IMPROVING SUPPLY SUPPORT BY SELECTIVELY APPLYING SAFETY LEVEL MULTIPLIERS

AFLMA FINAL REPORT LS200117601

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14. ABSTRACT
Currently the Air Force provides higher levels of supply support for OCONUS bases than it does for CONUS bases. OCONUS bases achieve higher levels of supply support because OCONUS bases have higher safety levels. OCONUS bases are authorized a safety level multiplier of 2 for weapon system items, while CONUS bases get a multiplier of 1. The SBSS calls the safety level multiplier the C factor. We found that by selectively applying the safety level multiplier(C factor) to a select group of items, based on cost, demand, and mission impact, the Air Force could reduce expected backorders at nearly no cost.

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EXECUTIVE SUMMARY

PROBLEM STATEMENT

Currently the Air Force (AF) provides higher levels of supply support for bases outside the continental United States (OCONUS) than it does for those bases in the continental United States (CONUS). For example, a sample of stockage effectiveness for consumable items shows OCONUS bases (Pacific Air Forces [PACAF] 90.8% and United States Air Forces in Europe [USAFE] 92.8%) have 2% to 4% higher rates than CONUS bases (Air Combat Command [ACC] 88.3% and Air Education and Training Command [AETC] 88.2%).

In his initial sponsor letter, the ACC Director of Logistics (ACC/LG) asked the Air Force Logistics Management Agency (AFLMA) to analyze ways to equalize supply support because, with the Air Expeditionary Forces, CONUS bases are as likely to support contingencies as OCONUS bases. In their reply to our proposed project plan, HQ ACC/LG asked the AFLMA to also develop methods to increase supply support of homeland defense bases in light of the September 11, 2001, attacks on the United States. ACC was then less concerned with equalizing support than with increasing supply support for CONUS bases, especially those tasked with homeland defense. We address both equalizing and increasing supply support in this report.

STUDY OBJECTIVES

Determine the impact of changing the safety levels for reparable (XD) and consumable (XB and XF) items on:

a) Inventory Cost.
b) Level of support – annual expected backordered units (AEBO), expected stockage effectiveness (ESE), and mission capability (aircraft availability and cannibalizations).

ANALYSIS RESULTS

Our analysis was conducted in two distinct areas. We evaluated Air Force reparable items (XD) and consumable items (XF & XB) separately.

XD Analysis. The AF uses readiness-based leveling (RBL) for setting base demand levels for AF-managed reparable (XD) items. OCONUS bases use a C factor of 2, while CONUS bases use a C factor of 1. The higher C factor biases RBL to allocate more stock to the OCONUS bases. Equalizing CONUS and OCONUS supply support, using a C factor of 1 for all bases, decreased worldwide-expected backorders (EBOs) by less than 5.

XB and XF Analysis. We evaluated several alternatives for increasing safety levels for XB and XF items. For an 8-base sample (3 ACC, 3 Air National Guard (ANG), and 2 OCONUS bases), we compared the cost and backorder impact of changing safety levels for all items and for selected groups of items. We tried various groupings of items based on the 1980's AFLMA study (LS831107, *Alternative Approaches To The Standard Base Supply System Economic Order Quantity Depth Model*) that emulated backorder optimization levels.

We found that by applying higher safety levels to only selected low-cost, high-demand, mission-impact items, the Air Force could reduce nearly 1 million annual expected backordered units (AEBOs) at no cost to the Air Force.

CONCLUSIONS

1. Today's policy to increase safety levels for *all* weapon system items at OCONUS bases is inefficient.

2. Our proposed policy to selectively increase CONUS safety levels will increase supply support to homeland defense and CONUS bases and will improve support AF-wide.

    - Applying the proposed policy (XB alternative 6 [$100 threshold] and XF alternative 6 [no XF items]) to homeland defense bases only will cost $3.9M and reduce 328K AEBOs.

    - Applying the proposed policy to all CONUS bases will cost $10.1M and reduce 829K AEBOs.

    - Applying the proposed policy AF-wide will actually *reduce* AF demand level cost by $2.1M and reduce 904K AEBOs.

3. The proposed cost-neutral policy will increase AF stockage effectiveness for XB items by 2% to 3% percent and increase available aircraft by at least 129 annually.

4. The additional alternative requested by the Air Force Stockage Policy Working Group (AFSPWG), to use the AFLMA proposal for XB items and retain increased safety levels for XF items with a unit cost of $750 or less at OCONUS bases only, is also cost-neutral and would mitigate some of the concerns of the OCONUS bases.

5. To achieve the benefits for AF-managed consumable items (budget code 8 XB and XF items), the consumable items variable safety level target in the Requirements Management System must be increased.

6. There is an error in the Standard Base Supply System (SBSS) calculation of variance of demand that could result in inaccurate and excessive safety levels, especially if safety levels are increased by using higher C factors.

7. The SBSS documentation for base demand levels is incomplete and inaccurate.

RECOMMENDATIONS

1. Implement the following policy AF-wide:

   - Use a C factor of 2 for all mission impact code (MIC) 1 and 2 XB items costing less than $100 and all MIC 1 items with a daily demand rate (DDR) greater than .3. Use a C factor of 3 for all MIC 1 & 2 XB items costing less than $25 and with a DDR greater than .1. Use a C factor of 1 for all XF and the remaining XB items.
     OPR: HQ USAF/ILG

   - Should it be necessary to retain higher safety levels at OCONUS bases for XF items, apply a C factor of 2 for XF items with a unit cost of $750 or less.
     OPR: HQ USAF/ILG

2. Develop a program to load a C factor of 2 (or 3) on the appropriate items.
   OPR: SSG/ILS

3. Increase the D200A variable safety level (VSL) target for AF-managed consumable items.
   OPR: HQ USAF/ILG **OCR: AFMC/LGI**

4. Correct the SBSS code that computes the variance of demand.
   OPR: SSG/ILS

5. Update and correct the AFMAN 23-110, *USAF Supply Manual*, stockage policy documentation.
   OPR: SSG/ILS

BENEFITS

Benefits to the AF for implementing our proposals include:

1. **Supply Support**. The proposed policy will decrease unit backorders by 10% and increase stockage effectiveness by 2%.

2. **Mission Support**. It is estimated that the proposed C factor policy will reduce nearly 1 million expected backordered units and provide for an annual increase of at least 129 mission capable aircraft.

3. **Efficiency**. The current policy is inefficient. The proposed policy provides for supply and mission improvements at no additional cost to the Air Force.

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CHAPTER 1
INTRODUCTION

PROBLEM

Currently the Air Force provides higher levels of supply support for bases outside the continental United States (OCONUS) than it does for those bases in the continental United States (CONUS). For example, a sample of stockage effectiveness for consumable items shows OCONUS bases (Pacific Air Forces [PACAF] 90.8% and United States Air Forces in Europe [USAFE] 92.8%) have 2 to 4% higher rates than CONUS bases (Air Combat Command [ACC] 88.3% and Air Education and Training Command [AETC] 88.2%).

SCOPE

In their initial sponsor letter, the ACC Director of Logistics (ACC/LG) asked the Air Force Logistics Management Agency (AFLMA) to analyze ways to equalize supply support because, with the Air Expeditionary Forces, CONUS bases are as likely to support contingencies as OCONUS bases are. In their reply to our proposed project plan, HQ ACC/LG asked the AFLMA to develop methods to increase supply support of homeland defense bases in light of the September 11, 2001, attacks on the United States. ACC was then less concerned with equalizing support than with increasing supply support for CONUS bases, especially those tasked with homeland defense. We address both equalizing and increasing supply support in this report.

BACKGROUND

OCONUS bases achieve higher levels of supply support because they use higher safety levels. OCONUS bases are authorized a safety level multiplier of 2 for weapon system items, while CONUS bases are authorized a multiplier of 1. The Standard Base Supply System (SBSS) calls the safety level multiplier the *C factor*. Figure 1-1 displays the effect of C factors

Assuming a normal distribution for demand during replenishment lead-time, a C factor of 1 provides a fill rate probability of 84%. For a normal distribution, the mean (X) plus one standard deviation (X+1S) covers 84% of the probability. A C factor of 2, meaning the mean plus 2 standard deviations of demand during the replenishment lead-time, yields a fill rate of 97%. Worth noting is the concept of diminishing returns. Increasing the C factor from 0 to 1 achieved a 34% (50% to 84%) increase in fill rate (reduction in the probability of a backorder). Increasing the C factor from 1 to 2 achieved a 13% percent (84% to 97%) fill rate increase. Increasing the C factor from 2 to 3 achieves less than a 3% (97% to 99.7%) fill rate increase. If the item is expensive, increasing the safety levels could cost more than the expected backorder reduction is worth or that the Air Force is willing to spend.

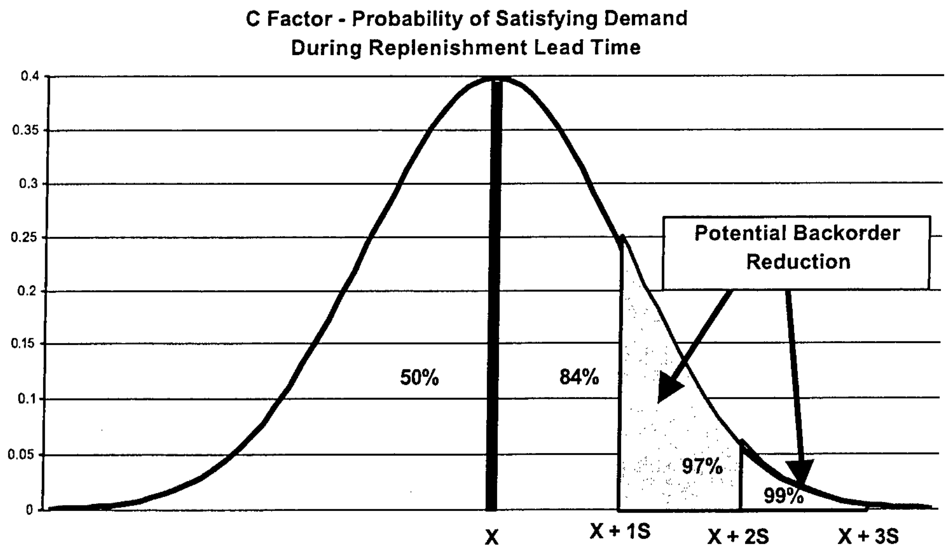

Figure 1-1. Probability Distribution

Increasing the safety level multiplier from 1 to 2 theoretically increases the replenishment time fill rate from 84% to 97%. However, actual practice does not always follow theory. Demand is not necessarily normally distributed. In addition, estimates of demand and lead-time are not always perfect. Nonetheless, higher safety levels will yield higher supply support in the long run, as shown by the current OCONUS and CONUS stockage effectiveness rates.

In the late 1980's, an AFLMA study (LS831107, *Alternative Approaches to the Standard Base Supply System Economic Order Quantity Depth Model*) compared levels resulting from a backorder optimization model to the current AF economic order quantity (EOQ) cost-minimization, fixed-safety-level approach. The backorder optimization model significantly reduced backorders and increased stockage effectiveness. Although the model was considered too complex for Standard Base Supply System (SBSS) use, AFLMA compared the levels of the backorder optimization model to SBSS EOQ demand and reorder levels. Compared to the EOQ model, the backorder optimization approach had significantly larger safety levels for selected high-demand, low-cost items. The AFLMA study recommended, and the AF approved, increased safety levels for selected high backorder items. However, the AFLMA-recommended policy was not implemented due to a lack of funds. This study built on the previous study and emulated the backorder optimization levels for high-demand, low-cost items. We also included mission impact thresholds. By selecting items with a mission impact code (MIC) of 1 or 2, we were able target previous MICAP (MIC 1) and previous high priority backordered items (MIC 2).

STUDY OBJECTIVES

Determine the impact of changing the safety levels for reparable (XD) and consumable (XB and XF) items on:

1. Inventory cost.
2. Level of support – annual expected backordered units (AEBO), expected stockage effectiveness (ESE), and mission capability (aircraft availability and cannibalizations).

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CHAPTER 2
RESEARCH AND ANALYSIS

OVERVIEW

This chapter is organized into five sections: 1) Reparable item methodology, 2) reparable item research and analysis, 3) consumable item methodology, 4) consumable item research and analysis, and 5) implementation issues.

REPARABLE ITEM METHODOLOGY

The AF uses readiness-based leveling (RBL) for setting base demand levels for AF-managed reparable (XD) items. RBL allocates the worldwide requirement to all using bases to minimize expected backorders (EBOs). RBL allocates each successive unit of the worldwide requirement to the base with the highest decrease in EBOs. For example, if Base A achieves a .05 decrease in EBO with a level increase of 1 while Base B achieves a .055 decrease in EBO with the same increase, RBL will allocate the next unit to Base B. RBL differentiates between CONUS and OCONUS bases by their C factor. For OCONUS bases (authorized a C factor of 2) RBL multiplies the EBO decrease by 1.15 (97% divided by 84% - the expected fill rate percentage for 2 standard deviations divided by the expected fill rate percentage for 1 standard deviation). Using the example, assume Base A is an OCONUS base and has a C factor of 2. RBL would multiply Base A's expected EBO reduction of .05 by 1.15. Base A's new EBO reduction would be .057; RBL would allocate the next level to Base A instead of Base B. The C factor does have an impact, but only when two competing bases have very similar expected EBO reductions. In essence, the C factor becomes a tiebreaker.

We wanted to measure the impact of excluding all C factors of 2 on the RBL levels and EBOs. The July 2001 RBL run had 404,768 stock number-base level (NSN-SRAN) allocations. There were 49,280 NSN-SRANs with a C factor of 2, and 19,023 of them had a positive daily demand rate (and therefore had an expected EBO reduction). Thus, less than 4% (19,023/404,768) of the RBL NSN-SRAN cases could be impacted by C factor changes.

REPARABLE ITEM RESEARCH AND ANALYSIS

We ran July 2001 RBL input data through RBL and made all C factors equal to 1. Using a C factor of 1, there were 954 level changes and a decrease of 4.68 AF-wide EBOs. Table 2-1 provides the results.

Table 2-1. XD Level and EBO Changes

NSN-SRANs	LEVEL CHANGES	EBO CHANGE
OCONUS Bases		
Increases	12	-0.1
Decreases	471	39.42
CONUS Bases		
Increases	471	-44
Decreases	0	
Total	954	-4.68

At OCONUS bases 483 levels changed; 12 went from one OCONUS base to another. A total of 471 levels moved from OCONUS to CONUS bases. These level changes increased OCONUS EBOs by 39.42 and decreased CONUS EBOs by 44. AF-wide, RBL estimated approximately 10,000 EBOs for items with RBL-pushed levels, so the decrease of 4.68 EBOs was a net EBO reduction of .04%. Equalizing C factors (making all bases use a C factor of 1) had little impact on XD levels and EBOs; therefore, we do not recommend a change to the stockage policy for XD items.

CONSUMABLE ITEM METHODOLOGY

We evaluated several alternatives for increasing safety levels for consumable items (XB and XF). For an 8-base sample (3 ACC, 3 Air National Guard (ANG), and 2 OCONUS bases), we compared the cost and backorder impact of changing safety levels for all and for selected groups of items. To compute the impact we used the SBSS depth formulas found in Air Force Manual (AFMAN) 23-110, *USAF Supply Manual*. These formulas are described in detail in Appendix B.

CONSUMABLE ITEM RESEARCH AND ANALYSIS

We tried various groupings of items based on the AFLMA study that emulated backorder optimization levels. We determined the cost and AEBO difference for each alternative at our sample bases and used those results to estimate the impact for their respective major commands (MAJCOM), then all CONUS MAJCOMs, and finally all MAJCOMs. Table 2-2 provides the various XB policy alternatives evaluated.

Table 2-2. XB Policy Alternatives

XB Alternative #	Abbreviated Logic	Complete Logic
1	All C 2	All items receive a C factor of 2
2	<$300 Alternative	All items with a unit price less than $300 receive a C factor of 2
3	<$300 MIC 1,2	All items with a unit price less than $300 and a MIC code 1 or 2 receive a C Factor of 2
4	<$300 MIC 1,2 and MIC 1 > $300 with DDR > .3	All items with a unit price less than $300 and a MIC code 1 or 2 and all MIC 1 items with a DDR >.3 receive a C factor of 2
5	<$300 MIC 1,2 and MIC 1 > $300 with DDR > .3 and C3 for MIC 1,2 <$25 & DDR >.1	All items with a unit price less than $300 and a MIC code 1 or 2 and all MIC 1 items with a DDR >.3 receive a C factor of 2 while all MIC 1 and 2 items with a unit price <$25 and a DDR >.1 receive a C factor of 3
6	<$100 MIC 1,2 and MIC 1 > $100 with DDR > .3 and C3 for MIC 1&2 <$25 & DDR >.1	All items with a unit price less than $100 and a MIC code 1 or 2 and all MIC 1 items with a DDR >.3 receive a C factor of 2 while all MIC 1 & 2 items with a unit price <$25 and a DDR >.1 receive a C factor of 3

Our goal was to maximize AEBO reduction while minimizing cost. We started with all items and then selected fewer items based on cost, mission impact, and demand criteria. The more items in the group, the higher the cost. We wanted the grouping that reduced AEBOs efficiently. Table 2-3 provides the results for all XB items (budget code 8 and 9) at Langley AFB, Virginia, that have a demand level. Appendix A includes the results for the remaining bases in our sample.

Table 2-3. Langley XB Analysis

XB Alternative	Logic	Increased DL$	Decreased AEBO units	% of Items with Increased Levels
1	All (C=2)	$675K	12559	100%
2	<$300	$185K	12196	90%
3	<300 MIC 1,2	$178K	11651	84%
4	#3 & MIC 1 > $300 with DDR >.3	$193K	11724	84%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$211K	14361	84%
6	<100MIC 1,2 & # 4 & #5	$131K	14002	75%

Changing the C factor to 2 for all XB items (Alternative 1) increased the demand level cost (DL $) by $675K and resulted in a reduction of 12,559 units backordered annually at Langley AFB (from the baseline case of all items having a C factor of 1). Establishing a price threshold decreased the number of items that would receive an increase in safety level (Alternative 2) and reduced the total cost increase, but it reduced the decrease in AEBO units from alternative 1. Selecting only mission-impact coded items (MIC 1 and 2) further reduced the number of items (Alternative 3) that would receive increased safety levels; but also further reduced the decrease in AEBO units. Adding more expensive, high-demand MIC 1 items increased the number of items with increased safety levels, and thus cost, but also slightly increased the number of AEBO units reduced. Selecting very low-cost, high-demand items for even larger safety levels (C factor of 3) added some cost but significantly increased the reduction in units backordered (Alternative 5). From Table 2-3 one should also note that increasing safety levels for all items was not efficient. We achieved more AEBO reduction at lower cost by using Alternative 5 than using C factor of 2 for all items. We targeted fewer items with Alternative 6 as part of our efforts to identify a cost-neutral policy alternative. As we will discuss later in the report, by applying Alternative 6 to both CONUS and OCONUS bases, the AF can reduce AEBOS at nearly no cost.

We provide Figure 2-1 to demonstrate the cost characteristic of the XB items. Note that the majority of XB items are inexpensive. Nearly 65% of the items cost $25 or less, while 80% of all XB items cost less than $100. Therefore, with our proposed policy alternatives, we are targeting various subsets of the 80% - 90% of the XB items.

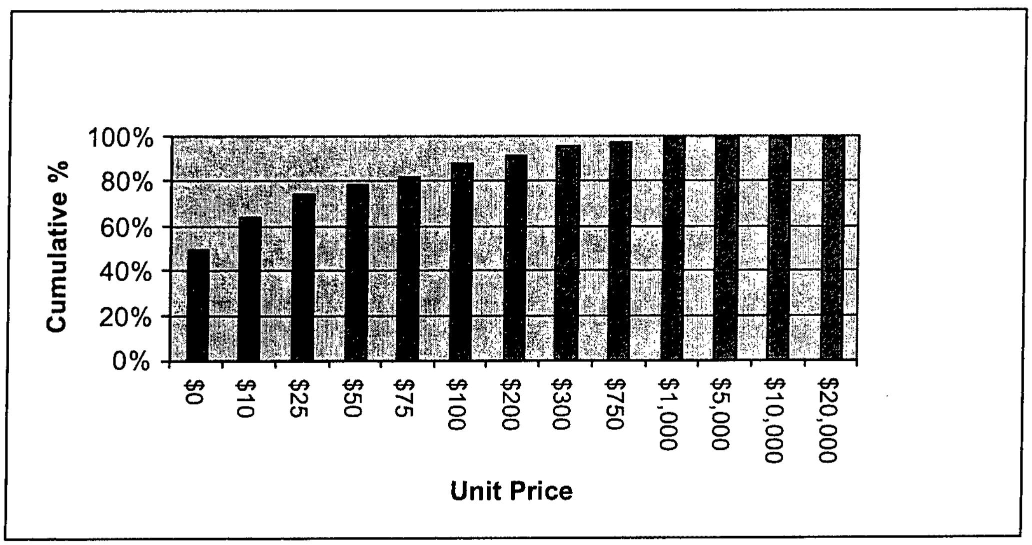

Figure 2-1. Cost Characteristics of XB Items

Next we looked at XF items. Table 2-4 provides the various XF alternative policies we evaluated.

Table 2-4. XF Policy Alternatives

XF Alternative #	Abbreviated Logic	Complete Logic
1	All C 2	All items receive a C factor of 2
2	<$750	All items with a unit price under $750 receive a C factor of 2
3	<$750 MIC 1,2	All MIC 1 and 2 items with a unit price under $750 receive a C factor of 2
4	<$1,000 MIC 1,2	All MIC 1 and 2 items with a unit price under $1,000 receive a C factor of 2
5	<$2,000 MIC 1,2	All MIC 1 and 2 items with a unit price under $2,000 receive a C factor of 2
6	All C 1	C factor of 1 for all items (CONUS Baseline)

Table 2-5 provides the results of applying these alternatives for XF items at Langley AFB.

Table 2-5. Langley XF Analysis

XB Alternative	Logic	Increase DL$	Decrease AEBO units	% of Items with Increased Levels
1	All C2	$245K	265	100%
2	<$750	$35K	120	45%
3	<750 MIC 1,2	$34K	120	45%
4	<$1000 MIC 1,2	$43K	148	55%
5	<2000 MIC 1,2	$76K	215	81%

Note that for the C=2 case (which is similar to the overseas policy), there is a relatively great increase in demand level cost for the small decrease in AEBOs (compared to our results for XB items). However, reducing the number of items with C=2, by setting price and mission impact thresholds reduces the cost increase significantly. Comparing the AEBO reduction to XB items, it was more efficient to increase safety levels for XB items than XF items. ***At the very least, an approach that reduces the number of XF items that use a C factor of 2 would seem to be promising and we investigate that in the CONUS cost estimate section.***

CONUS Cost Estimate. Next, we generalized our results AF-wide, starting with the CONUS cost estimates. For the alternative with the most AEBO reduction (alternative 5 for XB and alternative 3 for XF), we estimated the percentage change to total demand level cost, in order to estimate MAJCOM-wide cost changes. Table 2-6 and 2-7 show the percent cost increases for the 6 sample bases.

Table 2-6. CONUS (Active Bases) Percentage Demand Level Cost Change Computation

	Delta DL ($000)	Total Stock ($000)	% Increase
Shaw	228	3019	7.55%
XB	197	2538	7.76%
XF	31	481	6.44%
Langley	245	3505	6.99%
XB	211	3021	6.98%
XF	34	484	7.02%
S. Johnson	347	5225	6.64%
XB	292	3946	7.40%
XF	55	1279	4.30%
Totals	820	11749	6.98%

Table 2-7. CONUS (ANG Bases) Percentage Demand Level Cost Change

	Delta DL ($000)	Total Stock ($000)	% Increase
Fresno	50	507	9.86%
XB	36	404	8.91%
XF	14	103	13.59%
Portland	149	1649	9.04%
XB	123	1266	9.72%
XF	26	383	6.79%
Otis	55	658	8.36%
XB	44	550	8.00%
XF	11	108	10.19%
Totals	254	2814	9.03%

The weighted-average percentage increase across the three ACC bases was 6.98% for the XB Alternative 5 and XF Alternative 3. For the smaller ANG bases, the percent increase for the same alternatives was 9.03%. Next, we applied these percentages to each MAJCOM's demand level cost totals. Applying the results from ANG to AFRC data assumes that supply demand levels for these two commands are similar.

Table 2-8 applies the ANG percentage to AFRC's total demand level cost and ACC's percentage to the other CONUS MAJCOMs' demand level costs using the results from our 6 sample bases for the XB Alternative 5 and XF Alternative 3. Note that this assumes that supply demand and item characteristics experienced by ACC are similar across MAJCOMS. We reviewed XB item characteristics and policy impact for a base from each of these commands to validate our assumption. Appendix E provides analysis for selected bases from AMC, Air Force Materiel Command (AFMC), AETC, and Air Force Special Operations Command (AFSOC) to show they did, indeed, display similar item characteristics and experienced a similar policy impact.

Table 2-8. Estimated CONUS Demand Level Increase Alternative 5 (XB) and 3 (XF)

MAJCOM	Total DL$	% Increase	$ Increase
ACC	$72,779,824	6.98%	$5,080,032
ANG	$12,186,563	9.03%	$1,100,447
AFRC	$19,730,033	9.03%	$1,781,622
SPACECOM	$8,652,762	6.98%	$603,963
AMC	$63,381,825	6.98%	$4,424,051
AETC	$41,020,936	6.98%	$2,863,261
AFSOC	$6,533,953	6.98%	$456,070
AFMC	$53,094,650	6.98%	$3,706,007
Totals	$277,380,546		$20,015,452

Table 2-8 includes the total increase in budget code 9 demand levels for Alternatives 5 for XB and 3 for XF. ***CONUS-wide the total cost is $20M, with a reduction of 952K AEBOs.***

We computed the total AEBO units for each sample base as a measure of the impact of changing the safety level multiplier or C factor. To estimate the worldwide AEBO impact, we established a relationship between the sample bases AEBO and demand level changes for each alternative policy. We then used this relationship to estimate the AF-wide AEBO impact of the various safety level or C factor changes. For example, applying the initial proposed policy to our sample bases resulted in a \$1.08M demand level increase and a 51,651 AEBO decrease. Using these results and the \$20M CONUS demand level increase, we were able to estimate the CONUS AEBO change. As stated in the report, we estimated a 952K decrease in AEBOs

$$\frac{\$1{,}085{,}000}{\$20{,}015{,}000} = \frac{51{,}651}{X} \quad \text{So } X = 952{,}000$$

Figure 2-2. AEBO Calculation

OCONUS Cost Estimate. When evaluating OCONUS bases, our initial assumption was that the C factor of 2 was applied to all weapon system items (AF policy). The initial analysis discussed below was based on assuming a C factor of 2 was applied to all consumable items and further demonstrated the inefficiency of using a C factor of 2 for all items. However, during our analysis, we found that not all items had a C factor of 2. Our final recommendations are based on a comparison of the proposed policies and the current C factor application (baseline). With this in mind, we also presented the OCONUS charts differently than we did the CONUS tables. We presented the cost of each alternative so that comparisons can be made to both the C factor of 2 for all items and to the baseline, which represents the C factor policy as it is implemented today.

Current AF policy calls for OCONUS bases to apply a C factor of 2 to all weapon system items. However, we demonstrated in the CONUS analysis that applying a C factor of 2 to all items is not efficient; and we proposed a more efficient policy for all bases both CONUS and OCONUS. (Our policy does not directly target weapon system items; but, by targeting mission-impact coded items, we are able to target those items with a significant mission impact such as previous MICAPs and high demand backorders). Therefore, we must assess the impact of the proposed policies for OCONUS bases. Tables 2-9 and 2-10 provide the XB and XF results for Kadena AB, Japan.

Table 2-9. Kadena XB Demand Level Cost and AEBO Totals

Alternative	Logic	Demand Level $$ (C2)	AEBO Units	% of Items
	Baseline	$9,408,128	24240	-
	All (C=1)	$7,790,291	65057	100%
1	All (C=2)	$10,275,555	13501	100%
2	<$300	$8,571,793	14271	91%
3	<300 MIC 1,2	$8,476,593	19383	76.4%
4	#3 & MIC 1 with DDR >.3	$8,501,271	19308	76.5%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$8,577,033	9585	76.5%
6	<100MIC 1,2 & DDR >.3 and C3 for MIC 1,2 with DDR >.1	$8,273,689	10635	76.5%

Notice from Table 2-9, by *decreasing* the C factor from 2 to 1 for high-cost, low-demand items and *increasing* C factors from 2 to 3 for low-cost, high-demand items (Alternatives 5 and 6 for XB) the AF can actually reduce AEBO at Kadena (from 13501 to 9585 or 10635) with a demand level reduction (from $10.2M to $8.5M or $8.3M). Alternatives 5 and 6 retain or increase the C factor for 76.5% of the items, reduce the demand level cost by nearly 2 million, and decrease AEBOs by about 3,000 compared to the current AF policy (C=2).

Table 2-10. Kadena XF Demand Level Costs and AEBO Totals

Alternative	Logic	Demand Level Costs	AEBO Units	% of Items
	Baseline	$2,874,101	645	-
1	All C=2	$3,067,522	561	100%
2	<$750	$2,028,731	982	49%
3	<750 MIC 1,2	$2,021,854	1001	46%
4	<$1000 MIC 1,2	$2,059,870	943	51%
5	<2000 MIC 1,1	$2,211,991	753	70%
6	All C=1	$1,897,005	1295	100%

Notice from Table 2-10 that the all C=2 policy for XF items is inefficient. The C factor of 2 policy increased demand levels by $1.2M ($3.1M - $1.9M) over a C factor of 1 policy and reduced only 734 (1295 – 561) AEBOs. Applying increased C factors to selected items reduced the inefficiency, but is still inefficient.

We estimated the impact on OCONUS demand level the same way we estimated it for CONUS. Table 2-11 provides the cost impact of implementing the proposed policy at the two OCONUS sample bases.

Table 2-11. OCONUS Demand Level Cost Reduction (Alt. 5 for XB and Alt. 3 for XF)

	Delta DL($000)	Total Stock ($000)	% Reduction
Kadena	2743	13342	20.56%
XB	1698	10275	16.53%
XF	1045	3067	34.07%
Aviano	817	4824	16.94%
XB	598	4062	14.72%
XF	219	762	28.74%
Totals	3560	18166	19.60%

We then applied the 19.6% decrease to the demand level cost for budget code 9 items at all USAFE and PACAF bases. Table 2-12 shows how the AFLMA proposed policy alternatives (5 for XB and 3 for XF) reduced the OCONUS demand level cost by $13.9M while reducing 15K AEBO (compared to the all C=2 policy).

Table 2-12. OCONUS COSTS

	Total DL$	% Decrease	$ Decrease
USAFE	$28,512,413	19.60%	$5,588,433
PACAF	$42,818,000	19.60%	$8,392,328
Totals	$71,330,413		$13,980,761

Proposal. Up to this point we have highlighted the results for the policies alternatives that resulted in the most AEBO reduction (Alternative 5 for XB and Alternative 3 for XF). This policy (Alternative 5 for XB and Alternative 3 for XF) would increase CONUS demand levels for budget code 9 items by $20M and decrease OCONUS levels by $13.9M, while decreasing 967K (952K CONUS plus 15K OCONUS) AEBOs annually.

Up to this point we focused primarily on the AEBO reduction, not cost. Our next step was to provide a cost-neutral option. Table 2-13 compares the costs and impact on AEBOs for the 3 most promising alternatives including cost-neutral policy alternatives.

Table 2-13. Policy Alternatives, Assuming C=2 for all OCONUS Demand Levels

XB Alt	XF Alt	Proposal	CONUS Cost Increase (Millions)	OCONUS Cost Decrease (Millions)	Total AF Cost	AEBO Reduction
5	3	Initial Proposal	$20.0	($13.9)	6.1	.967M
5	6	Exclude XF	$16.9	($14.6)	2.3	.898M
6	6	Cost-Neutral	$10.1	($16.4)	-6.3	.835M

The initial proposal (XB Alternative 5 and XF Alternative 3) would cost $6.1M AF-wide ($20M increase CONUS and $13.9M decrease OCONUS) and reduce .967M AEBOs. Excluding all XF items (Alternative 5 for XB and 6 for XF) from getting increased safety levels reduced the CONUS cost increase by $3M and increased the OCONUS cost decrease by $.7M. Note that higher C factors were not efficient for XF items, so there was minimal drop off in the AEBO reduction. The cost-neutral policy (Alternative 6 for XB and 6 for XF) reduced the number of XB items that receive increased safety levels by reducing the cost threshold from $300 to $100.

Remember, initially we assumed all items at OCONUS bases received a C factor of 2. Therefore, it appeared that applying XB Alternative 6 and XF Alternative 6 would reduce Air Force demand levels by $6.3M. However, we found that a C factor of 2 was applied to only approximately 69% of the items at OCONUS bases (based on a sample of 9 USAFE and PACAF bases). Therefore, to assess the true impact of the proposed policy, we computed actual demand level costs using current C factors. We found the true decrease in OCONUS demand levels would be $12.2M, not $16.4M as originally thought. Table 2-14 illustrates this difference.

Table 2-14. Cost-Neutral Policy Alternatives with Current OCONUS C factor

XB Alt	XF Alt	Proposal	CONUS Cost Increase (Millions)	OCONUS Cost Decrease (Millions)	Total AF Cost	AEBO Reduction
6	6	Cost-Neutral (All C2)	$10.1	**($16.4)**	-6.3	.835M
6	6	Cost-Neutral (Actual)	$10.1	**($12.2)**	-2.1	.904M

Considering current, actual demand level costs, the cost-neutral policy (Alternative 6 for XB and Alternative 6 for XF), would provide increased safety levels for 70-80% of the XB items, reduce .904 M AEBOs, and actually *reduce* AF-wide demand level costs by $2.1M. We propose that the cost-neutral alternative (Alternative 6 for XB and XF) be implemented AF-wide. This cost-neutral policy will result in an approximate 2% to 3% percent increase in stockage effectiveness at CONUS bases and a slight increase in stockage effectiveness at OCONUS bases.

ACC requested we identify policies to improve supply support for Homeland Defense. We found that applying the proposed policy to Homeland Defense bases only will cost $3.9M and reduce 328K AEBOs. We defined the Homeland Defense cost using the cost increase for all CONUS ACC, ANG and Air Force Reserve (AFR) bases. Homeland Defense included support to F-15, F-16, KC135, C-130 and E-3 weapon systems. Homeland Defense, then, was more than just ACC, ANG, and AFR bases, and not all ACC, ANG, and AFR bases support Homeland Defense. However, there was no good way to apply the proposed policies to selected weapon systems, since there is currently no accurate method to identify items by weapon system. We propose Alternative 6 for XB and 6 for XF be implemented AF-wide. The policy we propose in this study provides benefit to all weapon system items. The policies decrease MICAPS and increases stockage effectiveness 2 to 3 points at no cost. Applying the proposed policy to *all CONUS bases* (and not changing any OCONUS policies) will cost $10.1M and reduce 829K AEBOs.

At the March 2002 Air Force Stockage Policy Working Group (AFSPWG), AFLMA recommended reducing the C factor to 1 for all XF items at all bases as described above. The OCONUS bases wanted to retain a C factor of 2, for at least some of the XF items. The AFLMA proposal would increase inventory levels at CONUS bases by $10.1M and reduce inventory levels at OCONUS bases by $12.2M, so it is basically an inventory neutral position AF-wide that would result in a reduction of 904K units backordered. To satisfy the concerns of the OCONUS MAJCOMs, we evaluated additional alternatives. Table 2-15 presents the results of the additional analysis.

Table 2-15. Additional Alternatives Requested by the AFSPWG

ALL XB Alt	CONUS XF Alt	OCOUNS XF Alt	Proposal	CONUS Cost Increase (Millions)	OCONUS Cost Decrease (Millions)	Total AF Cost	AEBO Reduction
6	6	6	AFLMA Cost Neutral Proposal (Original)	$10.1	($12.2)	($2.1)	.904M
6	6	Current C factor	AFLMA Proposal ($100) for XB and - No Change to current XF C factors for OCONUS	$10.1	($7.2)	$2.9	.907M
6	6	3	AFLMA Proposal ($100) for XB and - C factor of 2 for OCONUS MIC 1,2 XF < 750	$10.1	($11.4)	($1.3)	.905M
6	3	3	AFLMA Proposal ($100) for XB and - C factor of 2 for CONUS & OCONUS MIC 1,2 XF < 750	$13.2	($11.4)	$1.8	.943M

If the AF implemented the AFLMA-proposed XB policy AF-wide (all MAJCOMs agreed with the proposed XB policy) but did not change the OCONUS bases' C factors for XF items (remain as they are today), it would increase inventory AF-wide by $2.9M and reduce 907K AEBOs. That would be $5M ($12.2M – $7.5M) for 3K (.907M - .904M) AEBOs compared to the AFLMA proposal.

If the AF implemented the XB proposal but OCONUS bases retained the C factor of 2 for XF items with a unit cost of $750 or less, the AF-wide inventory reduction would be $1.3M and there would be a reduction of 905K AEBOs. So, increasing inventory by $.8M would reduce 1K AEBOs compared to the AFLMA proposal. That alternative seemed acceptable to the OCONUS bases at the AFSPWG, but we did not have the inventory totals for that alternative. It is still cost-neutral.

The final alternative is the AFLMA proposal for XB, which applies a C factor of 2 for all bases (not just OCONUS) and a C factor of 2 for XF items under $750. That would *increase* worldwide inventory by $1.8M and reduce 943K AEBOs. Compared to the AFLMA-proposed policy, it would increase inventory by nearly $4M and decrease AEBOs by 39K.

AFLMA recommends no increased C factors for XF items and still stands by its originally proposed alternative that reduces worldwide inventory by $2.1M and reduces 904K AEBOs. Note however, that the third alternative on the chart (Alternative 6 for XB, 6 for XF in CONUS and 3 for XF OCONUS) also reduces inventory and retains some C factors of 2 at OCONUS accounts. So this policy may be more acceptable to OCONUS commands and still meets the intent at increasing support without increasing inventory.

We used an AFLMA-developed model (LS200031200, *Relating Mission Capable (MICAP) Incidents to Air Force Aircraft Mission Capable (MC) Rates*) to relate backorder reduction to aircraft availability. We estimated an increase in 129 mission capable aircraft annually as a result of implementing the AFLMA cost-neutral alternative. Note the .904M units backordered do not translate directly to MICAP reductions. First, the units backordered must be converted into customer orders backordered. We divided the units backordered per NSN by the average lot size (the number of units ordered per customer order) to get the number of customer orders backordered. Only about half the NSNs with increased safety levels were MIC 1 items (caused a MICAP or AWP (awaiting part) backorder). We divided the number of customer backorders in half to get the MIC 1 customer orders backordered. Of those MIC 1 items, we estimated only 1/2 of those orders were for MICAP-causing items (the remaining were AWP orders). Finally, note the backorders were units out of stock in supply when the item was requested. That doesn't necessarily mean a hole in an aircraft; it may mean a shortage in bench stock items. We estimated about 1/2 to 3/4 of these customer backorders were actually bench stock replenishments. So we estimated that 1,006 (assuming 1/2 were bench stock backorders) to 2,012 (assuming 3/4 were bench stock backorders) customer backorders were MICAP preventions. Using this range of numbers in the AFLMA aircraft availability prediction model, we estimated an aircraft availability increase of 129 to 258 aircraft annually and a reduction of 2,729 to 5,458 cannibalizations annually.

IMPLEMENTATION ISSUES:

In this section we discuss seven implementation issues: AF-managed items, retail implementation, a long-term model, variance error, AMC Forward Supply Locations (FSLs), AFMAN 23-110 documentation, and implementation timing.

AF-Managed Items. Thus far, we have analyzed non-AF-managed items. To implement the policy for AF-managed items, one must address the Requirements Management System (D200A). D200A determines the requirement for AF-managed items. Changing base levels will not generate a commensurate increase in the AF gross requirement or the amount the AF buys. Increasing the levels will generate retail requisitions sooner but will not result in a commensurate increase in the D200A requirement. D200A may see a slight increase in the retail demand rates, but it will not generate increased safety level support. The D200A safety level (and buy) requirement is determined by the variable safety level (VSL) target D200A uses.

To increase support for AF-managed consumable items, the AF must increase the VSL target and implement our proposed C factor rules. There is no guarantee changing the VSL target will buy the same items our retail policy proposes. There is an inconsistency between the retail and wholesale policy for AF-managed consumable items. For the short term, the AF must change both the VSL target and the retail policy to achieve the benefits of the retail policy change for AF-managed consumable items.

We estimated the cost increase of our proposed policy for AF-managed items to be $3.1M, resulting in a reduction of 155K AEBOs. These changes should result in a stockage effectiveness increase of 2% to 3% for budget code 8 consumable items. Logistics Management Institute (LMI) estimated the cost to increase the VSL from its current 92% goal to 95% and from 92% to 98%. Table 2-16 provides the results.

Table 2-16. LMI's Buy Cost Estimate for Varying VSL Goals

Goal	Cost Increase
92%	Current
95%	$2M
98%	$11M

Retail Implementation. Implementing a cost-neutral policy will not require any SBSS programming changes. The SBSS item record already has a data element for the C factor. The data field is called *standard deviation*. Once the base loads a C factor of 2 (or 3), the SBSS will use that C factor as a multiplier of the standard deviation to determine the safety level.

In the near-term the MAJCOMs or the Standard Systems Group (SSG) can develop a surge program to load a C factor of 2 (or 3) on the item record of those items that qualify for the increased C factor. The surge program should be run regularly (we recommend quarterly) to update the C factor field.

Long-term Model. The current C factor field in the SBSS is a singe-digit field, so the only C factors allowed are 1, 2, or 3. We constrained our analysis to use only whole numbers for the C factor. However, it is likely that we could find an even more efficient policy using fractional C factors. In fact, the best way to efficiently reduce backorders is an optimization model that minimizes backorders given some level of funding. AFMC uses a backorder minimization model called the Customer Oriented Leveling Technique (COLT) to set levels for depot retail accounts. We suggest the AF explore these types of models for potential use within the Integrated Logistics System – Supply (ILS-S).

Variance Error. During the analysis we found that the SBSS made some erroneous variance calculations. In fact, we found variance calculations in excess of 100K. There is a cap on the safety level of: $2C\sqrt{Variance}$, so the impact of the incorrect and extremely large variance was reduced. However, if the proposal in this study to use C factors of 2 and 3 is adopted, large variances will have a greater impact. We identified the SBSS software error to SSG and they have documented it as a deficiency report (DIREP). It is important SSG fix the variance before the AF increases safety levels.

Air Mobility Command Forward Supply Locations. At the request of Air Mobility Command (AMC), we evaluated the impact of the proposed alternative on FSLs. We found little benefit to applying the proposed alternative to the FSLs. We identified only 962 XB and 91 XF items stocked by the FSLs. Our analysis showed these FSL items were more expensive and had less demand than a typical base. For example, only 43% of the FSL XB items had a unit price of $100 or less. Nearly 80% of the XB items at the other bases we analyzed had a unit price of $100 or less. As a result, FSLs will not realize the same benefit from applying the policy that other bases would receive. Application of the proposed alternative for XF items would result in an increase of 94 AEBOs and a decrease of $577K in demand level cost; applying it to XB items would decrease 85 AEBOs and increase demand level costs by $531K. The results are nearly a wash: an increase of 9 AEBOs with a cost decrease of $46K. Therefore, we recommend no change to the safety levels for the FSLs.

AFMAN 23-110, *USAF Supply Manual*, Documentation. AFMAN 23-110 documentation is inaccurate, fragmented, and incomplete. Attachment 19A-2 is titled "Formulas and Examples (Repair Cycle Demand Level)," yet contains formulas for consumable safety levels. Some of the formulas are incorrect due mainly to inaccurate mathematical notation. Figure 2-3 provides an example of incorrect notation symbolizing a square root.

SLQ--Formula: SLQ = C ÖO&ST(VOD) + DDR2 (VOO)

Vs.

$$SLQ = C\sqrt{O\,\&\,ST(VOD) + DDR(VOO)}$$

Figure 2-3. Example of AFMAN 23-110 Documentation Error

Implementation Timing. The cost-neutral proposal is cost-neutral AF-wide; it is not cost-neutral at individual bases. At CONUS bases, the levels will increase, while at OCONUS bases the levels will decrease. To avoid a large disruption in stock fund obligations, the AF should implement the new levels at the beginning of the fiscal year. That would provide time for OCONUS bases to *sell off* their inventory and compensate for the CONUS increases. It should take a year to *rebalance* the average inventory and stock fund obligations. Inventory level in units will increase at all bases, but AF-wide inventory dollar value will remain the same. There will be a redistribution of the inventory value; OCONUS bases will stock fewer expensive items and all bases will stock more inexpensive items

CHAPTER 3
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Today's policy to increase safety levels for *all* weapon system items at OCONUS bases is inefficient.

2. Our proposed policy to selectively increase CONUS safety levels will increase supply support to homeland defense and CONUS bases and will improve support AF-wide.

   - Applying the proposed policy (XB alternative 6 [$100 threshold] and XF alternative 6 [no XF items]) to homeland defense bases only will cost $3.9M and reduce 328K AEBOs.

   - Applying the proposed policy to all CONUS bases will cost $10.1M and reduce 829K AEBOs.

   - Applying the proposed policy AF-wide will actually *reduce* AF demand level cost by $2.1M and reduce 904K AEBOs.

3. The proposed cost-neutral policy will increase AF stockage effectiveness for XB items by 2 to 3 percent and increase available aircraft by at least 129 annually.

4. The additional alternative requested by the AFSPWG, to use the AFLMA proposal for XB items and retain increased safety levels for XF items with a unit cost of $750 or less at OCONUS bases only, is also cost-neutral and would mitigate some of the concerns of the OCONUS bases.

5. To achieve the benefits for AF-managed consumable items (budget code 8 XB and XF items), the consumable items variable safety level target in the Requirements Management System must be increased.

6. There is an error in SBSS calculation of variance of demand that could result in inaccurate and excessive safety levels, especially if safety levels are increased by using higher C factors.

7. The SBSS documentation for base demand levels is incomplete and inaccurate

RECOMMENDATIONS

1. Implement the following policy AF-wide:

   - Use a C factor of 2 for all MIC 1 and 2 XB items costing less than $100 and all MIC 1 items with a DDR greater than .3. Use a C factor of 3 for all MIC 1 & 2 XB items

costing less than $25 and a DDR greater than .1. Use a C factor of 1 for all XF and the remaining XB items.
OPR: HQ USAF/ILG

- Should it be necessary to retain higher safety levels at OCONUS bases for XF items, apply a C factor of 2 for XF items with a unit cost of $750 or less.
OPR: HQ USAF/ILG

2. Develop a program to load the C factor of 2 (or 3) to the appropriate items.
   OPR: SSG/ILS

3. Increase the D200A variable safety level target for AF-managed consumable items.
   OPR: HQ USAF/ILG **OCR: AFMC/LGI**

4. Correct the SBSS code that computes the variance of demand.
   OPR: SSG/ILS

5. Update and correct the *AFMAN 23-110, USAF SUPPLY MANUAL* stockage policy documentation.
   OPR: SSG/ILS

BENEFITS

Benefits to the AF for implementing our proposals include:

4. **Supply Support**. The proposed policy will decrease unit backorders by 10% and increase stockage effectiveness by 2%.

5. **Mission Support**. It is estimated that the proposed C factor policy will reduce nearly 1 million expected backordered units and provide for an annual increase of at least 129 mission capable aircraft.

Efficiency. The current policy is inefficient. The proposed policy provides for supply and mission improvements at no additional cost to the Air Force.

APPENDIX A
COMPARISON OF C FACTOR ALTERNATIVES

To assess the impact of varying the C factor, we estimated the percentage of cost change to total demand level cost for varying alternatives. The following tables show the demand-level impact for CONUS and OCONUS bases. The impact on CONUS bases is shown by delta in demand-level dollars (Delta DL $) and the change in annual expected backorders. The impact on the OCONUS bases can be seen by comparing the different demand-level totals and the expected backorders associated with each alternative.

Table A-1. Langley XF Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All C2	$245K	265	100%
2	<$750	$35K	120	45%
3	<750 MIC 1,2	$34K	120	45%
4	<$1000 MIC 1,2	$43K	148	55%
5	<2000 MIC 1,2	$76K	215	81%
	Logic	DL$	AEBO units	% of Items
6	All C1	$484K	585	100%

Table A-2. Langley XB Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All (C=2)	$675K	12559	100%
2	<$300	$185K	12196	90%
3	<300 MIC 1,2	$178K	11651	84%
4	#3 & MIC 1 > $300 with DDR >.3	$193K	11724	84%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$211K	14361	84%
6	Same as 5 except $100 threshold vs. $300 threshold	$131K	14002	75%

Table A-3. Shaw XF Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All C2	$287K	162	100%
2	<$750	$32K	52	42%
3	<750 MIC 1,2	$31K	43	39%
4	<$1000 MIC 1,2	$41K	72	46%
5	<2000 MIC 1,2	$66K	108	59%
	Logic	DL$	AEBO units	% of Items
6	All C1	$481K	533	100%

Table A-4. Shaw XB Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All (C=2)	$550K	6949	100%
2	<$300	$150K	6466	91%
3	<300 MIC 1,2	$140K	5858	83%
4	#3 & MIC 1 > $300 with DDR >.3	$185K	6040	83%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$197K	7302	83%
6	Same as 5 except $100 threshold vs. $300 threshold	$135K	7016	75%

Table A-5. Seymour Johnson XF Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All C2	$690K	556	100%
2	<$750	$58K	139	44%
3	<750 MIC 1,2	$55K	136	42%
4	<$1000 MIC 1,2	$76K	187	47%
5	<2000 MIC 1,2	$147K	330	62%
	Logic	DL$	AEBO units	% of Items
6	All C1	$1279K	1281	100%

Table A-6. Seymour Johnson XB Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All (C=2)	$1036K	17157	100%
2	<$300	$269K	16591	89%
3	<300 MIC 1,2	$254K	15590	78%
4	#3 & MIC 1 > $300 with DDR >.3	$267K	15674	78%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$292K	19160	78%
6	Same as 5 except $100 threshold vs. $300 threshold	$174K	18637	70%

Table A-7. Portland ANG XF Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All C2	$38K	138	100%
2	<$750	$29K	80	58%
3	<750 MIC 1,2	$26K	75	50%
4	<$1000 MIC 1,2	$36K	84	51%
5	<2000 MIC 1,2	$56K	104	70%
	Logic	DL$	AEBO units	% of Items
6	All C1	$383K	271	100%

Table A-8. Portland ANG XB Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All (C=2)	$334K	4476	100%
2	<$300	$119K	4318	93%
3	<300 MIC 1,2	$107K	3964	76%
4	#3 & MIC 1 > $300 with DDR >.3	$113K	4004	76%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$123K	4824	76%
6	Same as 5 except $100 threshold vs. $300 threshold	75K	4654	70%

Table A-9. Otis ANG XF Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All C2	$88K	39	100%
2	<$750	$13K	17	56%
3	<750 MIC 1,2	$11K	15	45%
4	<$1000 MIC 1,2	$16K	21	50%
5	<2000 MIC 1,2	$22K	29	66%
	Logic	DL$	AEBO units	% of Items
6	All C1	$108K	118	100%

Table A-10. Otis ANG XB Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All (C=2)	$111K	1380	100%
2	<$300	$45K	1317	94%
3	<300 MIC 1,2	$39K	1188	76%
5	#3 & MIC 1 > $300 with DDR >.3	$41K	1199	76%
6	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$44K	1446	76%
6	Same as 5 except $100 threshold vs. $300 threshold	$28K	1390	71%

Table A-11. Fresno ANG XF Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All C2	$63K	73	100%
2	<$750	$14K	27	61%
3	<750 MIC 1,2	$14K	27	59%
4	<$1000 MIC 1,2	$21K	49	69%
5	<2000 MIC 1,2	$28K	63	80%
	Logic	DL$	AEBO units	% of Items
6	All C1	$103K	145	100%

Table A-12. Fresno ANG XB Analysis

Alt.	Logic	Increase DL$	AEBO Units Reduced	% of Items
1	All (C=2)	$79K	1042	100%
2	<$300	$37K	994	93%
3	<300 MIC 1,2	$33K	845	67%
4	#3 & MIC 1 > $300 with DDR >.3	$33K	845	67%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$36K	992	67%
6	Same as 5 except $100 threshold vs. $300 threshold	$22K	928	61%

Table A-13. Kadena XF Costs and AEBOs

Alt.	Logic C=1	Demand Level Costs	AEBOs	% of Items
	Baseline	$2,874,101	645	100%
1	All C=2	$3,067,522	561	100%
2	<$750	$2,028,731	982	49%
3	<750 MIC 1,2	$2,021,854	1001	46%
4	<$1000 MIC 1,2	$2,059,870	943	51%
5	<2000 MIC 1,1	$2,211,991	753	70%
6	All C=1	$1,897,005	1295	100%

Table A-14. Kadena XB Costs and AEBOs

Alt.	Logic	Demand Level $$ (C2)	AEBO Units	% of Items
	Baseline	$9,408,128	24240	-
	All (C=1)	$7,790,291	65057	100%
1	All (C=2)	$10,275,555	13501	100%
2	<$300	$8,571,793	14271	91%
3	<300 MIC 1,2	$8,476,593	19383	76.4%
4	#3 & MIC 1 > $300 with DDR >.3	$8,501,271	19308	76.5%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$8,577,033	9585	76.5%
6	Same as 5 except $100 threshold vs. $300 threshold	$8,273,689	10635.00	69%

Table A-15. Aviano XF Costs and AEBOs

Alt.	Logic C=1	Demand Level Costs	AEBOs	% of Items
	Baseline	$697,451	291	-
1	All C=2	$762,407	209	100%
2	<$750	$558,237	322	61%
3	<750 MIC 1,2	$542,456	356	52%
4	<$1000 MIC 1,2	$564,128	333	60%
5	<2000 MIC 1,1	$598,070	307	70%
6	All C=1	$492,682	449	100%

Table A-16. Aviano XB Costs and AEBOs

Alt.	Logic	Demand Level $$	AEBO Units	% of Items
	Baseline	$3,883,979	9378	-
	All (C=1)	$3,102,640	19210	100%
1	All (C=2)	$4,062,156	4010	100%
2	<$300	$3,430,056	4329	91%
3	<300 MIC 1,2	$3,393,217	6744	76.4%
4	#3 & MIC 1 > $300 with DDR >.3	$3,439,983	6647	76.5%
5	# 4 & C3 for MIC 1 & 2 <$25 & DDR> .1	$3,464,726	4143	76.5%
6	Same as 5 except $100 threshold vs. $300 threshold	$3,321,333	4579	71%

APPENDIX B
REVIEW OF XB & XF STOCKAGE POLICY
(Depth)

In this study, we used some of the calculations the Standard Base Supply System (SBSS) uses to compute demand levels for XB and XF items. As we pointed out in the report, the current AFM 23-110 documentation is inaccurate and not very useful. We extracted portions of the AF Stockage Policy Handbook and included portions of the relevant sections in this appendix. This appendix highlights the SBSS formulas used to compute XB and XF demand levels

The Standard Base Supply System uses the Economic Order Quantity (EOQ) model to determine inventory levels for consumable items. The EOQ model minimizes the sum of two variable costs: holding and ordering. The SBSS computes an Economic Order Quantity and a reorder point, which consists of average demand and a measure of the variance of demand during the order and ship time. There are several data elements needed to compute those components. To compute the SBSS demand level, we need the cost to hold and the cost to order. The Air Force cost to hold is 15%, which consists of a 10 percent cost of capital and a 5 percent cost for obsolescence, storage and loss. There are two distinct costs to order: a non-local purchase (non-LP) cost to order of \$5.20 and a local purchase (LP) cost to order of \$19.94. We also need estimates of demand to compute demand levels. The SBSS computes a daily demand rate (DDR) by:

$$\text{DDR} = \frac{\text{Cumulative Recurring Demands (CRD)}}{[\text{Greater of either (Current Date (CD) - Date of First Demand (DOFD)), or, 180 days}]}$$

Where: CRD = The total number of units demanded since the date of first demand

The DDR is the average demand per day over the period of time the demand data is collected or 180 days, whichever is larger. The CRD can include up to an 18 months demand history. If the current date minus the date of first demand exceeds 545 days, the SBSS computes a new CRD and DOFD.

New CRD = DDR x 365 and

New DOFD = Current Date - 365.

This transforms the CRD and DOFD, but ensures the DDR is the same.

We can now compute the EOQ. The EOQ formula is:

$$\text{EOQ} = \sqrt{\frac{2(\text{Order Cost})(\text{Annu al Demand})}{(\text{Holding Cost Percent})(\text{Unit Cost})}}$$

To compute order and ship time quantity (O&STQ) you need the average order and ship time. The SBSS uses a routing identifier record to record the order and ship times for all routine receipts from each individual source of supply. For example, the SBSS collects data from all routine receipts from Warner-Robins Air Logistics Center (routing identifier FLZ) and computes the average of all receipts less than or equal to some cut-off value to truncate outliers. The Air Force excludes extreme values because these values will inflate the overall average.

$$\text{O \& ST Quantity} = (\text{O \& ST})(\text{DDR})$$

Order and ship time is the average demand during the (average) base order to receipt time. The next part of the demand level is the safety level quantity (SLQ). To compute the SLQ, you need the variance of demand (VOD) which is:

$$\text{VOD} = \frac{\sum_{i=1}^{n} (\text{Demand})^2 - (\text{CRD})^2 / \text{n}}{\text{n}}$$

The SBSS records the sum of demand squared ($\sum \text{Demand}^2$) on the EOQ consumption detail by squaring the number of units demanded for every customer order and adding that figure to the current sum. Now you have all the data elements to compute the safety level quantity.

$$\text{SLQ} = \text{C}\sqrt{(\text{VOD})(\text{O \& ST}) + (\text{DDR})(\text{VAR O \& ST})}$$

Where: C = C factor and VAR O&ST = the variance of the order and ship time.

Do not worry about the VAR O&ST; it is typically a very small number. It is a measure of the stock needed for the uncertainty in the order and ship time. Now we have all the components of an EOQ demand level. The entire demand level is:

$$\text{EOQDL} = \text{Truncate } [\text{EOQ} + \text{O \& STQ} + \text{SLQ} + .999]$$

Truncate means take the integer part of the number in the brackets. For example, truncate [6.9] is 6. The EOQ reorder point (ROP) is:

$$\text{EOQ ROP} = \text{Truncate } [\text{O \& STQ} + \text{SLQ} + .999]$$

The policy for these items is to order the EOQ amount whenever on-hand stock reaches the reorder point. The SBSS actually orders the difference between the demand level and the on-hand stock whenever the on-hand stock is equal to or falls below the ROP. So, if the customer demand reduces on-hand stock to the reorder point, the EOQ is ordered. If the on-hand stock falls below the reorder point, the SBSS orders the EOQ plus the amount the item is below the reorder point. So the SBSS demand level reorder point is sometimes referred to as the *order up to level.*

XF items use a repair cycle demand level (RCDL) which is, theoretically, a reorder point that consists of pipeline stock and a safety level. Recall for an economic order quantity (EOQ) item the demand level consisted of an operating level and a reorder point. The EOQ reorder point is the average pipeline stock plus a safety level. The only pipeline for an EOQ item was the depot; hence, pipeline stock consisted only of the order and ship time from the depot. Reparable items also have base repair pipelines; so, to ensure a smooth production flow, these pipelines must also be filled. The Repair Cycle Demand Level (RCDL) is computed by:

$$\text{RCDL} = \text{Truncate}\,[\,\text{Repair Cycle Quantity (RCQ)} + \text{Order and Ship Time Quantity (O \& STQ)} + \\ + \text{NRTS/Condemned Quantity (NCQ)} + \text{Safety Level Quantity (SLQ)} + \text{Factor}]$$

Where: the Factor = .9 if the unit price is less than or equal to $750 and .5 if the unit price is greater than $750.00.

The pipeline stock consists of the RCQ, NCQ and O&STQ. The following formula applies to the RCQ:

$$\text{RCQ} = (\text{Percent Base Repair}) * (\text{Daily Demand Rate}) * (\text{Repair Cycle Time})$$

Note: The repair cycle quantity is the average demand during the time it takes the base to repair an item multiplied by a weighting factor. The weighting factor is the percent base repair, which is a measure of the average number of times the item is repaired. The other pipeline quantities are similarly computed.

$$\text{NCQ} = (1 - \text{Percent Base Repair}) * (\text{Daily Demand Rate}) * (\text{NRTS/Condemned Time})$$
$$\text{O \& STQ} = (1 - \text{Percent Base Repair}) * (\text{Daily Demand Rate}) * (\text{Order and Ship Time})$$

One of two things happens. Either the item is repaired (and that is the pipeline) or it is not repaired (and it takes some time to determine it is not reparable). If it is deemed not reparable, it must be ordered from the wholesale source of supply. The demand-weighted average of the two pipeline times is the *overall* pipeline time.

NRTS/condemned time is the average amount of time it takes to determine an item cannot be repaired at the base. The item must either be shipped elsewhere for repair, not reparable this station (NRTS), or condemned. For almost all XF3 items, NRTS turn-ins result in sending the item to the Defense Reutilization and Marketing Office (DRMO).
The safety level quantity (SLQ) is:

$$\text{SLQ} = C\sqrt{3(\text{O \& STQ} + \text{RCQ} + \text{NCQ})}$$

The safety level quantity is a measure of the standard deviation of demand multiplied by the C factor. Note you assume a variance-to-mean ratio of 3 for XF items. The average demand during the pipeline is:

$$\text{Average Demand during Pipeline} = \text{O \& STQ} + \text{RCQ} + \text{NCQ}$$

This assumes the variance is 3 times the mean, and results in the formula for the safety level.

Field level reparable (XF3) items are managed differently depending on the source of supply. DLA manages most XF3 and their wholesale stockage policy treats them like consumables (XB3). In fact, until recently, AFMC also treated AF-managed XF3 items as consumable items. The question is "Are XF3 items reparable items (relatively expensive with some repair capability) or are they more like consumable items?" The answer is that most XF3 items are more similar to EOQ items, yet some have characteristics closer to reparable items.

For Items costing $750 or less and with a PBR less than 50 percent, the demand level is:

$$\text{Truncate } [EOQ + RCQ + NCQ + O\&STQ + SLQ + .9]$$

Where the EOQ is the same as for consumables:

$$EOQ = \sqrt{\frac{2(\text{Order Cost})(\text{Annu al Demand})}{(\text{Holding Cost Percent})\ (\text{Unit Cost})}}$$

The reorder point for these items is the RCDL. All XF3 items that do not meet this criterion, that is items costing more than $750 or with a PBR greater than 50 percent, use a RCDL. The reorder point for these items is one less the repair cycle demand level (RCDL-1). Hence, for those items the policy is use one, order one.

APPENDIX C
EXPECTED BACKORDER ESTIMATION

We computed annual expected backorders (AEBOs) as a measure of the impact of the changes in safety levels. AEBOs are a product of expected stockage effectiveness and annual demand rate. Therefore, to determine AEBOs, we first established expected stockage effectiveness, (ESE).

To determine an ESE, we used the following formula. Theoretically, stockouts can only occur once the reorder point (ROP) is reached. This means stockouts will only occur during the order and ship time. Prior to the ROP, all demands are met by the EOQ level. Thus, the expected stockage effectiveness depends on the percentage of time in the reorder cycle and the safety level multiplier.

$$\frac{EOQ}{DemandLevel(DL)} \text{ X } 100\% \quad + \quad \frac{ROP}{DL} * \text{Z}$$

(If C factor = 1, Z = 84%, if C factor = 2, Z = 97%; if C factor = 3, Z = 99%)

Once we computed the ESE for each stock number, we then computed the AEBOs. To compute the AEBOs, we found the product of the annual demand rate and 1-ESE.

$$(1 - ESE \times AnnualDemandRate)$$

As described in the report, we computed the total AEBOs for each sample base as a measure of the impact of changing the safety level multiplier or C factor. To estimate the worldwide AEBO impact, we established a relationship between the sample bases AEBO and demand level changes for each alternative policy. We then used this relationship to estimate the impact on AEBOs AF-wide of the various safety level or C factor changes. For example, applying the initial proposed policy to the sample bases resulted in a $1.08M demand level increase and a 51,651 AEBO decrease. Using these results and the $20M CONUS demand level increase, we were able to estimate the CONUS AEBO change. As stated in the report, we estimated a 952K decrease in AEBOs for CONUS.

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APPENDIX D
FORWARD SUPPLY LOCATION ANALYSIS

Our analysis revealed a limited number of XB and XF items stocked at FSLs. We identified 91 XF items and found that the 962 XB items were expensive and had low demand. These characteristics, displayed in the charts below, reduced the potential impact of the proposed safety level changes. Therefore, our recommendation is to not apply the proposed policy to FSLs. Note that less than 44% of the XB items had a unit price of less than $100. Also note the relatively low demand; 92% of the XB items had a daily demand rate of less than .1.

Table D-1. XB Unit Cost Distribution for FSLs

	Frequency	Percent	Cumulative Percent
0 - $10	258	26.82	26.82
$10 - 20	28	2.91	29.73
$20 - 30	28	2.91	32.64
$30 - 40	19	1.98	34.62
$40 - 50	17	1.77	36.38
$50 - 60	27	2.81	39.19
$60 - 70	15	1.56	40.75
$70 - 80	21	2.18	42.93
$80 - 90	2	0.21	43.14
$90 - 100	7	0.73	43.87
$100 - 200	72	7.48	51.35
$200 - 300	65	6.76	58.11
$300 - 400	65	6.76	64.86
$400 - 500	36	3.74	68.61
$500 - 600	22	2.29	70.89
$600 - 700	27	2.81	73.70
$700 - 800	21	2.18	75.88
$800 - 900	20	2.08	77.96
$900 - 1K	22	2.29	80.25
$1K - 2.5K	105	10.91	91.16
$2.5K - 5K	58	6.03	97.19
$5K - 10K	24	2.49	99.69
$10K - 20K	3	0.31	100.00
Total	962	100	

Table D-2. XB Daily Demand Rate (DDR) Frequency

DDR	Cumulative %
0.0025	2.93%
0.005	17.07%
0.015	61.95%
0.025	75.61%
0.05	86.83%
0.1	92.68%
0.2	96.10%
0.3	96.59%
0.4	97.56%
0.5	97.56%
0.75	98.05%
1	98.54%
> 1	100.00%

APPENDIX E
ADDITIONAL BASE ANALYSIS

To validate our assumption that our policy would apply to 70% to 80% of all XB items, we analyzed several additional bases that belong to CONUS MAJCOMS other than ACC. Each of the consumable inventories at the sample bases displayed common characteristics. We again found that approximately 80% of all XB items were valued at less than $100. Table E-1 shows the number of items, by C factor, impacted by our policy. The table shows how c factors are currently applied and how they would be applied under the new policy. Again, the additional bases displayed common results when the proposed policy was applied.

Table E-1. Additional CONUS Analysis

		Current C factor Allocation			C Factor Allocation Under Proposed Policy			
BASE	SRAN	1	2	C>1	1	2	3	C>1
McChord	4479	6881	0	0%	2098	3855	928	70%
Eglin	2823	16012	0	0%	3523	9797	2692	78%
Hurlburt	4417	11731	0	0%	2898	6934	1899	75%
Luke	4887	12013	0	0%	2664	7165	2184	78%

APPENDIX F
DISTRIBUTION

HQ USAF/IL
HQ USAF/IL-I
HQ USAF/ILG
HQ USAF/ILM
HQ USAF/ILP
SAF/AQC
HQ AFMC/LG
HQ ACC/LG
HQ AMC/LG
HQ AMC/DDO
HQ AFRC/LG
HQ USAFE/LG
HQ PACAF/LG
HQ AETC/LG
HQ AFSOC/LG
HQ AFSPC/LG
ANG/LG