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PHASE I VOLUME 1 MAIN REPORT(U) LOGISTICS STUDIES
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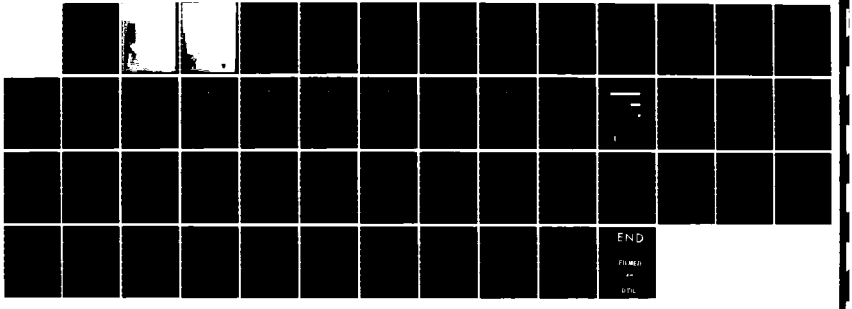

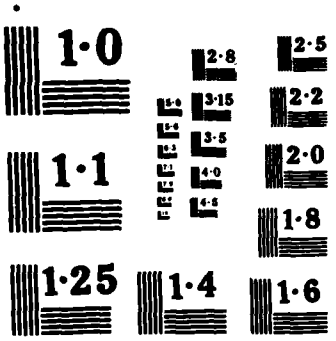

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A162 915	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Wholesale Stock Positioning and Distribution Policies, Phase I	5. TYPE OF REPORT & PERIOD COVERED Final Technical Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Paul E. Grover	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Logistics Studies Office US Army Materiel Systems Analysis Activity Fort Lee, VA 23801-6046	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Materiel Command, ATTN: AMCSM-POT 5001 Eisenhower Avenue Alexandria, VA 22333-0001	12. REPORT DATE August 1985
	13. NUMBER OF PAGES 50
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Supply, Transportation, Depot Operations, Cost Analysis, Stock Positioning, Inventory Control, Stock Control, Economic Analysis, ~~Distribution~~, Physical Distribution, Second Destination Transportation, First Destination Transportation.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A cost/benefit type analysis was performed on the CONUS physical distribution system for Army Class IX items to evaluate the impact of expanding the number of depots in which stocks are positioned. By positioning stock closer to the eventual customer, savings in second destination transportation cost and time were evaluated. However, those savings were offset by increased nonrecurring cost (start up costs) and recurring costs such as first destination transportation costs and supply depot operating costs. As the number of stock positioning points increases, total supply cost increases significantly. Therefore

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the existing distribution network is considered best at this time. However, because of less-than-perfect stock positioning, there is a considerable volume of shipments crossing geographical depot service boundaries which, if reduced, could significantly reduce total supply cost and time. Keywords:

ACKNOWLEDGMENTS

Without the cooperation and assistance from many outstanding individuals, this report could not be completed. Dozens of participants were involved in supplying data for this effort. A special acknowledgment to the contribution of the following few does not diminish my appreciation for the many others who responded faithfully to requests for data:

- Logistics Control Activity - Tom Swanson and Larry Mann
- Military Traffic Management Command - Irene Stegall
- HQ, Depot Systems Command - Richard Hoover

In addition, the author expresses gratitude to Mr. Francis Toner, the study sponsor for his expert guidance and advice throughout this phase of the effort. Additional technical assistance was provided by Dr. Gerald Garfinkel and David Dryden of this office along with outstanding clerical support from Mrs. Jewel Loftis.

SUMMARY

A cost/benefit type analysis was performed on the CONUS physical distribution system for Army Class IX items to evaluate the impact of expanding the number of depots in which stocks are positioned. By positioning stock closer to the eventual customer, savings in second destination transportation cost and time were evaluated. However, those savings were offset by increased nonrecurring cost (start up costs) and recurring costs such as first destination transportation costs and supply depot operating costs. As the number of stock positioning points increases, total supply cost increases significantly. Therefore, the existing distribution network is considered best at this time. However, because of less-than-perfect stock positioning, there is a considerable volume of shipments crossing geographical depot service boundaries which, if reduced, could significantly reduce total supply cost and time.

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MAIN REPORT

I. Background.

A. Following the Vietnam conflict, the Army stock positioning philosophy changed from decentralized storage in many depots to the more centralized Area Oriented Depot (AOD) concept. Under this concept, worldwide distribution for consumable items is assigned geographically to three Army depots. Because previous studies [1,2] have indicated that a four-area structure would be favorable and because of shifting demand patterns, it is possible that Army stock positioning policy, designed for optimality in 1973, is no longer optimal.

B. Since 1970, elements within the Department of Defense (DOD) have sponsored initiatives to standardize all, or part, of the Defense Logistics Agency (DLA) and the service's logistics systems into a single operating entity. One product of this initiative was a study titled "Wholesale Interservice Depot Support (WIDS)" [2] dated July 1982. This study, which subsequently reappeared as a Grace Commission [3] recommendation, proposed that significant reductions in second destination transportation costs could be achieved by positioning stocks at depots closer to the customer without regard to depot ownership. Although the services agreed to the general concept of WIDS since they presently position stocks in other services' depots where it is mutually beneficial, the Army, the Air Force, and the Navy [4,5,6] rebutted the study methodology. WIDS focused on second destination transportation costs; other costs associated with stock positioning were unaddressed. Thus, a more complete cost analysis must be made before the net savings of alternative stock positioning strategies can be quantified.

C. To address these issues, the Logistics Studies Office (LSO) began a two-phased study outlined in a Study Plan approved on 14 January 1985 [7]. This report covers the first phase of this study.

II. Objective. To determine the impact of expanded stock positioning on the Army wholesale logistics system through:

A. Determination of the total cost of expanded stock positioning to include:

1. First destination transportation (FDT) cost - The recurring cost of shipping from the source of production to the AOD.

2. Second destination transportation (SDT) cost - The recurring cost of shipping from the AOD to the customer.

3. Depot operating costs - The recurring cost associated with the receipt, storage, and issuing functions of the AOD.

4. Recurring management costs - Annual costs associated with managing/interfacing with the distribution system at Depot Systems Command (DESCOM), each National Inventory Control Point (NICP) and ADP system design agencies.

5. Non-recurring costs - One time costs associated with each distribution alternative, to include facilities, equipment, automatic data processing (ADP) system changes, inventory costs, and other costs.

B. Quantification of measures of effectiveness associated with distribution alternatives. For this phase of the study the only measure evaluated is response time or Order Ship Time.

III. Limits and Scope.

A. Army limited. Because of time constraints and data availability/compatibility, this study will not include items managed by other services and DLA. Only Army demand and only Army depots are evaluated in this analysis.

1. Depots available for stock positioning are the existing AODs (New Cumberland Army Depot, Red River Army Depot, and Sharpe Army Depot) plus five candidate depots, namely:

a. Anniston Army Depot (ANAD).

b. Letterkenny Army Depot (LEAD).

c. Lexington-Bluegrass Depot Activity (LBDA).

d. Pueblo Depot Activity (PUDA).

e. Tooele Army Depot (TEAD).

2. Items are limited to those Army managed items that are normally stocked in the AOD, i.e., Class IX. Excluded from the analysis are ammunition, major items, and items that require specialized storage facilities and equipment.

3. CONUS demand is evaluated. OCONUS stock positioning and AOD assignment will remain the same for all distribution alternatives. New Cumberland Army Depot (NCAD) is the Container Consolidation Point (CCP) for the Atlantic area and Sharpe Army Depot (SHAD) serves the Pacific area.

B. Time frame. This study is based on demand data, depot statistics, and transportation cost data pertaining to 1 January 1984 through 30 December 1984. Costs presented have been updated to constant FY 85 dollars unless otherwise specified.

IV. Assumptions. Minor working assumptions are documented in Volume 2.

A. Overseas shipments will continue to pass through the existing CCPs.

B. The mode of second destination transportation is primarily dependent upon the volume of demand by the customer. High volume customers which currently receive most of their shipments via truckload will continue to receive truckload shipments regardless of stock positioning location. Low volume demand that is

now satisfied by less-than-truckload, small package, and other less economical modes will continue using these modes regardless of stock positioning location.

C. Future demand patterns, transportation rates, and depot operations are reflected in the CY 84 data base. A major area of potential uncertainty that could drastically change this analysis is the effect of the Army AOD Modernization Program. For further discussion, see Vol 2, Chapter IV, para II-F.

D. Overall distribution effectiveness and out-of-area shipments will remain the same regardless of the number of depots used to position stock.

V. Methodology.

A. Cost Methodology. For each alternative distribution network the total cost is stratified into non-recurring cost and recurring cost. Detailed descriptions of methodology, calculations, and intermediate results are documented in Volume 2. Methodologies are summarized as follows:

1. First Destination Transportation costs - A sample of thirty representative procurements was selected by NICP personnel. Based on Logistics Intelligence File (LIF) demand data, the quantities shipped were reallocated to Army depots based on geographical demand patterns established for each alternative distribution network. Traffic management specialists within each NICP then estimated the cost of FDT for alternative shipping schedules for each procurement. Sample percentage changes were then applied to an estimate of the population FDT cost to estimate the population effect.

2. Second Destination Transportation cost - Shipment volumes by mode of shipment, source depot, and destination were obtained from the Logistics Intelligence File (see Appendix B, Vol 2) for CY 84. Rates used are actual rates or predicted rates based on parametric cost models generated from data obtained from the Military Traffic Management Command (MTMC) Freight Information System

or HQ DESCOM. Costs were computed for each mode of shipment by assigning each destination or customer to the appropriate AOD, assigning demand to the distribution network and applying transportation rates to the distribution flow pattern for each alternative.

3. Depot Operating Costs. It is hypothesized that operating costs are a function of tempo. As workload increases or decreases at a particular depot, its cost rate can be expected to change inversely. A parametric model based on FY 83 and FY 84 quarterly RCS AMCSM-305 reports quantifies the relationship between hourly rate and workload. As the workload is reallocated under various stock positioning alternatives, the effect on the operating costs of each depot is predicted.

4. Recurring management costs and non-recurring costs. Because of the subjective nature of these costs, the expertise required to assess the issues involved, and the numerous organizations involved, the study agency relied on expert opinion to estimate these costs. For uniformity, a questionnaire was sent to HQ DESCOM, six NICPs and two system design agencies to solicit cost estimates. The results are a tabulation of the responses, the accuracy of which cannot be validated. The rule of Caveat Emptor ("Let the buyer beware") applies.

B. Effectiveness. Reduction in Order Ship Time. It was determined that stock positioning only affects order ship time to the extent that closer positioning will reduce the transit time from the point that the shipment leaves the depot until it arrives at the second destination. This reduction in time was quantified by the use of relationships published in the DOD Materiel Distribution System [8] study of April 1978 for truckload, less-than-truckload and air shipments. These relationships were developed by the use of

regression analysis on MILSTEP data from July-December 1976. For small package deliveries, a heuristic relationship was developed based on published United Parcel Service delivery schedules as of June 1984.

VI. Analysis and Discussion.

A. Alternatives. Given the eight potential locations identified in para IIIA1, there are 219 ways to combine these depots to form a distinct alternative distribution network. To reduce the number of alternatives to a manageable number, three common sense rules were applied. First, all alternative networks contain the existing three AODs. This reduces the possible combinations to 32. Second, in selecting the addition of a depot to a network to form a new alternative, priority was given to depots that are near concentrations of demand. The third rule was to give priority to depots that currently have a significant supply workload. Using these rules, the following alternatives, summarized in Table 1, were developed:

1. Alternative 1 - Status quo. Continue the present stock positioning policies using the existing three AODs, namely NCAD, Red River Army Depot (RRAD), and SHAD. CONUS responsibilities are shown in Figure 1.

2. Alternative 1A - Status quo modified. This alternative was postulated to determine the potential savings of improving stock positioning policies. While maintaining the existing network (Figure 1), cost and time estimates were made assuming that all stock was ideally positioned such that out-of-area shipments were reduced to zero by some undetermined means. This is purely a hypothetical, ideal case that is intended only to show the potential for further study.

3. Alternative 2 - Four position points. Anniston Army Depot, Anniston, Alabama, is added to the network serving the Southeastern states per Figure 2. Boundaries in Figures 2-6 were determined by distance considerations only. ANAD has a significant maintenance and ammunition mission as well as a moderate amount of activity in supply functions in support of maintenance, ammunition and major item supply. It is strategically located near many large Army installations and has good access to commercial transportation facilities.

4. Alternative 3 - Five position points. Augmenting Alternative 4 with Tooele Army Depot, Tooele, Utah, serving the Rocky Mountain region results in a network shown in Figure 3. TEAD, like ANAD, currently has a moderate supply workload and has good transportation facilities. However, there are few major Army installations in the region.

5. Alternative 4 - Six position points. Lexington-Blue Grass Depot Activity, Lexington, Kentucky, serving the Midwest region is added to the network per Figure 4. LBDA is near two major installations but, as a Depot Activity rather than an Army Depot, has a very limited current supply mission. Should LBDA be assigned AOD-like status, its supply workload would approximately triple.

6. Alternative 5 - Seven position points. Pueblo Depot Activity, Pueblo, Colorado, serving the Eastern Rockies and western plains states was added to the network per Figure 5. Although near a major installation, PUDA has a very low existing supply workload. Its workload would increase five-fold if AOD-like status was achieved.

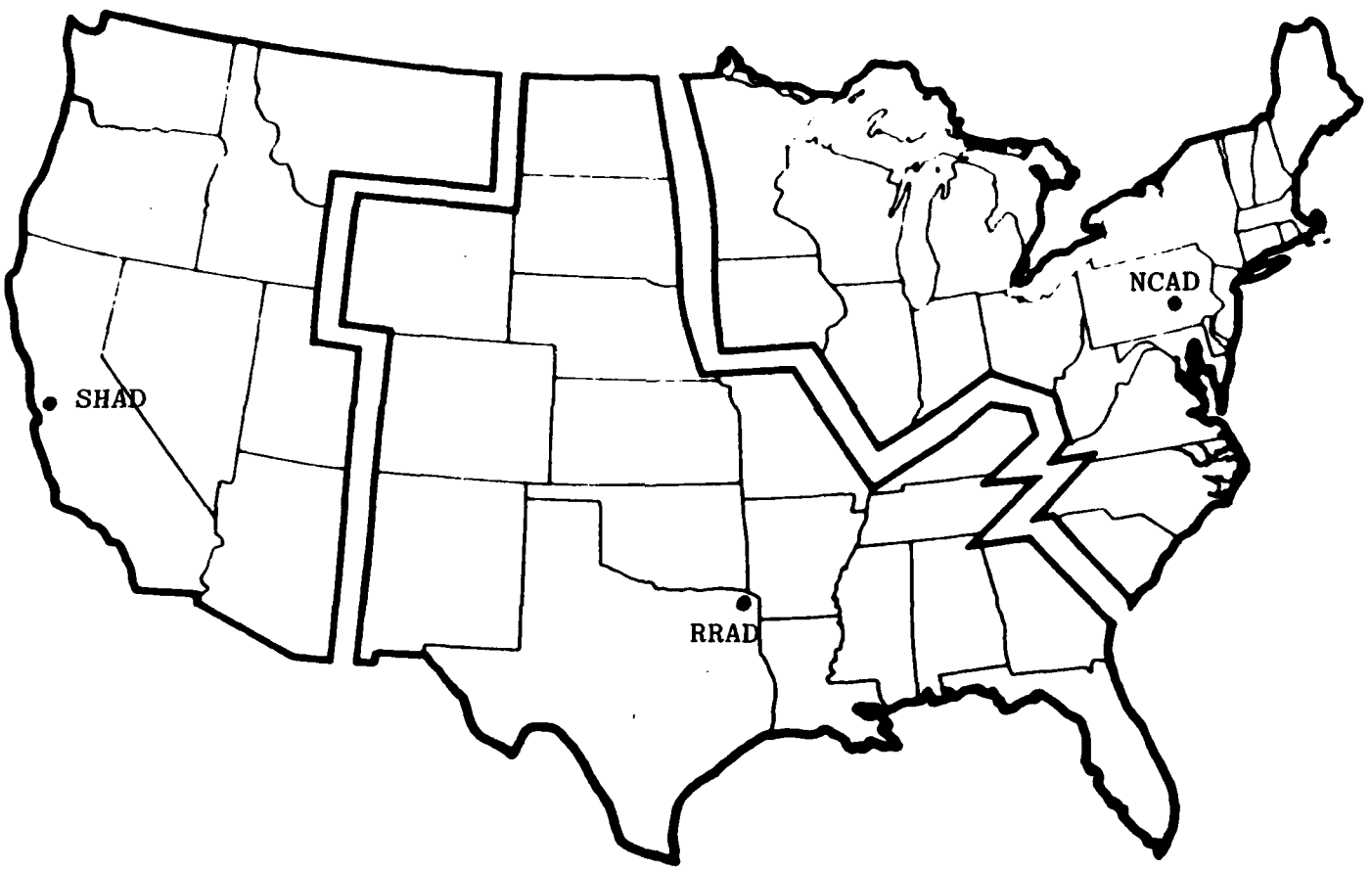

Figure 1. Alternatives 1 and 1A

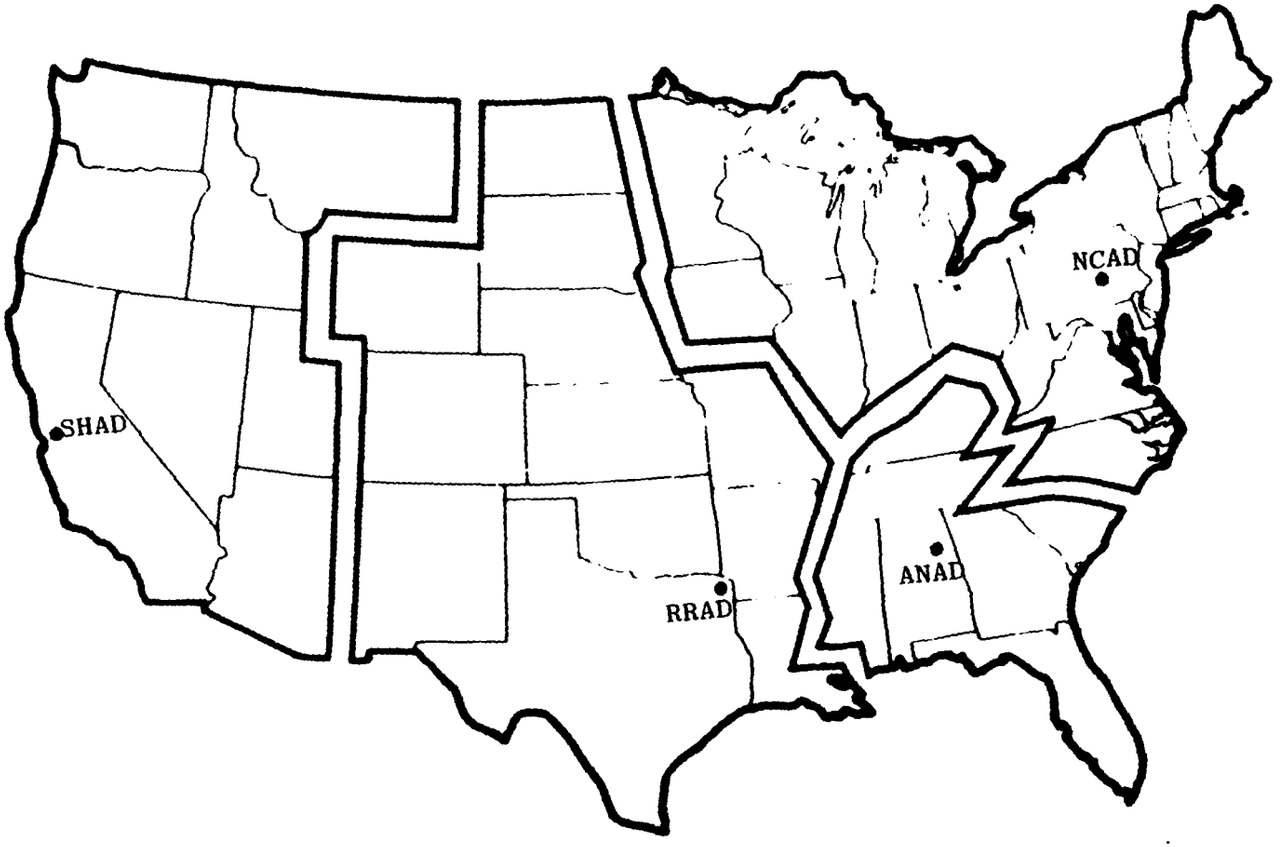

Figure 2. Alternative 2

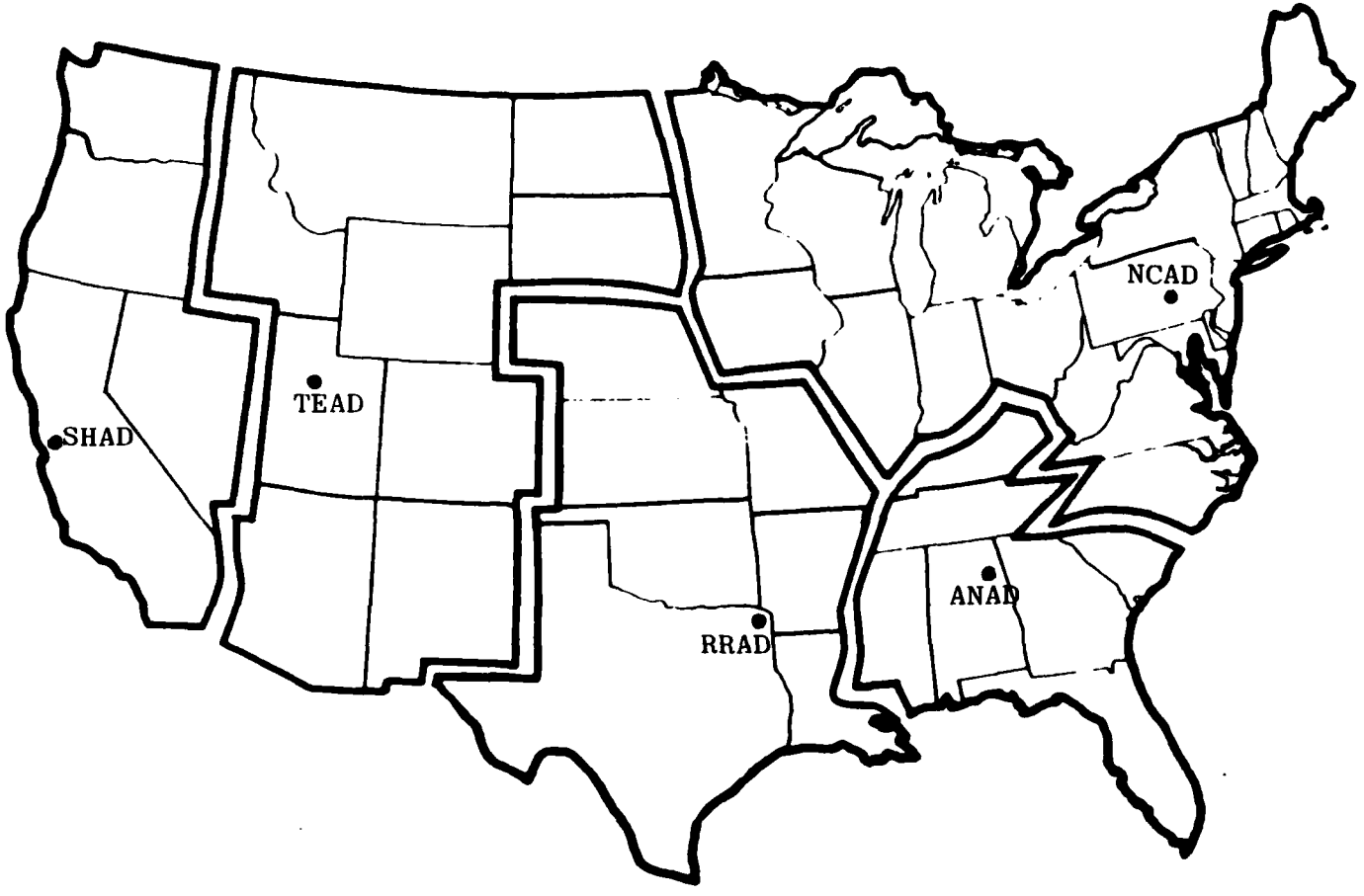

Figure 3. Alternative 3

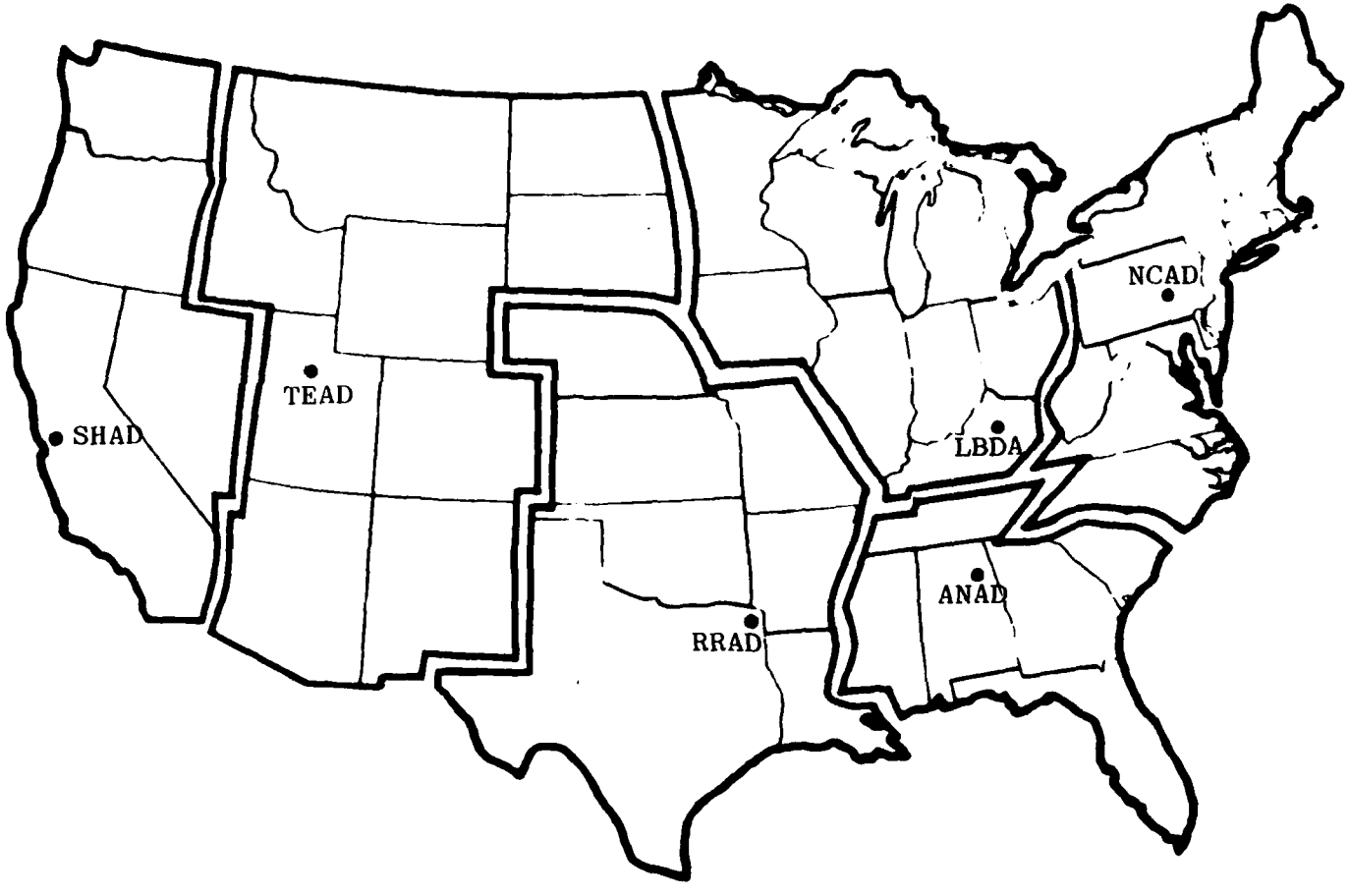

Figure 4. Alternative 4

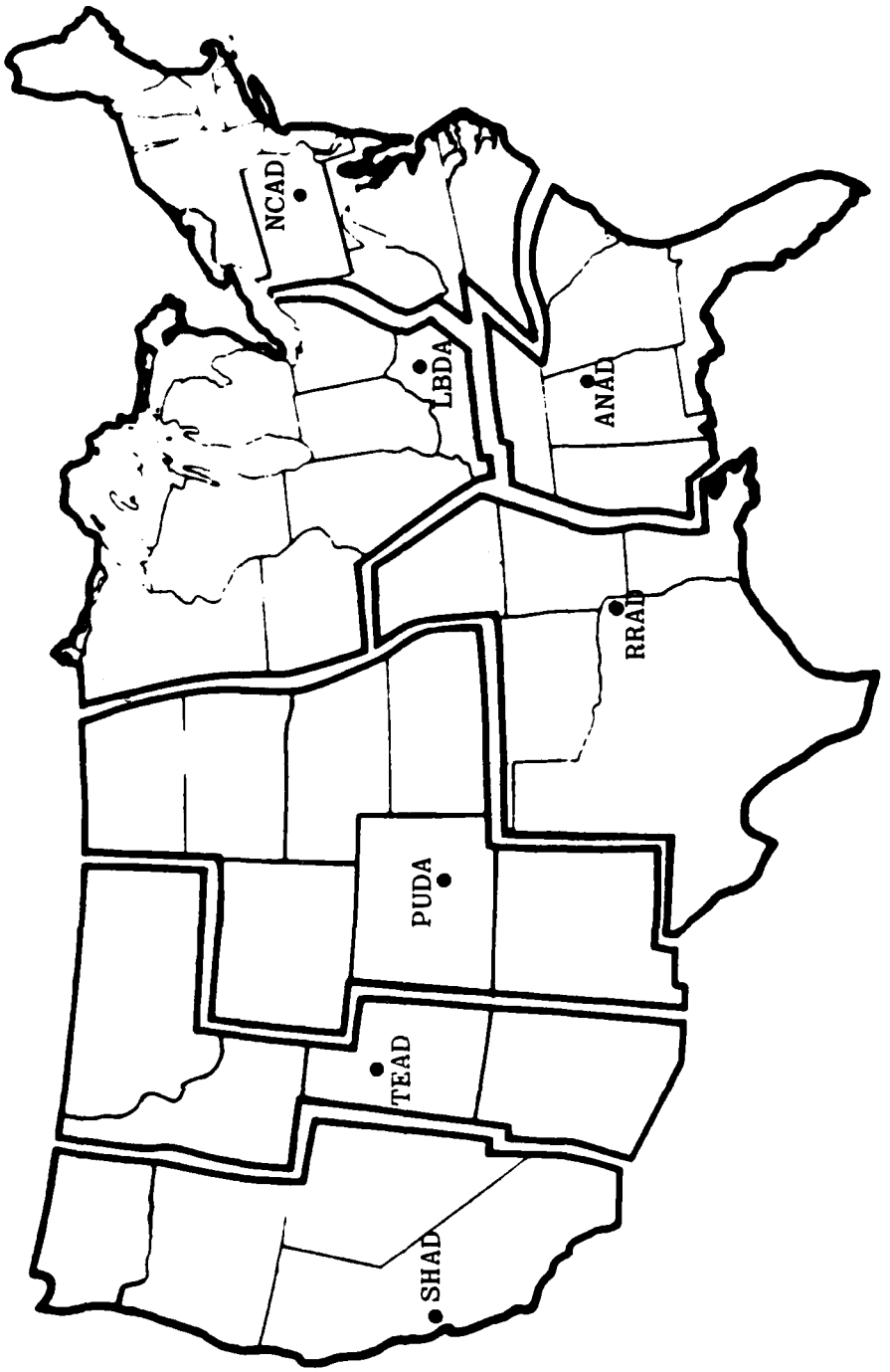

Figure 5. Alternative 5

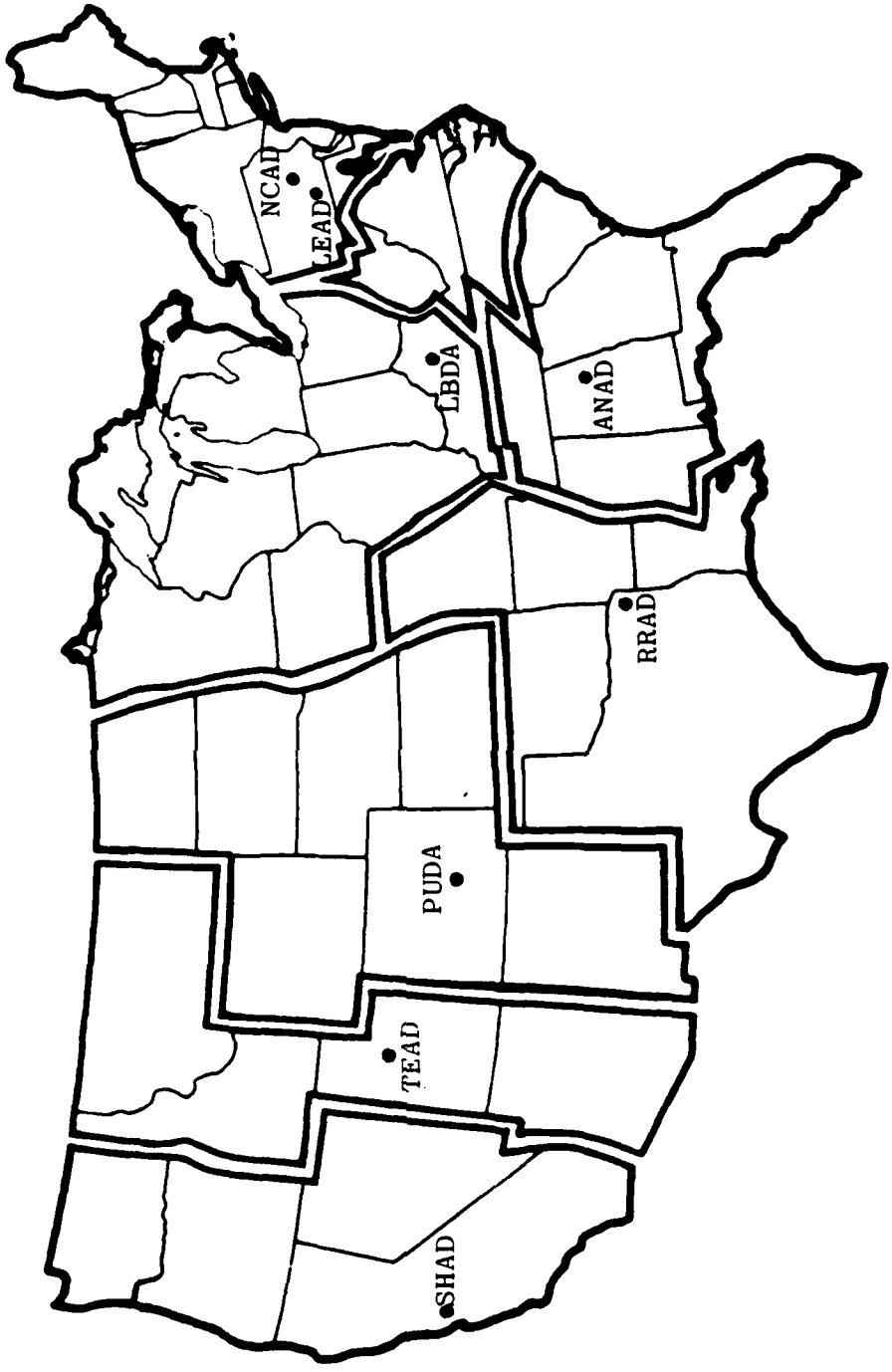

Figure 6. Alternative 6

7. Alternative 6 - Eight position points. Letterkenny Army Depot, Chambersburg, Pennsylvania, serving the Virginias and North Carolina, was added to the network per Figure 6. Although a good candidate by the criteria mentioned in Para VIA, its usefulness is limited by its proximity to NCAD (47 miles). The potential for second destination cost and time reductions are limited in using LEAD in lieu of NCAD.

TABLE 1. Alternatives

ALT NO.	NUMBER OF DEPOTS	LIST OF DEPOTS
1	3	NCAD, RRAD, SHAD
1A	3	NCAD, RRAD, SHAD
2	4	NCAD, RRAD, SHAD, ANAD
3	5	NCAD, RRAD, SHAD, ANAD, TEAD
4	6	NCAD, RRAD, SHAD, ANAD, TEAD, LBDA
5	7	NCAD, RRAD, SHAD, ANAD, TEAD, LBDA, PUDA
6	8	NCAD, RRAD, SHAD, ANAD, TEAD, LBDA, PUDA, LEAD

B. General Approach. Upon review of transportation data, it was clear that mode of shipment decisions were the cost drivers for FDT and SDT considerations. See Figure 7. Because of software limitations, and to some extent hardware processing time limits, it was necessary to classify mode of shipment into four dominant groups.

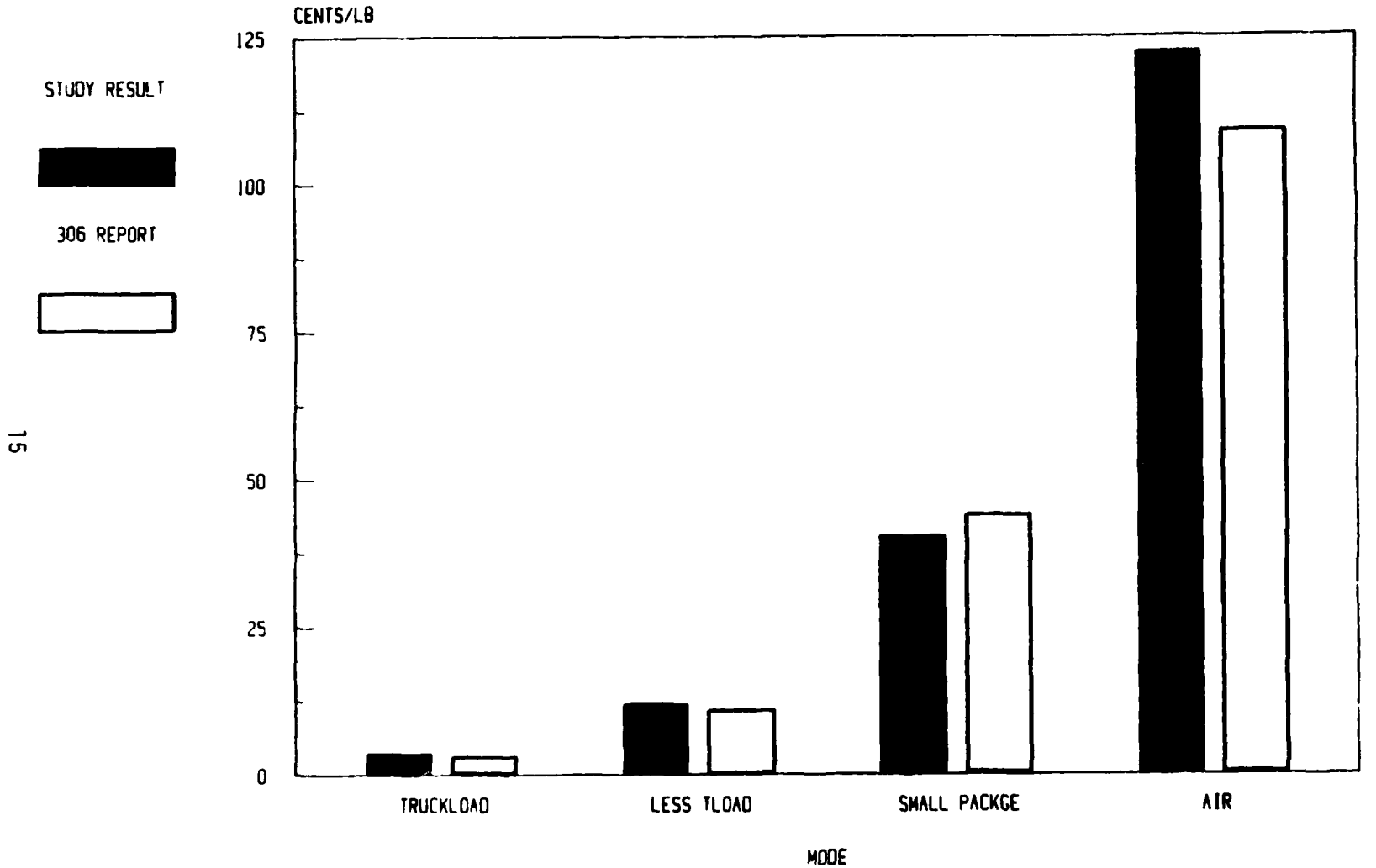

Figure 7. Average Transportation Cost Per Pound

1. Truckload - Motor van shipments of greater than 10,000 pounds were considered as "Truckload" as identified in the Logistics Intelligence File. For cost estimating purposes, a small number of "Local Delivery" shipments were also classified as "Truckload." LIF codes that apply are A and 9. [9]

2. Less-than-Truckload - Any motor shipment of less than 10,000 pounds. This corresponds to LIF code B.

3. Small Package - LIF codes G, J, and 5 corresponding respectively to Surface Parcel Post, Surface Small Package Carrier, and United Parcel Service (UPS) were combined and classified as "Small Package." UPS dominated this class at 75% of total lines.

4. Air - LIF codes H, *, Q, R, and T corresponding respectively to Air Parcel Post, Air-Small Package Carrier, Commercial Air Freight, Air Express, and Air Freight Forwarder were combined as "Air."

5. Other - LIF codes C, D, E, F, I, K, L, M, N, O, P, S, U, V, W, X, Y, Z, 2, 3, 4, 6, 7, and 8 accounted for 91 lines shipped from AODs out of over 1.3 million. These shipments were deleted from the analysis.

C. Results. Summary results are shown in this section. A more detailed description of methodology, data sources, calculations, and step-by-step procedures is contained in Volume 2 of this report.

1. Non-Recurring Cost. One time start up costs were obtained by questionnaires (see Vol 2, Appendix A) and summarized in Table 2. The major factors in these costs are the cost of ADP support needed to upgrade the capability of non-AODs to process all Standard Depot Systems modules. The cost of ADP hardware at depot level such as disk drives and terminals is the dominant cost. Depot facilities costs such as rewarehousing is also significant.

*Code not contained in Ref [9].

TABLE 2. Nonrecurring Cost Summary FY 85 $ K

ALT #	ORGANIZATION									
	AMCCOM	AVSCOM	CECOM	TACOM	MICOM	TROSCOM	ALMSA	LSSA	DESCOM	TOTAL
1										
1A										
2		100		50			100		650	900
3		100		50		50	100		1350	1650
4		100		50		50	100		1800	2100
5		100		50		50	100		2200	2500
6		100		50		50	100		3050	3350

2. Recurring Cost. Annual cost for FDT, SDT, depot operations, and recurring management costs are detailed in Vol 2, Chapter II - Chapter V.

a. FDT. The estimated cost of transportation from the producer to the depot for each alternative is shown in Table 3. Detailed procedures are documented in Volume 2, Chapter II. The increase in FDT cost is a result of subdividing large shipments into a greater number of smaller shipments.

TABLE 3. Annual First Destination Transportation Cost - FY 85 $ K

ALT #	FDT COST	DIFFERENCE FROM ALT 1
1	14,000	0
1A	14,000	0
2	14,400	400
3	14,800	800
4	15,100	1100
5	15,200	1200
6	15,600	1600

b. SDT. The costs of transportation from the depot to the customer shown in Table 4 is for direct shipping charges only. It does not include the in-house costs at both ends of the shipment. To effectively reduce SDT cost, the results indicate that improving distribution effectiveness of the existing network (Alternative 1A) offers better potential than expanding the network.

TABLE 4. Second Destination Transportation Costs - FY 85 $ K

ALT #	TRUCKLOAD	LESS THAN TRUCKLOAD	SMALL PACKAGE	AIR	TOTAL
1	3070	2660	820	2430	8970
1A	2070	2270	670	2430	7450
2	2870	2570	790	2430	8660
3	2780	2550	790	2430	8540
4	2660	2470	770	2430	8330
5	2610	2460	770	2430	8270
6	2610	2460	770	2430	8270

c. Depot Operations Cost. A significant cost of stock positioning is the cost of receiving, storing, and issuing an item. Supply depot operating costs are known to vary widely from depot to depot because of factors such as differences in wage rates, overhead structure, mission, workload, productivity, and management. Based on an analysis documented in Vol 2, Chapter IV, the cost of depot operations will increase as stocks are positioned in more Army depots. This effect, shown in Table 5, is the result of reallocating work from efficient, high volume depots to less efficient, low volume depots.

TABLE 5. Summary of Depot Operating Costs - FY 85 $ K

ALT #	ANNUAL OPERATING COST	INCREASED COST RELATIVE TO ALT 1
1	22990	0
1A	23050	60
2	24090	1100
3	24480	1490
4	25230	2240
5	25920	2930
6	26440	3450

d. Management Costs. As the distribution system becomes more complex, concern was expressed that by proliferating stock positioning points there would be a recurring cost throughout the wholesale logistics community to manage items stored in more locations. Using the same approach identified for nonrecurring cost, results of survey questionnaires are summarized in Table 6.

TABLE 6. Increase in Recurring Management Costs - FY 85 $ K

	ORGANIZATION								
ALT #	AMCCOM	AVCOM	CECOM	MICOM	TACOM	TROSCOM	ALMSA	LSSA	TOTAL
1									
1A									
2	50			50	50	100			250
3	50			50	300	150			550
4	50			50	300	150			550
5	50			50	300	400			800
6	50			50	300	400			800

e. Summary. The annual effect of increasing stock positioning locations is summarized in Table 7. The slight decrease in SDT cost is negated by significant increases in the other elements, resulting in significantly higher annual costs as more depots are added to the distribution network.

TABLE 7. Summary of Recurring Cost Elements - Annual Cost (FY 85 $ K)

ALT #	FDT COST	SDT COST	DEPOT OPNS	MANAGEMENT COST	TOTAL COST	DIFFERENCE FROM ALT 1
1	14000	8970	22990	0	45960	0
1A	14000	7450	23050	0	44500	-1460
2	14400	8660	24090	250	47400	1440
3	14800	8540	24480	550	48370	2410
4	15100	8330	25230	550	49210	3250
5	15200	8270	25920	800	50190	4230
6	15600	8270	26440	800	51110	5150

3. Order-Ship-Time. Reductions in order-ship-time will result as stock is positioned in more locations and hence closer to the customer. Reduction in transit times from depot to customer documented in Volume 2, Chapter VII, are shown in Table 8. The effect of out-of-area shipments on transit time, reflected by the results of ALT 1A, is greater than the effect of closer positioning.

TABLE 8. Average Transit Time from Depot to Customer - Days

ALT #	TRUCKLOAD*	LESS THAN TRUCKLOAD*	SMALL PACKAGE	AIR**	WEIGHTED AVERAGE	DIFFERENCE FROM ALT 1
1	4.64	7.41	2.44	1	4.00	-
1A	4.47	6.54	.80	1	3.48	-.52
2	4.44	7.24	2.25	1	3.83	-.17
3	4.39	7.20	2.20	1	3.80	-.20
4	4.34	7.13	2.10	1	3.73	-.27
5	4.26	7.11	2.07	1	3.67	-.33
6	4.26	7.11	2.07	1	3.67	-.33

*Includes consolidation/hold time
**Assumption

4. Summary. Depending on the degree of expansion, increasing stock positioning within the Army will have a one-time cost of up to $3 million and an annual cost increase of up to $5 million. This expenditure would improve average response time to requisitions by up to one-third day. Greater improvement in response time can be achieved while simultaneously reducing recurring costs if out-of-area shipments can be reduced by more effective stock positioning within the existing distribution network.

D. Relevance to Other Studies.

1. WIDS [2]. Should the Army position stocks in other services' depots? Applying the methodology of this study to WIDS issues should result in comparable findings. Depot operating costs should be carefully evaluated since these appear to be the cost driver of stock positioning decisions. The relative efficiency of Army depots to other service depots should be the main issue; not Second Destination Transportation cost. If differential depot operating cost and SDT cost offset the increase in FDT cost and nonrecurring and other recurring costs, then cost savings can be projected.

2. Grace Commission [3]. Can the Army save $20 M per year in SDT by positioning stock in other service depots? Since the Army spends only about $9 million for CONUS Class IX SDT, the savings claimed in the Grace Commission report seem exaggerated. Furthermore, the effect on other costs such as FDT is not considered. If the recommendation of the Grace Commission report is implemented, the Army budget should increase assuming that the other services' depots are of equal efficiency to the Army AOD's.

3. AOD Modernization Studies [10]. If the existing three Army AOD's are modernized, the cost advantage to maintaining the status quo will be further solidified. As AODs become more efficient, it would make little sense to reallocate portions of their supply workload to non-modernized facilities. Volume II, Chapter IV, contains a sensitivity analysis of AOD modernization.

VII. Conclusions.

A. Changes to the existing Army structure of three AODs will significantly increase total supply costs for Class IX items for CONUS customers.

B. Supply depot operating costs, which vary between depots, are the dominant costs relating to stock positioning decisions. Expanding stock positioning within the Army will significantly increase these costs.

C. Increasing the number of stock positioning points increases first destination transportation costs more than it decreases second destination transportation costs. Therefore, net transportation costs are increased by increasing stock positioning points within the Army.

D. There is a significant non-recurring cost at the depot level to increase stock positioning points. Changes to the distribution network also have some non-recurring and recurring cost implications at organizations beyond the supply depots.

E. Positioning stocks closer to customers by increasing the number of Army supply depots results in a marginal improvement in order-ship-time.

F. The current stock positioning goal for distribution effectiveness is 85%. The 15% non-effectiveness, representing out-of-area shipments, costs the Army about $1.5 million per year in increased second destination transportation costs and adds about one-half day to the average order-ship-time for CONUS shipments.

VIII. Recommendations.

A. The existing structure of three Area Oriented Depots should be maintained.

B. All future Army stock positioning decisions and analyses should include depot operating costs as a primary consideration.

C. Future Army stock positioning decisions and analyses, where cost is an issue, should consider the effects on first destination transportation cost.

D. No changes to the CONUS physical distribution system should be made without an assessment on the resulting impact at the NICPs, system design agencies, and HQ DESCOM.

E. Improving supply responsiveness by expanded stock positioning is an expensive option. Rather, it is recommended that alternative stock positioning policy changes be investigated to achieve order-ship-time reductions by improving the distribution effectiveness of the existing network.

F. Further research designed to improve distribution effectiveness is recommended. Policy changes such as revisions to the CCSS stock positioning algorithm, use of FOB origin contracts, safety stock positioning schemes, interdepot transfers, AOD boundary changes, and the issue of war reserves

could be evaluated in an effort to improve the existing distribution system. Proposed policy changes that suboptimize CONUS distribution should not adversely affect OCONUS distribution.

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APPENDIX A

ACRONYMS

ADP	Automated Data Processing
ALMSA	Automated Logistics Management Systems Activity
ALT	Alternative
AMCCOM	Armament, Munitions, and Chemical Command
ANAD	Anniston Army Depot
AOD	Area Oriented Depot
AVCOM	Aviation Systems Command (officially AVSCOM)
CCP	Container Consolidation Point
CECOM	Communications-Electronics Command
CONUS	Continental United States
CY	Calendar Year
DESCOM	Depot Systems Command
DLA	Defense Logistics Agency
DOD	Department of Defense
FDT	First Destination Transportation
FOB	Free on Board
FY	Fiscal Year
HQ	Headquarters
K	Thousands
LBDA	Lexington-Bluegrass Depot Activity
LEAD	Letterkenny Army Depot
LIF	Logistics Intelligence File
LSO	Logistics Studies Office
LSSA	Logistic Systems Support Activity
M	Million
MICOM	Missile Command
MILSTEP	Military Supply Transportation Evaluation Procedure
MTMC	Military Traffic Management Command
NCAD	New Cumberland Army Depot
NICP	National Inventory Control Point
NO	Number
OCONUS	Outside Continental United States
PUDA	Pueblo Depot Activity
RRAD	Red River Army Depot

SDT	Second Destination Transportation
SHAD	Sharpe Army Depot
TACOM	Tank-Automotive Command
TEAD	Tooele Army Depot
TROSCOM	Troop Support Command
UPS	United Parcel Service
WIDS	Wholesale Interservice Depot Support

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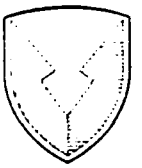

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3. Distribution non-effectiveness, measured as percent of "out-of-area" shipments is high, resulting in a higher than optimal cost of $1.5M per year in second destination transportation charges and an average transit time increase of one-half day per line shipped. Further study is recommended to investigate strategies to improve distribution effectiveness.

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THE STUDY EFFORT was directed by Mr. Francis Toner, Directorate for Supply, Maintenance and Transportation, Supply Division, Depot Operations Branch.

ADDRESS FOR COMMENTS AND QUESTIONS. Director, AMSAA, ATTN: AMXSY-LLSO, Mr. Paul E. Grover.

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