AIR FORCE LOGISTICS COMMAND

MATERIEL ANALYSIS
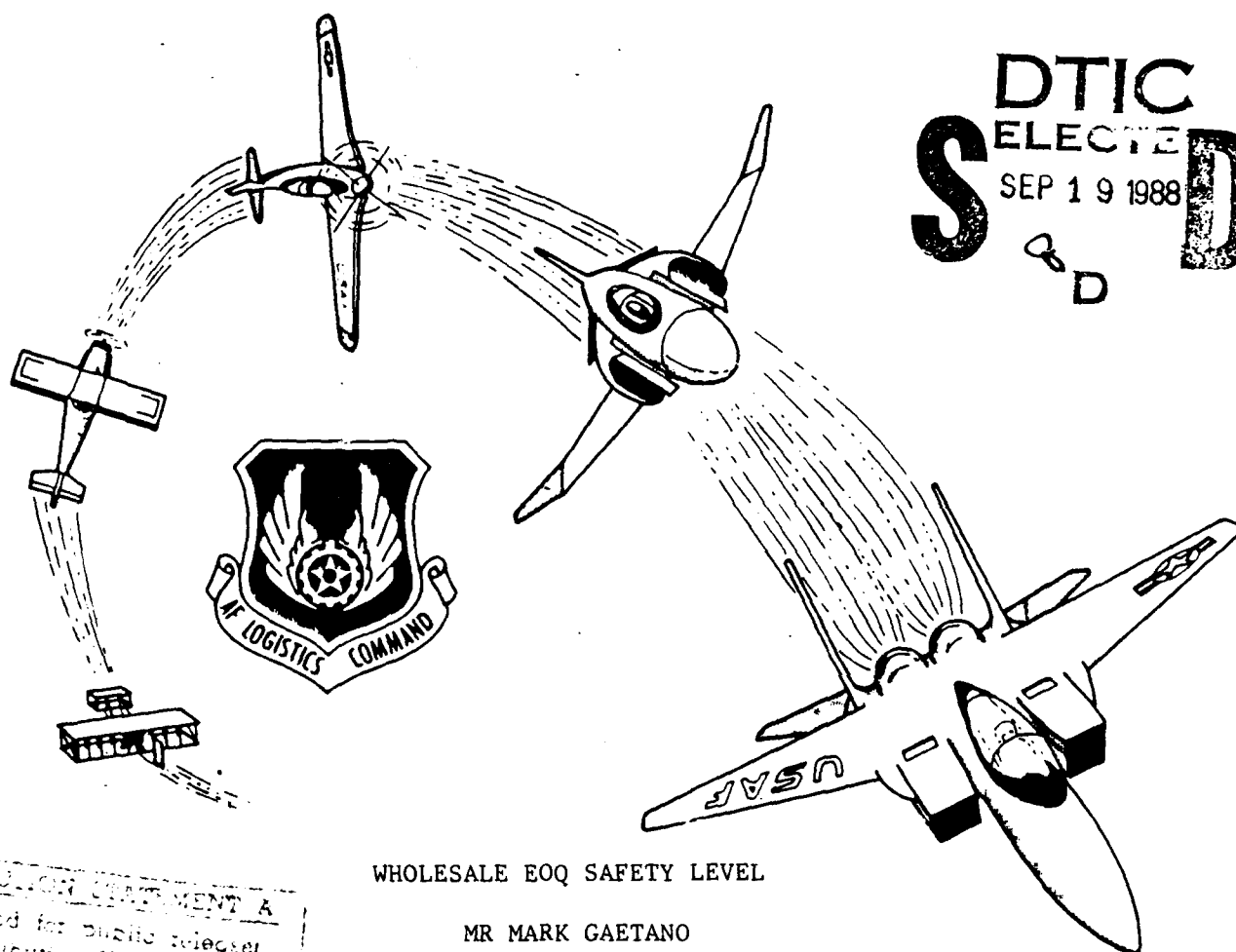
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WHOLESALE EOQ SAFETY LEVEL

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ABSTRACT

The Air Force's System Support Division (SSD) consumable item wholesale fill rate has decreased from 87 percent to 76 percent since 1981. In addition, the wholesale SSD safety level computation has been changed several times over the last five years. This study measures the impact of those safety level computation changes and examines alternative safety levels in an effort to improve wholesale fill rates.

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EXECUTIVE SUMMARY

Since 1981, the Air Force's System Support Division (SSD) consumable item fill rates have decreased from 87 percent to its current level of 76 percent. The current Economic Order Quantity (EOQ) Requirements System (D062) computes requirements to reach an implied fill rate of 85 percent, which we currently fall well below. One of the causes of the declining performance is the current safety level computation.

To analyze the effectiveness of the current safety level, we used the Air Force Logistic Management Center developed multi-echelon simulation model, [Rinks]. This model simulates transactions between bases and depot and from the depot to vendors. We ran the model for a 50-year simulation period using actual data from three different Air Logistic Centers.

As a result of our analysis, we recommend improvements to the safety level that increase fill rate performance by almost 4 percent at the same requirements cost as today. In addition, we can develop trade-off curves which relate dollars to fill rate performance, which will help budget managers provide estimates for future funding requirements, provide more mission oriented performance targets and more accurately stratify existing inventory.

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CHAPTER 1

THE PROBLEM

PROBLEM STATEMENT

Since 1981, the Air Force's Systems Support Division (SSD) consumable item wholesale fill rates have decreased from 87 percent to 76 percent. The current Economic Order Quantity (EOQ) Requirements System (D062) computes requirements to reach an implied 85 percent fill rate target, yet fill rates are way below the targeted level. This report documents our study to analyze and recommend improvements to the wholesale SSD safety level computation for consumable items.

CURRENT SYSTEM

The current EOQ Requirements System computes requirements to minimize the holding, ordering, and penalty (i.e., back order) cost [Presutti]. The current system computes an Economic Order Quantity (EOQ), which is constrained to be between one and three years of stock. An EOQ is the amount to order when an item reaches its reorder level. The EOQ requirements level consists of the EOQ plus a reorder level, which includes the average amount of stock needed during the procurement replenishment pipeline time plus a safety level. The safety level is the amount of stock necessary to provide protection against fluctuations in demand and procurement lead times. The current safety level is funds constrained; the safety level is set to correspond to an average of 55 days. That is, budget managers determine the cost to stock 55 days of each item and that aggregated total cost is the targeted safety level amount. Each item does not have a 55-day safety level; some items may have no safety level while others have over 100-days safety level. Individual safety levels are set according to a formula in Appendix A. Basically, HQ AFLC managers set an implied shortage factor (ISF), which acts as a tuning knob to minimize back orders within the available funding target (set at 55 days). The assumption is the 55-day safety level provides 85 percent fill-rate support. Figure 1-1 shows AFLC fill-rate statistics for 1980 through 1987.
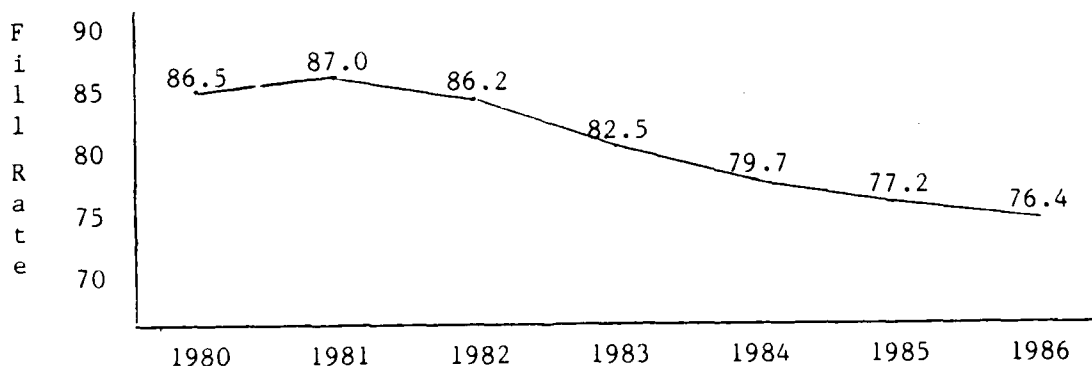
AFLC Fill Rate Trend

Figure 1-1

AFLC changed the safety level formulas in 1984 as a result of an audit report. The original safety level model was an optimal model; it resulted in the fewest number of back orders with available dollars. A 1983 audit report [Audit] indicated the pre-1984 safety level was overly biased to stock too much for inexpensive items. Futhermore, the pre-1984 safety level did not consider an item's mission essentiality. The audit report implied essential items were generally more expensive items, and the pre-1984 safety levels were too small for these essential items. As a result, AFLC implemented a change to dampen the cost (the model used the square root of the unit cost) and implemented a mission item essentiality coding system.

The change to dampen the unit cost "tricks" the model into increasing the safety levels for some expensive items. As a result, the model invests safety level dollars on higher cost items which would reduce more back orders if spent on other lower cost items. It would make sense to dampen the unit cost if higher costs meant more essential items. However, that is not the case (see Table 1-1). More essential items do not necessarily have higher unit costs. Secondly, the essentiality coding system identifies an item's essentiality more accurately than unit cost.

MIEC Groups vs. Cost

MIEC GROUP	AVERAGE COST
1 - 12	$387.21
13 - 36	$351.91
37 - 73	$408.18

Table 1-1

The current system's essentiality coding scheme identifies 72 separate essentialities with an additional default value set at 73. The safety level change in 1984 reduces the safety level for all items coded 2 through 73 (assuming the same implied shortage factor is used). The lower the essentiality, the less investment in the safety level for the item. As a result, most items with low essentiality codes do not get any safety level. Table 1-2 shows the percent of items within each essentiality grouping by Air Logistic Center. It should come as no surprise that Ogden and Oklahoma City Air Logistic Centers have the highest fill-rate performance for EOQ items, since they have an overall average of relatively more essential items and a higher overall average of MIECs coded 1 through 12. See Appendix C for explanation on how essentiality codes are assigned.

MIEC Frequency

ALC	MIEC < 12	13 < MIEC < 36	MIEC > 37
OC	67.1%	29.9%	3.0%
OO	79.6%	5.0%	15.4%
SA	47.7%	27.8%	24.5%
SM	44.6%	41.4%	14.0%
WR	47.6%	24.8%	27.6%

Table 1-2

Earlier in this report, we briefly discussed the setting of the implied shortage factor. Basically the implied shortage factor is a control knob to compute safety levels to meet a given funding target. The higher the implied shortage factor, the larger the safety level and the more money spent. An Air Force Institute of Technology (AFIT) study [AFIT] showed that AFLC has not done particularly well in setting the implied shortage factor to meet the funding target. The AFIT study showed AFLC historically underestimates the implied shortage factor, thereby not spending up to its target. However, there were cases where AFLC overestimated the implied shortage factor as well.

There are three points we want to make regarding the current system. First, the current safety level formula computation is not optimal; it does not minimize expected back orders per dollar spent. The changes to dampen the cost and the use of the mission essentiality codes make the model "non-optimal." Second, the current safety level is not computed to reach a given mission-oriented performance target (either weapon system availability or fill-rate targets). The safety level is funds constrained to a 55-day safety level, which is not a mission-oriented performance target. Finally, we need a better, more scientific method to set the implied shortage factor to more accurately meet given funding levels.

OBJECTIVES

Our objectives are to:

1. Evaluate alternative consumable item wholesale safety level formulas.

2. Develop a methodology to set mission-oriented performance targets.

3. Develop a scientific method to more accurately determine the implied shortage factor to spend available funds.

4. Recommend improvements to the current system, if appropriate.

CHAPTER 2

ANALYSIS

We document our analysis in three sections. In the first section, we discuss the analysis approach. In the second section, we describe the results. Finally, we discuss our implementation plans.

APPROACH

We used the Air Force Logistics Management Center developed multi-echelon simulation model [Rinks] to test various alternative safety level policies. The multi-echelon model simulates base-level demands and orders stock from the depot, whenever the base reaches its reorder point (routine replenishment) or stocks out (priority request). The model then simulates the depot's inventory policy. It satisfies the bases' requisition whenever depot stock exists and back orders if no stock exists. Whenever the depot reaches its reorder point, the model places an order to a vendor that arrives an administrative (ALT) plus production (PLT) lead time away. The base demands are simulated according to a (constant Poisson) probability distribution. The ALT plus PLT is also simulated by a (truncated lognormal) probability distribution. We based these probability distributions based on actual data from the EOQ (D062) data base. For example, if an item had an average monthly demand rate of ten units, the simulated demand in the model averages ten demands per month.

We used 1986 data from three Air Logistics Centers (SA-ALC, OC-ALC, and SM-ALC). In the body of the report we present data from SA-ALC. Appendix B will present the results for the other centers. We selected a sample size of 192 items from each center. We were constrained to this sample size because of the CREATE computer size limitations. We selected the samples to represent the same characteristics as the entire population of items from the center. Table 2-1 compares the SA-ALC sample characteristics compared to the total population.

Sample Vs. Population
(SA-ALC Items)

SMGC = 'T'

Category	Sample	Population
Monthly Demand Rate	7.14	7.08
Unit Cost	$111.07	$96.00
Lead Time (Days)	450.80	463.59

SMGC = 'P'

Category	Sample	Population
Monthly Demand Rate	40.02	50.85
Unit Cost	$485.37	$488.83
Lead Time (Days)	485.37	553.19

SMGC = 'M'

Category	Sample	Population
Monthly Demand Rate	278.60	291.54
Unit Cost	$1415.21	$1269.26
Lead Time (Days)	638.06	660.16

Table 2-1

As Table 2-1 shows, the sample had approximately the same demand, price, and procurement lead time characteristics as the population of items by Supply Management Grouping Code (SMGC). The SMGC groups items according to its expected dollar value of annual demand as shown in Table 2-2.

SMGC Categories

SMGC	Dollar Value of Demand
T	0 - 2,500
P	2,500 - 50,000
M	50,000 - UP

Table 2-2

The model collects and averages cost and fill-rate performance statistics for the length of the simulation run. We ran the model for a simulated 50-year period. Thus the model predicts long run performance for a given stockage policy.

We compared the cost and stockage performance for several alternative safety level formulas; however, we document only five formulas in this report. These five include:

MODEL A - CURRENT SYSTEM
This is the model currently used in the EOQ requirements system. It includes the changes to dampen the unit cost and the mission item essentiality coding system. For mathematical details see Appendix A.

MODEL B - 30 DAY MINIMUM LEVEL
For this model we ensure each item has at least a 30-day safety level. We compute the safety level using the optimal model (described below), and then if appropriate, increase the safety level to at least 30 days of supply.

MODEL C - OPTIMAL MODEL USING THE SQUARE ROOT OF THE UNIT COST
This is the optimal model [Presutti] with the square root of unit cost used to dampen the effect of the cost. We included this model to measure the impact of one of the two changes AFLC made in 1984.

MODEL D - OPTIMAL MODEL
This model is described in [Presutti] and computes safety levels to minimize back orders. This model will result in the fewest number of back orders per dollar invested.

MODEL E - OPTIMAL MODEL WITH 3 MISSION ITEM ESSENTIALITY (MIEC) GROUPS)
We use three different implied shortage factors for three essentiality groups. Model E then is three applications of the optimal model, with a higher implied shortage factor for higher essentiality items.

The safety level formulas we do not document in this report are either not relevant or were clearly inferior to the models we do include. We attempted to compare the models for the same level of inventory investments as used today with the current system. We couldn't precisely get the same cost for each model; however, we can still make comparisons of performance to cost.

RESULTS

COMPARISON OF ALTERNATIVE MODELS

Table 2-3 displays the safety level cost and fill-rate performance for the five alternative models.

Comparative Analysis Results
(192 SA-ALC EOQ Items)

Model	Cost	Fill Rate
A. Current System	332K	82.93
B. 30-Day Min Level	1464K	81.66
C. Optimal Model With SQRT(Cost)	281K	84.65
D. Optimal Model	221K	86.15
E. Three MIEC Groups	268K	86.29

Table 2-3

As table 2-3 shows, the current system (Model A) spends more money to achieve a lower fill rate than Models C through E. Model B (30-day minimum level) spends money on all items regardless of the need, and thereby can not invest in safety levels for items with high demand. Hence model B's low fill rate and high cost. A 30-day minimum safety level is not an effective safety level policy.

Let's compare Model C to Model D. They are the same formula except Model C dampens the unit cost. As a result, Model C invests in a safety level for higher cost items at the expense of some lower cost, higher demand items. Recall the auditors recommended a change to the model to dampen unit cost, assuming high cost items were more essential items. As shown previously in Table 1-1, higher essentiality items do not necessarily cost more. In addition, the MIEC identifies essentiality directly and should be used to ensure higher essentiality items are afforded extra safety level protection.

Model D and E achieve the highest fill rate performance. Model D is the optimal model; for the same cost, Model D will always achieve the highest fill-rate performance. However, Model D does not differentiate between levels of essentiality. Model E on the other hand, considers essentiality. Basically, Model E is the optimal model with a different implied shortage factor for each essentiality group. The objective of Model E is to achieve better fill-rate performance for more essential items. Table 2-4 compares the results of Model D to Model E by essentiality group. Appendix C describes the three essentiality groups. Basically, Group 1 (MIEC 1 through 12) includes items that ground strategic weapon systems. Group 2 (MIEC 13 through 36) includes items that impairs performance of strategic weapon system and Group 3 (MIEC 37 through 73) includes all other items.

Comparison Analysis
Optimal Model Vs. 3 MIEC Groups

MIEC Value	Optimal		3 MIEC Groups	
	Cost	Fill Rate	Cost	Fill Rate
1 < MIEC < 12	178K	86.26	246K	87.43
13 < MIEC < 36	13K	84.01	9K	83.48
37 < MIEC < 73	30K	85.30	13K	82.96
TOTALS	221K	86.15	268K	86.29

Table 2-4

Model E (3 MIEC groups) increases the fill rate for high essentiality items without significantly reducing the overall fill rate. So, we've proved **we can achieve about a 4 ((86.29 - 82.93)/82.93) percent increase in fill-rate performance at the same cost as the current system.**

However, **we should set the safety level based on performance targets, not on money availability.** Recall AFLC currently sets safety levels to an average 55-day investment levels. We've developed programs that can now build trade-off curves to show the dollars required to meet a given fill-rate performance target. Figure 2-1 and Table 2-5 show a trade-off between fill rates and dollars.
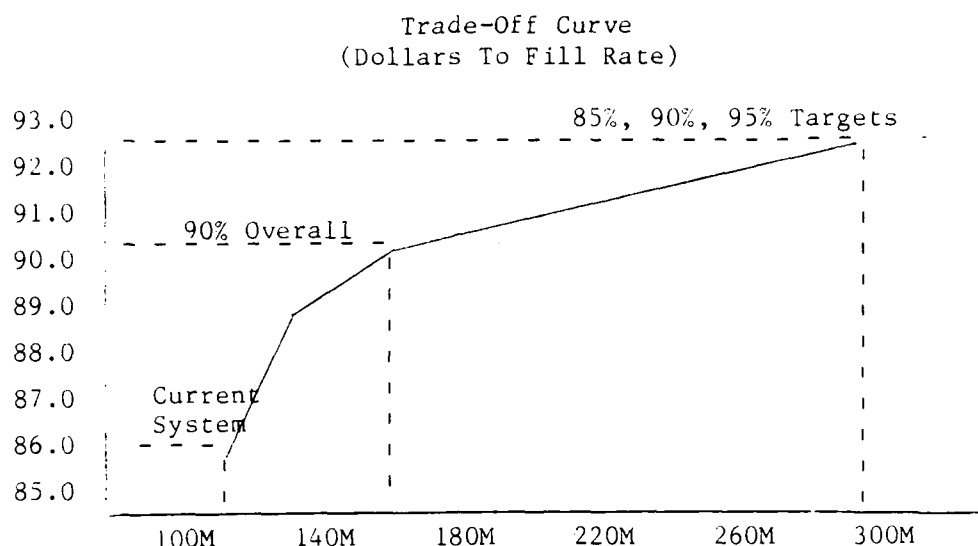
Trade-Off Curve
(Dollars To Fill Rate)

Figure 2-1

Fill Rates Vs. Dollars
(All Items at SA-ALC)

MIEC Ranking	Current $ (105m)	90% Overall (164m)	85%, 90%, 95% (293m)
1 < MIEC < 12	87.43%	91.65%	93.86%
13 < MIEC < 36	83.48%	88.76%	89.56%
37 < MIEC < 73	82.95%	85.04%	85.30%
TOTAL	86.73%	90.67%	92.40%

Table 2-5

For example, with the current system dollars, we can achieve an 86 percent fill-rate target using the optimal model with three MIEC groups. If the fill-rate target is set to 90 percent, an investment of $164 million is needed for SA-ALC items. Actually, the Air Force should set targets by essentiality group. Setting targets at 95 percent, 90 percent, and 85 percent for essentiality Groups 1, 2, and 3 respectively will cost $293 million.

The point is we now have the tools to determine the dollars needed to reach given performance targets. Using the optimal model, we can set the implied shortage factor by essentiality groupings to reach targeted fill-rate performance levels or available dollars. We realize funds may not be currently available to reach acceptable performance targets. However, AFLC needs to be able to build targets based on requirements not available dollars. **AFLC needs both a full-funding and limited-funding computation.** The full-funding computation will compute the requirements to meet a targeted performance level. The full-funding computation will be used to budget requirements and stratify existing inventory. Currently, assets are stratified as inapplicable only because levels are set to available funds. Much of this inapplicable inventory is needed to meet mission requirements. Table 2-6 compares the AFLC inventory with the current funds constrained levels to full-funding levels set to achieve a 90 percent fill-rate objective.

Serviceable Asset Stratification
(SA-ALC)

	Limited Funding	Full Funding	Diff
AFAO	859.7M	877.0M	+17.3M
Total Retention	1306.8M	1310.6M	+3.8M
Potential DOD Excess	133.5M	129.5M	-4.0M
Total Assets	1434.5M	1434.5M	—

Table 2-6

Currently, over 17 million of required inventory at SA-ALC stratifies as inapplicable because safety levels are fund constrained. A full-funding computation equates to a 2 (17.3/859.7) percent increase in San Antonio's Approved Force Acquisition Objective (AFAO). Applying the 2 percent increase to the AFLC applicable inventory total, we project over 46 million of required inventory will stratify within the AFAO, and thus, stratify as applicable inventory. AFLC should continue to use the limited-funding computation to execute, thereby ensuring the highest fill-rate performance with available dollars. However, AFLC should use the full-funding safety levels to stratify existing inventory and budget for future requirements.

Besides the full and limited-funding computations, the trade-off curves will provide the tools to more accurately set the implied shortage factor. Using current data, we can develop trade-off curves to identify the implied shortage factor that spends the available funds.

IMPLEMENTATION

HQ USAF/LEYS has already approved implementation of the optimal model with three MIEC groups. AFLC intends to implement the new safety level by June 1988. MMMA has the capability to develop trade-off curves and will maintain this capability until it can be programmed either as part of the current system or the Requirements Data Bank (RDB). Thus the MMMA programs will provide the EOQ policy makers the necessary information to determine the implied shortage factors, and provide estimates for full-funding requirements. The full funding requirement will be included as part of the RDB program.

CHAPTER 3

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. The current safety level formula is ineffective

2. The optimal model with three essentiality groups will increase fill rates by 4 percent at no increase in today's requirements cost.

3. AFLC needs a more accurate way to set the implied shortage factor.

4. Inventory levels should be based on mission-performance targets, not some arbitrary target like 55 days of supply.

5. Over $46 million of EOQ inventory stratifies as inapplicable because AFLC is not using full-funding requirements.

6. AFLC needs both a full and limited-funding computation for consumable item requirements. The full-funding computation will be used to budget future requirements and stratify inventory, and the limited funding requirement will be used to execute buys.

RECOMMENDATIONS

1. Implement the optimal safety level computation with three essentiality groups immediately (within current system).
(OPR: HQ AFLC/MMM)

2. Until the current system automates the trade-off curve, use MMMA's trade-off program to set the implied shortage factor and budget future requirements.
(OPR: HQ AFLC/MMME   OCR: HQ AFLC/MMMA)

3. Incorporate the following changes into the Requirements Data Bank (RDB) baseline:

    a. A full-funding and limited-funding computation.

    b. The capability to build trade-off curves relating the implied shortage factor to dollars spent, and

    c. The optimal safety level computation with three essentiality groupings.
(OPR: HQ AFLC/MMME   OCR: HQ AFLC/MMMG)

APPENDIX A

SAFETY LEVEL COMPUTATION

APPENDIX A

SAFETY LEVEL COMPUTATION

In this appendix, we show the safety level computation which is being used in the current system and describe the changes we are recommending. The safety level, SL = K*sigma, determines how many (K) standard deviations (sigma) worth of demands to stock for on a particular item. The standard deviation is a statistical measure of items variability.

sigma = (PPR**0.85) * (0.5945 * MAD) * (0.82375 + 0.42625 * LT)

where

PPR = Peacetime program ratio
MAD = Mean absolute deviation
LT = Procurement lead time (in months)

NOTE: The numeric constants 0.82375 and 0.42625 express the variance (MAD) over lead time and the constant 0.5945 converts the quarterly MAD into a monthly MAD.

Currently, the number of standard deviations to stock is determined by:

$$K = -0.707 \, LN \, \frac{2\sqrt{2} \; * \; HC \; * \; EOQ \; * \; \sqrt{UC}}{ISF \; * \; (1/MIEC) \; * \quad * \; (1 - EXP(-2 \; * \; EOQ/sigma))}$$

where

HC   = Holding cost
EOQ   = Air Force EOQ quantity
UC   = Actual unit price
ISF   = Implied shortage factor
MIEC = Mission Item Essentiality Code
Sigma = Standard deviation of lead time demands
LN   = Natural logarithm
EXP   = Exponential function

CURRENT SYSTEM

The safety level is a "cushion" of additional stock to protect against demand and lead time uncertainties. The safety level is adjusted by the implied shortage factor (ISF) which represents the penalty cost. The penalty cost is akin to the profit loss for not having an item in stock. For example, if a customer wants to buy a car, and the car dealer does not have any cars in stock, then the dealer has just incurred a penalty cost for the amount of money he could have made if he had a car in stock. Determining the penalty cost for the car dealer was relatively easy, it's not quite as simple for the Air Force. How does the Air Force assign a dollar value for not having a particular item? What's the cost of a MICAP condition? Assigning 500,000 penalty costs to 500,000 EOQ items would be almost impossible. Instead the Air Force assigns one penalty cost (i.e., the implied shortage factor) and weights this factor by the Mission Item Essentiality Code (MIEC). The higher the dollar value of the implied shortage factor, the higher the safety level. In other words, the higher the penalty cost, the less chance we are willing

to take to have a back order. In addition to the implied shortage factor, an item is assigned a Mission Item Essentiality Code. This code ranks the item from a scale of 1 to 73 with 1 being the most essential item. The more essential the item, the higher the safety level. Thus the variable safety level is adjusted by both the value of the penalty cost (i.e., the implied shortage factor) and the importance of the item (i.e., the Mission Item Essentiality Code).

RECOMMENDED CHANGES

We are recommending two changes to the current safety level computation. First, remove the radical (square root) from the unit cost factor in the numerator. The original model [Presutti], which minimizes total variable costs, did not use the square root of the unit cost. The square root of unit cost was the result of an audit report [audit] which recommended the safety level formula be changed to "Eliminate or substantially reduce the influence of unit cost." Therefore, HQ AFLC dampened the unit cost by taking the square root inorder to "trick" the model. However, the "trick" did not work, and the result was a less than optimal formula. The second change to the safety level computation is to change the essentiality coding scheme. The Mission Item Essentilaity Code (MIEC) is needed; however, the range being used today is too wide. Items with low essentiality codes have little chance of getting any safety level at all. We recommend replacing (1/MIEC) in the denominator with a multiple of the implied shortage factor based on three essentiality groups. Thus, instead of one formula with 73 different MIEC groups, we will have three optimal formulas for three groups of items. The groupings are based on the essentiality codes. By making both of these changes, we will optimally compute levels which minimize costs and we will weight the safety level by item essentiality.

Thus the new formula for K (the number of standard deviations) is:

$$K = -0.707 \ LN \ \frac{2\sqrt{2} * HC * EOQ * UC}{ISF * MULT * \ * (1 - EXP(- 2 * EOQ/sigma))}$$

where

HC   = Holding cost
EOQ   = Air Force EOQ quantity
UC   = Actual unit cost
ISF   = Implied Shortage Factor
sigma = Standard deviation of lead time demands
MULT = Multiple of the implied shortage factor based
        on essentiality groups

APPENDIX B

ANALYSIS RESULTS

APPENDIX B

ANALYSIS RESULTS

In this appendix, we describe our analysis results for two other Air Logistics Centers. We ran the multi-echelon model for a 50-year period using actual data from Oklahoma City (OC) and Sacramento (SM) Air Logistic Centers. Tables B-1 and B-4 show how our sample represents that center's the population by Supply Management Grouping Code (SMGC). This relates to Table 2-1 in the main report. Using these samples, we compared alternative safety level formulas and the results are shown in Table B-2 and Table B-5. Again, you can easily see that Model D and Model E clearly dominate the other models. This is the same comparison we made earlier in the report (Table 2-3) with data from San Antonio (SA). In order to compare Model D and Model E more closely, we examined their fill-rate performance by essentiality group, which is shown in Tables B-3 and B-6. This corresponds to the comparison made in Table 2-4. Since items in the first group are more essential, we want to provide them with better support. The optimal model (Model D) performs the best, but fails to consider essentiality. So, by using a different implied shortage factor for each of three essentiality groups, we identify the correct items for increased support.

Sample Vs. Population
(OC-ALC Items)

Category	Sample	Population
SMGC = 'T'		
Monthly Demand Rate	6.97	6.94
Unit Cost	$106.47	$96.08
Lead Time (Days)	335	343
SMGC = 'P'		
Monthly Demand Rate	42.31	46.88
Unit Cost	$584.60	$522.42
Lead Time (Days)	599	579
SMGC = 'M'		
Monthly Demand Rate	138.27	144.40
Unit Cost	$1488.34	$1497.96
Lead Time (Days)	693	668

Table B-1

Comparative Analysis
(OC-ALC)
(192 EOQ Items)

Model Comparison

Model	Cost	Fill Rate
A. Current System	502K	82.11%
B. 30-Day Min. Level	1348K	80.93%
C. Optimal Model With SQRT(Cost)	480K	82.52%
D. Optimal Model	527K	86.98%
E. Three MIEC Groups	465K	86.01%

Table B-2

Optimal Model Vs. Three MIEC Groups
(OC-ALC)

MIEC Rankings	Optimal Model		3 MIEC Groups	
	Cost	Fill Rate	Cost	Fill Rate
1 < MIEC < 12	337K	87.94	367K	88.53
13 < MIEC < 36	190K	82.58	98K	80.68
37 < MIEC < 73	0K	80.49	0K	80.49
TOTAL	527K	86.98	465K	86.01

Table B-3

Sample Vs. Population
(SM-ALC)

Category	Sample	Population
SMGC = 'T'		
Monthly Demand Rate	1.64	1.79
Unit Cost	$140.46	$169.17
Lead Time (Days)	320	334
SMGC = 'P'		
Monthly Demand Rate	7.20	8.70
Unit Cost	$729.34	$795.75
Lead Time (Days)	516	537
SMGC = 'M'		
Monthly Demand Rate	295.63	319.70
Unit Cost	$1863.41	$1978.46
Lead Time (Days)	567	584

Table B-4

Comparative Analysis
SM-ALC
(192 EOQ Items)

Model Comparisons

Model	Cost	Fill Rate
A. Current System	718K	84.18%
B. 30-Day Min. Level	4228K	84.40%
C. Optimal Model With SQRT (Cost)	608K	84.05%
D. Optimal Model	547K	85.65%
E. Three MIEC Groups	572K	85.09%

Table B-5

Optimal Model Vs. Three MIEC Groups
(SM-ALC)

MIEC Rankings	Optimal Model		3 MIEC Groups	
	Cost	Fill Rate	Cost	Fill Rate
1 < MIEC < 12	321K	85.68	518K	86.17
13 < MIEC < 36	44K	83.67	51K	84.07
37 < MIEC < 73	182K	85.04	3K	81.86
TOTAL	547K	85.65	572K	85.09

Table B-6

APPENDIX C

MISSION ITEM ESSENTIALITY CODE

APPENDIX C

MISSION ITEM ESSENTIALTY CODE

In this appendix, we explain how Mission Item Essentiality Codes (MIEC) are currently assigned, and how we derived the three essentiality groups. The purpose of the MIEC is to enable the Air Force to determine the essentiality of its items. The MIEC provides the Air Force with a method of allocating resources based on weapon system support. The MIEC is composed of three alpha-numeric positions with the System Essentiality Code (SEC) as the first position. This is a numeric value ranging from 1 to 6 and is assigned by HQ USAF based on the following definitions:

SEC	Definition
1	Highly critical system
2	Strategic systems
3	Forward-deployed systems
4	CONUS systems in place by D+30
5	Reserve systems in place by D+30
6	Systems in place by D+90 or rear echelon

There are some instances when the SEC will use a pseudo code of 7 or 8 which are reserved for special purpose usage only; these codes have no support implication.

The second position is the Subsystem Essentiality Code (SSEC) which identifies how critical a subsystem is to the performance of the system's assigned mission. These codes are assigned by the MAJCOM based on the following criteria:

SSEC	Definition
A	Not Mission Capable
B	Not Wartime/Assigned Mission Capable
C	Not Fully Mission Capable
D	Not Peacetime/Training Capable

The third position of the MIEC is the Item Essentiality Code (IEC) which identifies the relationship of the individual component to the subsystem. The definitions are as follows:

IEC	Definition
E	Critical for Operation
F	Impairs Operation
G	Not Critical for Operation

The IEC is assigned by the Equipment Specialist at the Air Logistic Center (ALC) and must be updated periodically.

The MIEC is then assigned a numeric value ranging from 1 to 72 based on a look-up table (see Table C-1) in the D062 system. Seventy-three is used as a default value, whenever the MIEC is not identified. The numeric value is based on the three digits. For example, 1AE converts to an MIEC value of 1, 1BE converts to a value of 2 and so on. Table C-1 contains a complete listing of the essentiality codes and their corresponding values.

MIEC Priority Sequence Code Values

MIEC Priority	MIEC Code	MIEC Priority	MIEC Code	MIEC Priority	MIEC Code
1	1AE	26	6BE	51	3CG
2	1BE	27	6CE	52	4CG
3	1CE	28	4AF	53	5CG
4	2AE	29	4BF	54	6CG
5	2BE	30	4CF	55	1DE
6	2CE	31	5AF	56	2DE
7	3AE	32	5BF	57	3DE
8	3BE	33	5CF	58	4DE
9	3CE	34	6AF	59	5DE
10	1AF	35	6BF	60	6DE
11	1BF	36	6CF	61	1DF
12	1CF	37	1AG	62	2DF
13	2AF	38	2AG	63	3DF
14	2BF	39	3AG	64	4DF
15	2CF	40	4AG	65	5DF
16	3AF	41	5AG	66	6DF
17	3BF	42	6AG	67	1DG
18	3CF	43	1BG	68	2DG
19	4AE	44	2BG	69	3DG
20	4BE	45	3BG	70	4DG
21	4CE	46	4BG	71	5DG
22	5AE	47	5BG	72	6DG
23	5BE	48	6BG		
24	5CE	49	1CG		
25	6AE	50	2CG		

Table C-1

A numeric value is then used in the safety level formula to weight the implied shortage factor based on the item's importance.

The problem with the current system is that the range of the MIEC values is too wide. Items with low essentiality values have very little chance of getting any safety level at all. So instead of using 73 different MIECs, we divided the items into three groups. In determining how to divide the MIEC into groups, we had to consider two factors. The first was identifying the logical break points in the essentiality coding system. For example, there isn't a distinct difference between an MIEC of 2AE and 2BE. Both of these codes are assigned to items used on strategic systems in which the subsystem is critical to the performance of the assigned mission. On the other hand, there is a distinct difference between MIEC codes 1CF and 2AF. These codes are assigned to items which support different types of weapon system. The

second factor to consider was the number of items within each group. We developed several different ways in which to break the MIEC into groups, but we had to make sure that all of the items did not fall into one group. After considering both the logical divisions of the MIEC and the number of items within in group, we developed the following: The first group contains all items with an essentiality value of less than or equal to 12. These are items which either impair the operation of critical systems or are critical for operation of strategic systems. Group 2 are items with essentiality values between 13 and 36. These are items which impair the operation of weapon systems, but are not in Group 1. The last group contains all the items which are not critical for operation or are used for peacetime training capabilities. In the current system, we have a less than optimal model because the safety level is decreased for less essential items instead of increased for more essential items. By dividing the items into three groups, we can weight the implied shortage factor by each group. Basically what this does is optimally compute safety levels within each essentiality group.

MIEC Frequency

ALC	Group 1	Group 2	Group 3
OC	67.1	29.9	3.0
OO	79.6	5.0	15.4
SA	47.7	27.8	24.5
SM	44.6	41.4	14.0
WR	47.6	24.8	27.6

Table C-2

REFERENCES

1. Air Force Audit Agency Report, "Review of Procedures for Managing Consumable Supply Assets within Air Force Logistics Command," Project 827537, August 3, 1983.

2. Presutti, Victor J., Trepp, Richard C., "More Ado About Economic Order Quantity (EOQ)," Naval Research Logistics Quarterly, June 1970, Vol 17, No. 2.

3. Rinks, D.B., "Mech: A Simscript Simulation Program of a Multi-Echelon EOQ System for Consumables", User/Programmer Guide, Air Force Logistics Management Center, Gunter AFS, Alabama, August 1986.

4. Rinks, D.B., "Final Report: Multi-Echelon Inventory Models for EOQ Items", 1986 USAF-UES Summer Faculty Research Program/Graduate Student Summer Support Program, Air Force Logistics Management Center, Gunter AFS, Alabama, September 18, 1986.

5. Smith, Lee J. Capt, "An Evaluation of the Implied Shortage Factor and Its Effect on the Air Force Logistics Command's Economic Order Quantity (EOQ) Variable Safety Level," Air Force Institute of Technology Air University, September 1986.