitivity analyses was conducted to evaluate the potential impact on the wholesale distribution system due to changes in the depot maintenance structure/mission.

The methodology to conduct this sensitivity analysis consisted of evaluating four collocated maintenance activities in three different clusters with the assumption that the depot missions at these four sites were relocated elsewhere. When the maintenance shift data were analyzed, the proposed DODMDS system structure was confirmed. Some materiel flow patterns did shift, as would be expected, but the basic cluster pattern was unchanged. The conclusion drawn from these results pointed out that future changes in depot maintenance missions should have little impact on the proposed DODMDS structure. Clusters losing maintenance missions would likely have sufficient residual demand from other customers in the area to warrant their continuation as economically favorable wholesale distribution locations.

4. Areas For Further Study

There are several areas that may be appropriate for further study. Of these, maintenance and management information systems loom as the most logical in view of their significant relationship to the DODMDS.

G. CONCLUDING COMMENT

The DODMDS study has, for the first time, analyzed the total DOD Materiel Distribution System as an entity. At a minimum, the data and models developed provide an existing, sustainable tool for evaluating current and future logistics problems.

When compared to the DODMDS baseline cost, the proposed DODMDS offers an opportunity to reduce facility operating costs by about $40 million annually, with another $57 million annual reduction in transportation costs. Other options are possible and may be more desirable, even though more costly, due to socioeconomic and/or political factors. In any event, the necessary information to assist in making such decisions is contained in this report and appendices. It is expected that the DODMDS data base and the analytical models developed for its analysis can aid in the solution of other logistics related problems for many years.

CHAPTER 8
IMPLEMENTATION CONSIDERATIONS

A. INTRODUCTION

The purpose of this chapter is to provide an overview of the implementation process to those tasked with the responsibility for implementing the approved study options. This overview is not exhaustive but it does address the major actions/events that must take place as well as significant interrelationships over time, regardless of the options selected. The discussion of these actions/events which follows is complemented by Figure 8-1 at the end of this chapter and by the two sections in Volume III, Book 8, Appendix G.

B. IMPLEMENTATION PLANNING

1. General

Final analysis and ranking of priorities will lead to a decision as to which system realignments should be pursued. Following decision on realignments, an implementation schedule must be developed. Decisions on realignments within the wholesale distribution system will also create requirements for a variety of staffing and study actions as well. These actions (or events) fall into three broad categories: administrative actions which include staffing/review/decisions of all proposals by such senior authorities as the Services/DLA, JLC, OSD and Congress; system realignment actions which directly involve the process of realignment; and economic/environmental actions which result from a DOD requirement to comply with the provisions of The National Environmental Policy Act (NEPA).

Figure 8-1 highlights the two major actions to which most other actions relate, the Secretary of Defense's announcement of candidate depots for mission realignment and his subsequent final decision announcement. These two actions divide the entire implementation process into three time oriented phases.

Phase I, which includes all actions taken prior to the candidate announcement, is devoted to determining how best to realign each distribution system to take advantage of DODMDS study findings. During Phase II, the seven months between announcements, intensive study and staffing efforts are expended to provide the Secretary of Defense with decision data. Phase III actions emphasize the execution of the Secretary's decisions. The three phases are discussed in more detail in the remainder of this chapter.

2. Phase I

A key area that must be addressed is the selection of primary and secondary candidates for mission realignment based on DODMDS study findings, and JLC and OSD guidance.

As discussed in Chapters 6 and 7, a site-specific analysis of the depots in the Georgia/Florida cluster (Warner-Robins ALC, MCLSBLANT and NAS Jacksonville) should be conducted to determine more precisely the impact of the greately increased workload proposed on that cluster's fixed cost. It is estimated that this additional analysis would require two to four weeks. Residual members of the DODMDS study group could assist, if desired.

The data presented in the DODMDS study should greatly simplify this process and, in view of the extensive coordination afforded the Services/DLA during the study, further staffing of study options should be limited to significant new developments resulting from Service/DLA in-house feasibility studies.

A significant event in the Phase I period is the establishment of a Joint Steering Group as a focal point for the entire implementation process. This group would establish an implementation schedule and a reporting system to monitor overall progress, and would exert a major influence on the achievement of steady progress through the three implementation phases.

3. Phase II

Phase II begins immediately upon the public announcement of candidate locations. The pacing activity for this phase is the numerous economic/ environmental impact assessments and studies required. Although the possibility exists that the initial economic/environmental studies could lead to a more lengthy process prior to execution, (i.e., Environmental Impact Assessment could result in the need for an Environmental Impact Statement; see Appendix G, Section 1) many would not.

The Services/DLA draft decision statements are forwarded to OSD for staffing and approval during this phase.

4. Phase III

SECDEF approval and the resulting decision announcement begin Phase III, which involves execution actions for which planning was accomplished in Phase II. However, in addition to the delay incurred as a result of any Environmental Impact Statements required, an additional delay could be encountered at this time under the provisions of 10 USC 2687 which requires a congressional review of at least 60 days for any closures, personnel reductions in excess of 1,000 (or 50 percent of authorized civlian personnel) or construction resulting from related personnel movement. This review period is also a DOD waiting period during which no irrevocable actions may be taken affecting these locations.

Despite the limitations of this waiting period, many actions may be initiated concurrently with it in order to retain momentum. These actions include the Services/DLA revising distribution system policy and procedures where necessary.

Upon expiration of the Congressionally directed waiting period and after adjusting for any resultant changes, execution actions will begin.

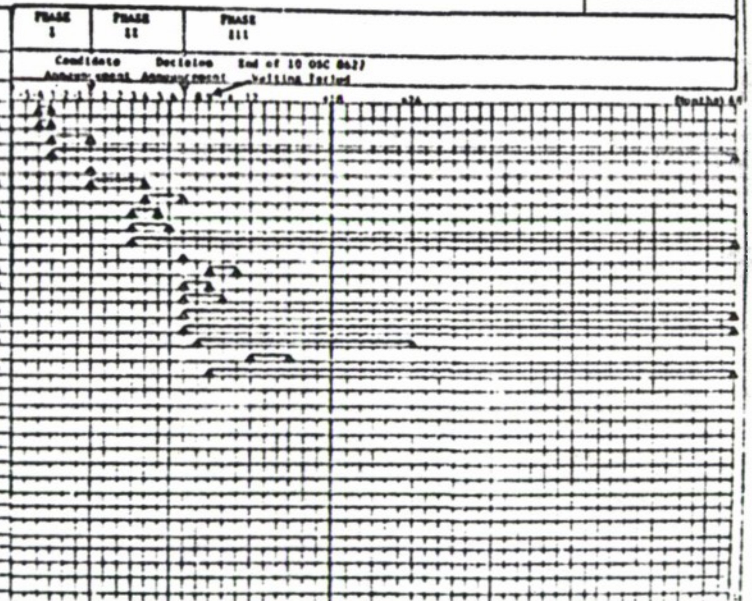
During Phase III, the Joint Steering Group will closely monitor all related Service/DLA and OEA activities and provide periodic progress reports to ASD(MRA&L) and the Services/DLA.

C. SUMMARY

Once the decision makers have selected from among the options presented in Chapters 6 and 7 of this study, it becomes the responsibility of others to translate these decisions into the realigned distribution system. This chapter provides a time-phased overview upon which a detailed implementation schedule can be built as specific Service/DLA actions are identified.

Figure 8-1. [illegible] IMPLEMENTATION OVERVIEW

SEQ. NO.	ADMINISTRATIVE	SYSTEM REALIGNMENT	ECONOMIC/ENVIRONMENTAL	RESPONSIBLE ACTIVITY
1.	Prelim. Staffing of [illegible] Report			PLC
2.			Assess Local Impacts	Services/DLA
3.	Staffing & Services Coordination			OSD
4.	Establish Steering Group			OSD
5.	Announce Candidates			OSD
6.			Environ/Economic Studies	Services/DLA
7.	Staff Decision Package			OSD
8.		Define Event Assignments		Services/DLA
9.		Establish Productivity Benchmarks		Services/DLA
10.		Reallocate Resources		Services/DLA
11.	Decision Announcement			OSD
12.		Submit Budget Proposals		Services/DLA
13.	Congressional Review			Services/DLA
14.			Ofc. Econ. Adj. (OEA) Visits	OEA
15.		Develop Policy & Procedures		Services/DLA
16.	Issue Orders			Services/DLA
17.		Screen Excess Property		Services/DLA
18.			Full Econ. Adjust. Comm. Team Visit	OEA
19.		Commodity Realignments		Services/DLA



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