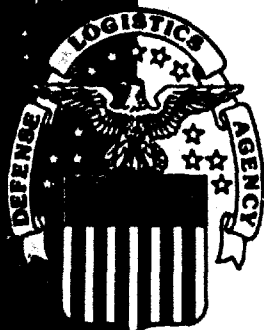


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DEPARTMENT OF DEFENSE

**DEFENSE
LOGISTICS
AGENCY**

Cameron Station,
Alexandria, Virginia 22304 6100

**DECISION SUPPORT SYSTEM
FOR
RESOURCE ALLOCATION MODEL**

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JUN 20 1989
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Operations Research and Economic Analysis Office

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DECISION SUPPORT SYSTEM FOR
RESOURCE ALLOCATION MODEL

April 1989

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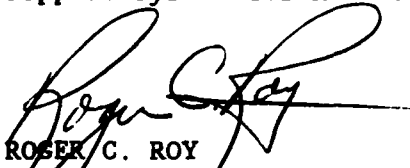
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DLA-LO

FOREWORD

In 1987, the Defense Logistics Agency (DLA) began investigating the benefits of incorporating Decision Support System (DSS) technology within the Agency. Efforts to develop a prototype DSS for resource allocation were initiated. There are various components of a DSS which include rational databases, data processing programs, mathematical programs and user friendly interfaces. This report documents the mathematical models developed in support of a Decision Support System for Resource Allocation.



ROGER C. ROY
Assistant Director
Office of Policy and Plans

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EXECUTIVE SUMMARY

In FY 87, the Defense Logistics Agency (DLA) began investigating the benefits of incorporating Decision Support System (DSS) technology in the Agency. As a result, the DLA Operations Research and Economic Analysis Management Support Office (DLA-DORO) was requested to develop an operational prototype DSS to assist decision makers in allocating constrained resource dollars. Two optimization models were created, a Stock Fund Allocation Model and a Commitment Dollar Allocation Model. The Commitment Dollar Allocation Model was used for integration into the prototype DSS as it was designed to answer the real time question of what items to buy and how much of each should be bought at this time.

Testing results indicate that this optimization model provides supply availability projections equal to or greater than current operations when funding levels are below the stated Standard Automated Materiel Management System (SAMMS) requirements levels. The primary benefit of this model within the DSS is that it gives the decision maker an idea of the effect a reduced buy or a delayed buy will have on an item and throughout the system as a whole.

*Keywords: National data bases
mathematical programming, data processing programs,
user friendly interfaces. (K.R.)*

I. INTRODUCTION. Decision Support Systems (DSS) were quickly recognized as valuable computer-based tools which assist managers at all levels in decision-making. The Defense Logistics Agency (DLA) has undertaken the implementation of a prototype Decision Support System for Resource Allocation. There are various components of a DSS which include relational databases, data processing programs, mathematical programs, and user friendly interfaces. This report documents the mathematical models developed in support of the Resource Allocation DSS.

A. Background. In May 1987, members of DLA Headquarters attended a briefing concerning a Decision Support System which was being developed by the Department of the Army. As a result of that briefing, the DLA Director requested that a prototype Decision Support System for DLA be developed using existing data and Automated Data Processing (ADP) hardware and software. Given recent budget constraints, the initial focus of the DSS was to address the question of what items DLA should buy and how much of each should be bought.

B. Purpose. The DLA effort to develop an operational prototype DSS had a twofold purpose: first, to provide a tool to managers at all levels to assist them in deciding how to allocate constrained resource dollars; and second, to educate the DLA community on the value of Decision Support Systems. In support of this effort, the DLA Operations Research and Economic Analysis Office was asked to develop the models necessary to address the optimization issue.

C. Objective. Our primary objective in the initial DSS effort was to develop and program a mathematical model which optimally allocates constrained dollars in order to maximize projected supply availability. The mathematical model would then later be integrated into the operational DSS.

D. Scope. Two distinct models were initially developed in support of the DSS effort. The Commitment Dollar Allocation Model determines optimal buy quantities for near term buy decisions when commitment authority dollars are constrained. The second model, the Stock Fund Allocation Model, focuses on optimizing the requirement levels of safety level and buy quantities for long term or steady state projections. Both models can use currently available data and ADP hardware and software. These mathematical models were designed for the four hardware commodities.

II. CONCLUSIONS. The Commitment Dollar Allocation Model was used for integration into the prototype Decision Support System. The Stock Fund Dollar Allocation Model could be incorporated into the system; however, it is not an active part of the DSS. The Commitment Dollar Allocation Model within the framework of the DSS provides managers with a decision tool for allocating constrained commitment dollar resources. Testing results indicate that the optimization routines provide supply availability projections equal to or greater than current operations when funding levels are below the stated Standard Automated Materiel Management System (SAMMS) requirement levels. When enough money is available to meet the requirement

levels established by SAMMS, model supply availability projections and requirement levels are comparable to those in SAMMS. Model development was successful in providing optimization routines which could be used to determine what to buy and how much to buy under a constrained resource budget. Model results should be used only as a decision aid to assist the manager in making his decisions. The manager must exercise his judgement in evaluating the impact of model results on selected items and procurement workload.

III. BENEFITS. The primary benefit of this Decision Support System is that it gives the decision maker an additional tool for evaluating allocation of constrained resources. It gives the decision maker an idea of the effect a reduced buy or a delayed buy will have both on the items themselves and throughout the system as a whole. For an example, there are buys that SAMMS recommends which can be delayed or reduced with minimal impact on the item's supply availability. This is calculated mathematically within the model which then recommends this reduced or delayed buy. This capability allows the decision maker to determine how to optimally allocate his resources among many groups of items.

IV. IMPLEMENTATION. The Commitment Dollar Allocation Model is part of the prototype Decision Support System. The overall effort for implementing the DSS for Resource Allocation will successfully field the system to each hardware commodity and DLA Headquarters. The DLA Operations Research and Economic Analysis Office (DORO) is responsible for maintenance and any future enhancements for the model. The DLA Office of Telecommunications and Information Systems (DLA-Z) and the DLA Systems Automation Center (DSAC) are responsible for maintenance of the fielded system and any future enhancements to the database or user interface. The DLA Directorate of Supply Operations (DLA-O) is responsible for model execution and appropriate application in the supply offices at the centers. The DLA Comptroller (DLA-C) is responsible for execution and appropriate application in the revolving fund offices.

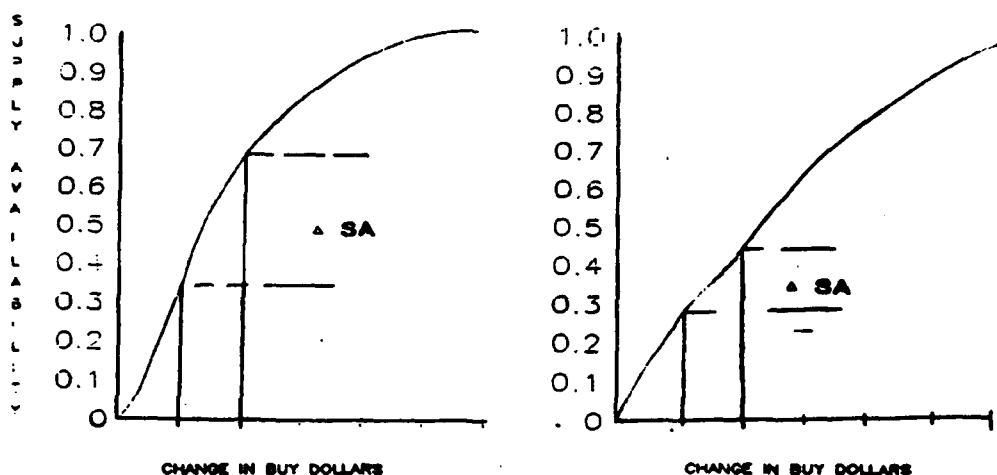
V. METHODOLOGY. Two distinct models were initially developed in support of the DSS effort. While each model focuses on slightly different aspects of resource dollar allocation, the final objective of maximizing supply availability within a constrained budget is the same. Also, both models require similar data inputs. We will first discuss the similar aspects of the mathematical objectives and the data input requirements. The distinct mathematical formulation of each model will then be discussed in turn.

A. Objective. The computer models developed for the Decision Support System were formulated and programmed as optimization programs in FORTRAN. Each model attempts to maximize system supply availability by minimizing the total number of backorder lines. Figure 1 presents a simplified explanation of the mathematical objective of each model. The two items represented in Figure 1 show the relationship between buy dollars and supply availability. All items in an inventory system can be mathematically

represented in a similar fashion. This simple two item system shows that for a fixed increment of dollars the item on the left yields a higher change in supply availability. This is true up to a point in the curve where the slope decreases such that the item on the right yields the greater change in supply availability. In this example the model would recommend buying the item on the left up to a quantity where the incremental supply availability is less than the item on the right for the same dollar change. The model would then shift the buys to the item on the right. This is a very simplistic representation and in reality it is a bit more complicated but the general idea is the same.

Figure 1

EXAMPLE OF HOW MODEL ALLOCATES RESOURCES



B. Model Input Data

The developed models minimize the probability of a stockout across selected item categories. Within given budget constraints, optimal order quantities are identified for the Commitment Dollar Allocation Model and optimal combinations of order quantities and safety levels are identified for the Stock Fund Allocation Model. The models can provide solutions for either individual items or item categories. Up to 10,000 individual items or 10,000 item categories can be accommodated. It is relatively easy to develop an optimal operating doctrine for a single item, but is much more difficult for a multi-item system. The approach used in each program is based upon the assumption that items with similar characteristics and demand patterns behave similarly.

Selection and aggregation of categories occur during a preprocessing step prior to running the model. This preprocessing step is part of the total DSS. Category breakouts are selected by the user.

Item characteristics can be divided into categories based on their annual demand value, unit price, average requisition sizes, weapon system codes, etc. Figure 2 presents an example of one possible matrix configuration.

Figure 2

		<u>MATRIX CATEGORIES</u>			
		UP < 100		UP ≥ 100	
		AD < 50	AD ≥ 50	AD < 50	AD ≥ 50
WS	ARS ≤ 12	I	II	III	IV
	ARS > 12	V	VI	VII	VIII
NON WS	ARS ≤ 12	IX	X	XI	XII
	ARS > 12	XIII	XIV	XV	XVI

As shown in Figure 2, the item population has been divided into 16 categories. Category 1 includes Weapon System (WS) items that have a Unit Price less than \$100, annual demands less than 50 and average requisition sizes less than or equal to 12. In the same way, each of the other 15 categories identifies a unique subset of the system. The items in each category are averaged together to get a representative value for the category as a whole. All items within the category will be represented by the average. Once categories are selected, all categories are treated equally with the objective of maximizing supply availability throughout the system.

Using unit price as one of the category selections is strongly recommended. Initial testing results highlighted the standard unit price categories as a key selection criteria. Application of these multiple cost categories provides the greatest reduction in the cost variances experienced due to item aggregation. Maximum reduction in cost variance is necessary to forecast buy dollar requirements and expenditures.

C. Mathematical Models. In the optimization of mathematical representations of real processes, two areas of difficulty are encountered. The first is the formulation of the mathematical model and the second is the numerical technique used for solution. The formulations and the numerical techniques for the solutions in each model are explained in Appendices A and B.

1. Commitment Dollar Allocation Model

The Commitment Dollar Allocation Model provides a short term approximation of projected supply availability based upon current reorder points and issuable asset quantities. The model is used to determine the optimal mix of buy quantities for those items which have or are expected to breach their reorder points within a user specified time frame.

The penalties to supply availability incurred by delaying a buy or reducing a buy are also considered. Supply availability projections are calculated based upon a three year time horizon. The basis for the first cycle if there is no delay or reduction in the buy quantity is the quantity which can be demanded before we breach reorder point. With a buy reduction or delay, the length of the first cycle is increased by the number of cycle days. This results in an increase in the expected number of backorders incurred during this cycle.

The computations for expected backorders are performed on each item or item category under consideration. Expected backorders are converted to expected backorder lines and buy dollars are allocated to the item that minimizes total system backorders. Incremental dollar allocations are made until all budget resources have been spent. The model optimizes total system supply availability by calculating the buy quantity mix which minimizes the total backorder lines incurred.

Supply availability is calculated for each item or item category and also as a system total.

2. Stock Fund Allocation Model

The Stock Fund Allocation Model provides steady state supply availability projections based upon an optimal mix of safety levels and buy quantities across all items. This model was formulated and programmed as a non-linear optimization program.

A non-linear program, in its broadest sense, takes a mathematical representation of a real process as an objective function and attempts to locate an extreme point (minimum or maximum) from an infinite number of possible solutions.

VI. ANALYSIS

When the commitment dollar allocation model was developed, extensive testing and validation was performed. This testing and validation was accomplished using the Defense General Supply Center (DGSC) Recommended Buy Output Control System (REBOCS) data. The model was run using various aggregation groupings. Use of the Rebocs database allowed us to compare the model output to SAMMS recommended buys and the item manager approved buys for the months of April, May and June 1988. Sensitivity analysis on the factors used for aggregation of items into categories showed that unit price was the most significant factor in reducing the variance in buy dollars among the items and item categories. In Appendix D the results of the model and aggregation testing for April and May data are shown. The initial testing was run on data from May 1988. The first run was on a National Stock Number (NSN) by NSN basis. With an expenditure of \$22.2 million dollars the buys recommended by the item manager had a projected supply availability of 91.6% versus 95.4% for the model buys. We then tried three aggregation methods, the first being the DGSC Supply Management Category Code (SMCC) breakouts. This aggregation resulted in a large overstatement of the dollars required by the item manager. This is due to the large variances experienced in the average dollar values. In our second aggregation we introduced unit price as a third variable which greatly reduced this variance. In all aggregation methods we have seen that unit price is the major factor in bringing our average values in line with actual values. Our next step was to look at individual categories within the matrix and run the items from these categories on an NSN by NSN basis using the dollar amount recommended by the model. The final step in the analysis was to use a percent application. We took the ratio of the SAMMS buy to the model buy and then applied that percentage to each item's buy and compared projected supply availabilities. In almost every case the model results were better than the item manager actions. A similar analysis was done for data recorded from April 1988. A summary of the analysis is listed in Appendix D.

APPENDIX A

Commitment Dollar Allocation Model

A. Mathematical Formulation

$$\text{maximize } \sum_{i=1}^n \frac{3\lambda_i - [\eta(\text{STKP}_i) + N(\eta(\text{ROP}_i))]}{3\lambda_i}$$

$$\text{S.T. } \sum (Q_i \cdot C_i) \leq \text{Obligation Dollars}$$

$$Q_i \leq 3 \cdot \lambda_i$$

$$Q_i \geq \lambda_i/4$$

where Q_i - EOQ

STKP_i - Stock Position

λ_i - Annual Demand

C_i - Unit Price

ROP_i - Reorder Point

N_i - Cycles Remaining Over Three Year Time Horizon

$$\eta(x) = \int_{r_i}^{\infty} xh(x)dx - r_i H(r) = E[\text{Backorders}]$$

$h(x)$ - marginal distribution of lead time demand in this case
we assume a normal distribution

B. Numerical Technique for Solution

In determining the projected supply availability of an item over a three year time horizon there are a number of checks and conditions that will affect the calculations. With the assumption that there will not be enough commitment dollars to fully fund the buy quantities recommended by SAMMS, the computations for supply availability need to reflect the effect of a reduced buy or a delayed buy. This is done mathematically by adjusting the

reorder points and leadtimes based upon current asset positions, daily demand rates, and the length of delay in days or the reduction in the buy quantity.

An item has breached its reorder point when its stock position (STKP) is at or below the calculated reorder point. Stock position is calculated as:

$$\text{STKP} = \text{IAQ} + \text{Due-in Quantity} - \text{Backorder Quantity}$$

where IAQ = Issuable Asset Quantity

The projected buy quantity (Q) will influence the timing of the next reorder point breach. Therefore, a first check is made to determine how the projected buy quantity in conjunction with forecasted demand affects the item's stock position over the cycle days selected by the user. The actual calculation is:

$$\text{CHECK1} = \text{STKP} + Q - (\text{cycle days} * \text{DDR})$$

where DDR = Daily Demand Rate

CHECK1, which represents the adjusted stock position, is then compared to the calculated reorder point. The computations used to calculate expected backorders and projected supply availability are based upon the results of this check.

Calculations for the average number of backorders incurred per year, or the expected number of backorders per cycle times the number of cycles per year (AD/Q ; where AD = annual demand; Q = EOQ) are based upon the methodology described in Hadley & Whitin's "Analysis of Inventory Systems." [1]

1. First Cycle Demand Satisfied

If the adjusted stock position is greater than the calculated reorder point, then the projected buy quantity provides sufficient stock so that the item does not breach its reorder point again during the first cycle. The expected number of backorders ($E[B/O]$) over the three year time horizon will be the $E[B/O]$ of the first cycle based upon the current stock position and the $E[B/O]$ based upon the reorder point times the number of cycles remaining over the three year horizon. The number of cycles per year is AD/Q^* (AD = annual demand, Q^* = Wilson EOQ); therefore, the number of cycles over a three year horizon for the constant Q^* is $3*AD/Q^*$ (Hadley & Whitin). However, the length of the first cycle determines the number of cycles remaining over our three year horizon. The model calculates the length of the first cycle in terms of the quantity which can be demanded before we breach reorder point.

$$\text{TAU} = Q^* + \text{STKP} - \text{ROP}$$

The number of cycles remaining over the three year horizon is, therefore, computed as:

$$N = \frac{3*AD - TAU}{Q*}$$

The expected number of backorders for an item is then calculated as:

$$EBO = eta(STKP) + N eta(ROP)$$

where $eta(STKP)$ - $E[B/O]$ for the first cycles based upon the current stock position

$eta(ROP)$ - $E[B/O]$ per remaining cycle based upon the ROP

N - number of remaining cycles

2. First Cycle Reorder Point Breach

If the adjusted stock position is less than the calculated reorder point, then the item will breach its reorder point again during the first cycle. Even though we will experience another reorder point breach during the first cycle, the next buy decision will be delayed until the second cycle. By sufficiently reducing a buy quantity or delaying a buy, we have increased the probability of experiencing backorders. This imposed penalty on the item is reflected as an additional delay cycle and requires adjustments to the ROP and the calculation of a new leadtime. The calculation of cycles is adjusted as follows:

$$TAU = \text{cycle days} + Q*/DDR$$

and the number of cycles remaining becomes

$$N = \frac{(3*AD - TAU*DDR)}{Q*}$$

The new leadtime in years calculated for the delayed cycle is:

$$NEWLT = \text{cycle days} / 365.0$$

A new ROP is calculated for the delay cycle. The reorder point recalculation is dependent upon the $E[B/O]$ based on our stock position or $eta(STKP)$. If we have experienced backorders during the first cycle then our delay cycle ROP is the projected buy quantity minus the expected backorders. If backorders were not incurred during the first cycle then the delay cycle ROP is:

$$ROPNEW = STKP - DEMLT + Q$$

where $DEMLT$ - demand over the leadtime.

We then calculate $\eta(Q)$ which is the $E[B/O]$ based upon the projected buy quantity. These are the additional backorders incurred when the buy quantity is reduced or the buy is delayed. The total backorder calculation for a three year time horizon now becomes:

$$EBO = \eta(STKP) + \eta(Q) + N*(\eta(ROP))$$

C. Supply Availability Computation

The equation for supply availability used in the Commitment Dollar Allocation Model is:

$$SA = \frac{3*ADF - EBO}{3*ADF}$$

where ADF - annual demand frequency

 EBO - expected backorder lines over a three
 year time horizon

APPENDIX B

Stock Fund Allocation Model

A. Mathematical Formulation

Minimize

$$\sum_{i=1}^n \left[\frac{.5 \sigma_i}{\sqrt{2} Q_i} \left(1 - \exp \left(\frac{-\sqrt{2} Q_i}{\sigma_i} \right) \right) \exp \left(\frac{-\sqrt{2} S_i}{\sigma_i} \right) \right] \cdot \left(\frac{AD_i}{\text{Total AD}} \right)$$

$$\text{S.T. } \sum_{i=1}^n \left(Q_i/2 + S_i \right) \cdot C_i \leq \text{Stock fund dollars}$$

$$Q_i \leq 3 \cdot AD_i$$

$$Q_i \geq QFD_i$$

$$S_i \leq \text{MIN} (1.25 \text{ MADLT}, \text{DEMLT})$$

$$S_i \geq 0$$

where Q_i - Economic Order Quantity

C_i - Unit Cost

σ_i - 1.25 MADLT

AD_i - Annual Demand

Total AD - Total Annual Demand

QFD_i - Quarterly Forecasted Demand

S_i - Safety Level Quantity (SL)

$$SL = 1.25 * K * MADLT$$

$$K = 0.88388 * MAD \text{ LN } \left[\frac{\text{SYSRATIO} \left(\frac{ARS \cdot EOQ}{MADLT (1 - \exp \left(\frac{-1.13137EOQ}{MADLT} \right))} \right)}{\right]$$

B. Numerical Technique For Solution

The basic approach used in this model is known as a Sequential Unconstrained Minimization Technique (SUMT) and is structured as a penalty function. This structure allows us to solve an unconstrained nonlinear program because the penalty factor penalizes any constraint violations. If the penalty is severe, the solution to the unconstrained problem will approximate the optimum of a constrained problem.

The objective function for a Probability of Stockout (POUT) was formulated by Presutti and Trepp in their paper "Much Ado about EOQ." [2]

The constraints used in the stock fund model are total stock fund dollars and limits on economic order quantity and safety level. The first computation required in the model is the gradient $\nabla f(X_k)$. This is the first derivative of the objective function. The gradient is one factor used in determining a search direction (d_k) at each iteration of the program. The second computation required is an approximation to the Hessian matrix (S_k). The Hessian matrix is the inverse of the $N \times N$ matrix of second derivatives of the objective function. This is the second factor used in determining a search direction. The Hessian approximation used in this model is the Davidon-Fletcher-Powell approximation which is shown here. [3]

Hessian Approximation

Davidon-Fletcher-Powell

$S_1 = I$ (identity matrix)

$$S_{k+1} = S_k + \frac{P_k P_k^T}{P_k^T Q_k} - \frac{S_k Q_k Q_k^T S_k}{Q_k^T S_k Q_k}$$

where: $P_k = X_{k+1} - X_k$, change in Q values

$Q_k = \nabla f(X_{k+1}) - \nabla f(X_k)$, change in gradient values

and: $S_k = n \times n$ matrix; n = number of items/categories

k = iteration

$P_k = n \times 1$ matrix

$Q_k = n \times 1$ matrix

The search direction is then calculated as $d_k = -S_k \nabla f(X_k)$. The model searches along this direction vector evaluating the objective function at each step until an interval is bracketed within which the objective function has passed a minimum value. A fibonacci search is then conducted to locate this minimum value. When the minimum value is located an optimality check is conducted to determine if we have an optimal solution for the objective function. If we have reached optimality, the program stops. If the solution is not optimal, we recalculate the gradient and Hessian approximation. This then gives us a new search direction and the procedure is repeated.

C. Supply Availability Computation

The equation used for the calculation of supply availability is:

$$S.A. = (1.0 - POUT) * (ADF / \text{Total ADF}) * 100$$

where ADF = annual demand frequency of the item or category

Total ADF = total annual demand frequency of the system

APPENDIX C

Format Of Data Input

A. The following is the order and numerical formatting required for input to each category being optimized:

1. Data: CAT1(I),CAT2(I),CAT3(I),CAT4(I),NSNCT(I),ROPC(I),AVTLT(I),AVPLT(I),AVALT(I),SLYRS(I),ADV(I),AVRQN(I), MAD(I), AVRQS(I), DUEINQ(I),PCP(I),UPRICE(I),ADQ(I),BOQ(I),ROP(I)
2. Format: (4I2,I5,F11.1,4F6.3,F15.2,2F10.1,F8.1,2F11.1,F10.2,3F11.1)
3. If the data is on an NSN by NSN basis the first 13 bytes of the format statement will list the NSN.

B. Where: CAT1,2,3,4(I) - Matrix location of category
NSNCT(I) - No. of Items in Category I
ROPC(I) - Stock Position
AVTLT(I) - Avg Total Lead Time
AVPLT(I) - Avg Procurement Lead Time
AVALT(I) - Avg Administrative Lead Time
SLYRS(I) - Avg Safety Level in Years
ADV(I) - Avg Annual Demand Value
AVRQN(I) - Avg Requisition Number
MADLT(I) - Avg Mean Absolute Deviation of Lead Time Demand
AVRQS(I) - Avg Requisition Size
DUEINQ(I) - Avg Due in Quantity
PCP(I) - Avg Procurement Cycle Period in Months
UPRICE(I) - Avg Unit Price
ADQ(I) - Avg Annual Demand Quantity
BOQ(I) - Avg Backorder Quantity
ROP(I) - Avg Reorder Point Quantity

APPENDIX D

RESULTS OF BSS MODEL AND AGGREGATION TESTING DGSC Recommended Buy Data

** APRIL **

AGGREGATION METHOD

	INITIAL NSN x NSN ANALYSIS			UP x FREQ 45 cells		INITIAL NSN x NSN ANALYSIS			% BUY APPLIED derived from AGGREGATE		
	\$	SAX	# BUYS	\$	SAX	\$	SAX	# BUYS	\$	SAX	# BUYS
ITEM MGR	20.801M	92.82	2427	22.486M	92.74	20.801M	92.8	2427	20.801M	92.8	2427
MODEL	20.813M	95.38	1059	20.806M	94.16	20.813M	95.3	1059	19.782M	93.8	2911
SAMMS	41.425M	95.21	3185	44.035M	95.46	41.425M	95.2	3185	41.425M	95.2	3185

EFFECTS OF AGGREGATION ANALYSIS OF SELECTED CATEGOR FROM (UP x FREQ)

** APRIL **

CELL 1,3,1,1

CELL 2,5,1,1

	AGGREGATED			AGGREGATED		
	NSN x NSN	SAX	\$	NSN x NSN	SAX	\$
ITEM MGR	99.99	36730	98.38	100.00	334280	94.68
MODEL	99.98	19509	99.05	100.00	0	92.33
SAMMS	99.99	38616	99.05	100.00	750185	96.64

CELL 3,5,1,1

CELL 7,5,1,1

	AGGREGATED			AGGREGATED		
	NSN x NSN	SAX	\$	NSN x NSN	SAX	\$
ITEM MGR	76.94	260977	70.99	82.97	515111	89.74
MODEL	83.59	539002	83.42	81.48	0	89.03
SAMMS	78.93	260977	73.77	90.69	3061192	94.73

RESULTS OF DSS MODEL AND AGGREGATION TESTING
DGSC Recommended Buy Data

**** MAY ****

AGGREGATION METHODS

	INITIAL NSN x NSN ANALYSIS			ADVxFREQ DGSC SMCC		UPxADVxFREQ 270 cells		UPxFREQ 45 cells	
	\$	SAX	# BUYS	\$	SAX	\$	SAX	\$	SAX
ITEM MGR	22.215M	91.66	1382	260.7M	94.16	24.556M	94.93	24.079M	92.72
MODEL	22.214M	95.47	1026	22.81M	91.73	22.338M	95.42	22.322M	94.49
SAMMS	59.532M	94.78	2929	831.2M	97.08	63.955M	97.11	62.076M	96.17

EFFECTS OF AGGREGATION
ANALYSIS OF SELECTED CATEGORIES
FROM (UP x FREQ)

**** MAY ****

	CELL 1,4,1,1			CELL 1,5,1,1			CELL 3,5,1,1		
	AGGREGATED	NSN x NSN		AGGREGATED	NSN x NSN		AGGREGATED	NSN x NSN	
	SAX	\$	SAX	SAX	\$	SAX	SAX	\$	SAX
ITEM MGR	100.00	69072	98.39	97.94	450296	96.44	73.69	1078381	89.78
MODEL	100.00	0	94.89	99.85	1207472	99.53	89.08	5980467	96.46
SAMMS	100.00	157007	99.39	100.00	1095865	99.00	76.59	1920016	91.69
% APPL								5760048	93.10

**** MAY ****

	INITIAL NSN x NSN ANALYSIS			% BUY APPLIED derived from AGGREGATE		
	\$	SAX	# BUYS	\$	SAX	# BUYS
ITEM MGR	22.215M	91.66	1382	22.215M	91.66	1382
MODEL	22.214M	95.47	1026	21.662M	93.24	2371
SAMMS	59.532M	94.78	2929	59.532M	94.78	2929

APPENDIX E

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