DECISION PAPER

ON

Base Operating Support (BOS) Cost Adjustment Factor

Purpose: To seek SAF/IEB and AF/XP concurrence to implement a BOS Cost Adjustment Factor.

Discussion:

Air Force UCA Development

The following formula was proposed and approved by the Cost of Base Realignment Actions (COBRA) model Joint Process Action Team (JPAT) for modeling changes in BOS costs with changes in installation population.

$$\text{Revised BOS} = (\text{Starting BOS}) + \left(\frac{\text{Starting BOS}}{\text{Population}} \quad 1 - \frac{1}{1 + \frac{\text{Population}}{\text{UCA}}} \right)$$

An Air Force (AF) regression analysis was accomplished as proposed by the JPAT to develop a Service Unit Cost Adjustment (UCA) factor (three-year average of historical BOS obligations and installation population). AF data did not yield the high correlation between BOS expenditures and population as was experienced by other military departments (apparently because AF installations have larger differences in mission than other services). Numerous other data scenarios were conducted which marginally improved the regression statistics. The most theoretically and statistically sound UCA resulted from excluding Bolling AFB from the regression analysis. This is because Bolling AFB experiences extremely high BOS costs in its mission of supporting the national capital region.

A more detailed comparison is attached.

Rationale for recommendation

After numerous methods of reviewing and analyzing this data, many deliberations within the COBRA JPAT, and many deliberations within the AF on BOS estimating for COBRA, we recommend the JPAT methodology, and an AF UCA developed excluding Bolling AFB, for the following reasons:

- Marginal changes in BOS due to realignment do not have a significant cost impact in COBRA. BOS savings are significant for a base closure – but the UCA formula is not utilized for base closure scenarios.
- This UCA equation estimates cost increases as population increases and cost decreases as population decreases. However, the equation also recognizes a fixed portion of BOS

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expenses and thus will not overestimate BOS savings as the installation population approaches zero.

- This equation methodology has verifiable/certifiable data points which can be easily audited and reproduced
- Other methodologies may produce improved regression statistics but do not necessarily provide an improved estimate of changes in BOS costs. This equation and UCA will work well in the most likely BRAC scenarios, with population changes in the 0-1500 person range.
- Methodology employed to estimate BOS changes is required to be approved and adopted by all the military departments. Recommendation meets this criterion for the COBRA model.

Recommendation:

SAF/IEB and AF/XP concur with the approach described above.

Certification:

We have reviewed the above rationale and recognize the associated risk of a moderate r^2 correlation. In our concurrence, we received in-depth briefings on this topic, coordinated our approach with the Base Closure Executive Committee, and AF/ILE. We are aware of the discussions of alternative models proposed by the Air Force Studies and Analysis Center, but believe the timing and risks involved are acceptable.

MICHAEL A. AIMONE, P.E.
Deputy Assistant Secretary
(Basing & Infrastructure Analysis)

GARY W. HECKMAN,
Major General, USAF
Assistant DCS, Plans & Programs (BRAC

Attachment:
Talking Paper on BOS Cost Adjustment Factor

cc:
DASA(IE)
SAF/FMC
AF/ILE
AFSAA/CD

MEMORANDUM FOR RECORD

SUBJECT: BOS Algorithm Discussion with GAO

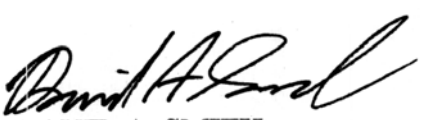
1. On 3 June 2004, representatives from the Army Basing Study (TABS) group had a meeting with representatives from the General Accounting Office to discuss the Base Operating Support (BOS) Algorithm in the Cost of Base Realignment Actions (COBRA) program.

2. The following personnel attended:

COL Bill Tarantino	TABS
MAJ Dave Smith	TABS
Mr. Larry Wickens	AAA
Mr. Clarence Johnson	AAA
Ms. Andrea Beck	AAA
Mr. Tom Mahalek	GAO
Mr. Carl Barden	GAO

3. MAJ Smith opened the meeting by explaining the algorithm, how it was developed and how it fits into the model. The algorithm is a linear approximation that has a slope based on the BOS costs over the installation population. Then, realizing that all costs are not variable, we use a regression to find the percent variable. We then multiply the percent variable, a number less than one but greater than 0, by the slope and use that as the variable cost factor. This slows the rate of change in the BOS with respect to population, thus leaving a fixed cost if the installation is closed.

4. After reviewing the algorithm, GAO agreed that the attempt to discover a fixed cost is valid and that the algorithm is reasonable.



DAVID A. SMITH
MAJ, AR
ORSA Analyst

TALKING PAPER

ON

Base Operating Support (BOS) Cost Adjustment Factor

In the process of reviewing and updating the standard factors for the Cost of Base Realignment Actions (COBRA) model, members of the COBRA JPAT were unable to find documentation in the historical files to support the development of a BOS adjustment equation and the BOS index (standard factor input). COBRA JPAT members determined that the equation and the BOS index would not stand up to an audit without the supportive documentation. As a result, the JPAT developed a new methodology to make BOS adjustments with data inputs that can be documented and provide an audit trail.

Background - COBRA 1995 BOS Adjustment Equation:
The COBRA BOS algorithm used in for the FY1995 BRAC process calculates the change in BOS and Net BOS costs using the equations below. This equation simualted changes in BOS expenditures in a curilinear manner, increasing BOS expenditures at a lower rate as population increased, and decreasing BOS at a higher rate as population decreased. The JPAT was unable to find documentation for the BOS index factor, which is the determinate for the rate of increasing or decreasing BOS expenditures.

$$\text{Revised BOS} = (\text{Starting BOS})(\%\ \text{Population Change})^{\text{BOS Index}}$$

Starting Population = Total Officers + Enlisted + Civilians + Students (input screen 4)

$$\%\ \text{FS Change}_{\text{Year=n}} = \frac{\text{Starting Population} + \Sigma_{1,n}\ (\text{Force Structure Changes, input screen 6})}{\text{Starting Population}}$$

$$\text{Actual BOS Cost}_{\text{Year=n}} = (\text{Comm Cost} + \text{BOS Non-Pay Cost}) \times (\%\ \text{FS Change}_{\text{Year=n}})$$

$$\text{BRAC Changes}_{\text{Year=1}} = \text{Scenario Changes}_{\text{Year=1}} + \text{Realign In}_{\text{Year=1}} - \tfrac{1}{2}\ \text{Realign Out}_{\text{Year=1}}$$

$$\text{BRAC Changes}_{\text{Year=n}} = \Sigma_{1,n}\ (\text{Scenario Changes}) + \Sigma_{1,n}\ (\text{Realign In}) - \Sigma_{1,n-1}\ (\text{Realign Out}) - \tfrac{1}{2}\ \text{Realign Out}_{\text{Year=n}}$$

$$\text{BRAC Changes}_{\text{Year=Beyond}} = \Sigma\ (\text{Scenario Changes}) + \Sigma\ (\text{Realign In}) - \Sigma\ (\text{Realign Out})$$

$$\%\ \text{BRAC Change}_{\text{Year=n}} = \frac{\text{Starting Population} + \Sigma_{1,n}\ (\text{FS Changes}) + \text{BRAC Changes}_{\text{Year=n}}}{\text{Starting Population} + \Sigma_{1,n}\ (\text{FS Changes})}$$

$$\text{Revised BOS Cost}_{\text{Year=n}} = \text{Actual BOS Cost}_{\text{Year=n}} \times (\%\text{BRAC Change}_{\text{Year=n}})^{\text{BOS Index}}$$

$$\text{Net BOS Cost}_{\text{Year=n}} = \text{Revised BOS Cost}_{\text{Year=n}} - \text{Actual BOS Cost}_{\text{Year=n}}$$

JPAT Proposed 2005 COBRA BOS Adjustment Algorithm:
Much of the BOS adjustment discussion originated from GAO reports criticizing the military Services for not adequately maintaining enough fixed BOS costs for significantly downsized installations. The COBRA JPAT determined that a certain level of BOS expenditures are fixed or should be increased or decreased in step functions rather than on a linear basis. Modeling a

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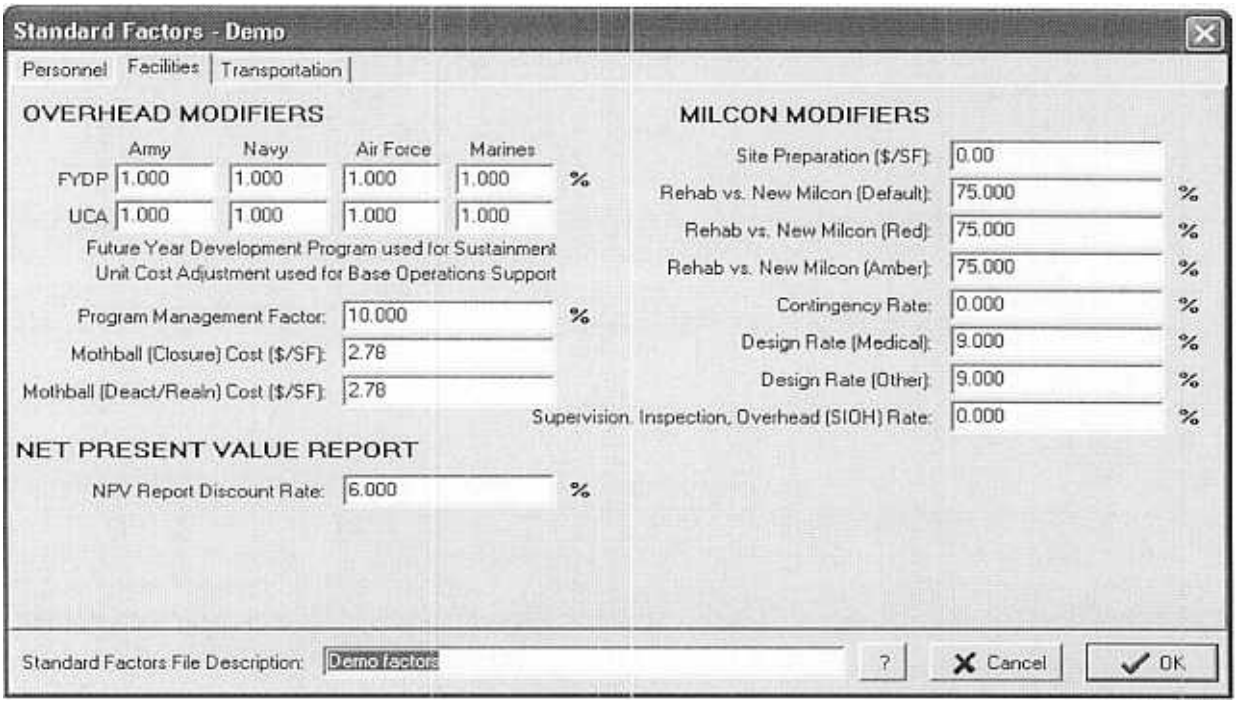
series of step functions is extremely difficult and would be excessively data intensive. After much deliberation about modeling BOS, a linear formula was determined to be the most effective method of fluctuating BOS expenditures in a "macro model" such as COBRA. The following formula was proposed and approved by the JPAT.

$$\text{Revised BOS} = (\text{Starting BOS}) + \left(\frac{\text{Starting BOS}}{\text{Population}}\right)\left(1 - \frac{1}{1 + \frac{\text{Population}}{\quad}}\right)(1$$

This new algorithm includes a fixed cost component to non-payroll BOS and a linear relationship between non-payroll BOS costs and base population changes. An important component of the equation is the UCA factor that allows the calculation of the percent of BOS costs that change as the populations are adjusted. Since the primary objective of COBRA analysis is to determine cost changes, this algorithm performs the intended purpose.

The Unit Cost Adjustment (UCA) factor will be Service specific/unique in order to capture the difference in funding installation support based on the mission. UCA factors are developed from a bivariate regression equation. This regression data set is the average of FY01-FY03 BOS non-payroll dollars by installation and installation population to result in a Service specific UCA. (Th) ?

The COBRA model was reprogrammed to include this updated BOS estimating algoritim. Each Service can input a Service unique UCA factor and only one factor.



Army UCA Development

The Army developed a service UCA as follows:

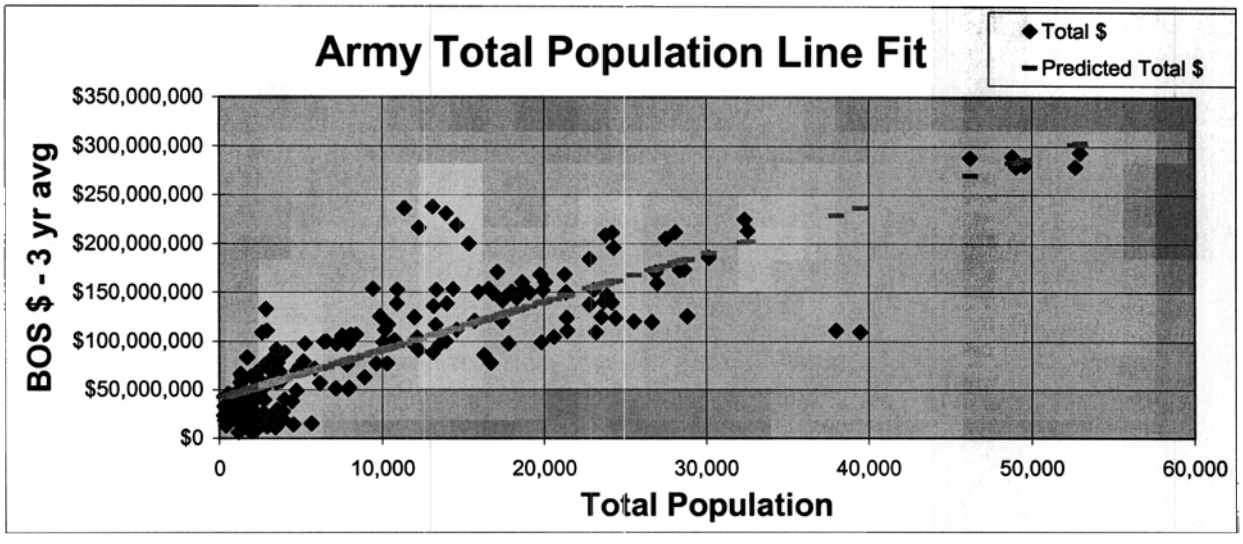
$$Y_r = Y_c + \left(\frac{Y_c}{TP_c}\right)\left(1 - \frac{1}{1 + \frac{TP_c}{8378.72}}\right)($$

Y= Revised Base Operations Cost
Yc = Current (Starting) Base Operations Cost
TPc= Current (Starting) Installation Population
UCA= Unit Cost Adjustment Factor (y intercept / x variable)
Estimates portion of Unit Cost that is Variable = 8378.72
TPr= Revised Installation Population

A summary of the data set and the regression analysis results from major Army installations is provided in the following tables:

	BOS$	Population	Unit Cost
Avg	$96,328,884	11,117	$16,441
Min	$6,181,833	304	$2,740
Max	$293,601,875	52,980	$104,375

R Square	**0.7121**
y Intercept	41,398,622
x Variable	4,941
UCA	8,379



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Air Force UCA Development

Air Force UCA development began with BOS expenditure data provided by SAF/FMOO which included FY01-03 BOS non-payroll expenditures for each installation. Population data was provided by AF/DPMP which was the FY04 baseline from the FY03 Unit Manpower Document (UMD). Expenditures for military payroll, civilian payroll, the war in Iraq, Depot Purchased Equipment Maintenance (DPEM), environmental restoration, and Sustainment, Restoration, and Modernization (SRM) were not included. The data set included the following non-pay program elements in order to account for BOS in a similar to the other Services:

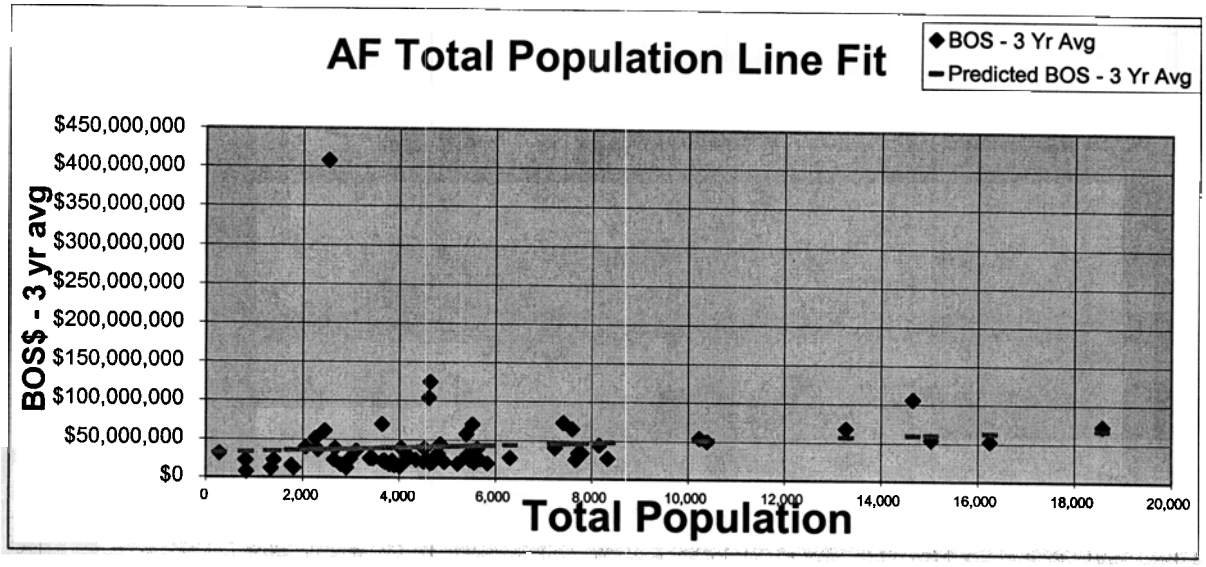
- Base Communications (***95 PEs)
- Audiovisual (***90 PEs)
- Child Development Centers (***19 PEs)
- Family Centers (***20 PEs)
- Environmental Compliance (***56 PEs)
- Enviro. Pollution Prevention (***54 PEs)
- Enviro. Conservation (***53 PEs)
- Real Property Services (***79 PEs)
- Base Operating Support (***96 PEs)

Air Force data variation is so great that a strong correlation between BOS expenditures and base population does not exist, as was demonstrated by the Army. BOS expeditures did not provide a strong statistical relationship with installation population largely due in part to differences in mission, MAJCOM, and operational concepts that are found across the Air Force bases (ICBM mission, Space mission, Bomber mission, Fighter Mission, Training Mission, Depot/Lab/Test Center, Rome Research Center, Brooks City-base, Bolling support of national capital region, Peterson space support in CO, Arnold and Vance contracted operations).

A summary of the data set and the regression analysis results from major Air Force installations is provided in the following tables. Note the low correlation value with $R^2 = .02$ and the calculataed UCA value of 16,888.18.

	BOSS	Population	Unit Cost
Avg	$41,852,447	5,278	$12,174
Min	$7,305,602	276	$3,209
Max	$407,707,650	18,575	$161,725

R Square	**0.0760**
y Intercept	19,484,540
x Variable	3,475
UCA	5,607



Other Regression Scenarios:

From a statistical perspective, the correlation would be considered extremely low at R^2=.0760. Due to the low correlation, some of the statistical outliers were excluded from the data set and the regression analysis was reaccomplished. Exclusions were bases that were significant outliers such as Bolling AFB. Other exlusions became apparent such as Peterson AFB for abnormally high BOS expenditures, Arnold and Vance AFBs as contract operations with small populations, and others for a high cost per capita. As a result, the regression scenarios show that the correlation increased significantly. Several other data sets were regressed to determine mission relationships and command relationships for BOS expenditures and population (see table below).

Regression Description	R Square	Y Intercept	X Variable	UCA
All AF Data Points	0.0760	19,484,540	3,475	5,607
All - Less Bolling AFB	**0.3892**	**12,286,956**	**4,052**	**3,032**
Major AF Intallations	0.0182	31,886,746	1,888	16,888
Selected AF Installations	0.5348	11,140,826	3,776	2,950
Army - All Data Points	0.7122	41,398,623	4,941	8,379
Combined Army - AF	0.6440	29,577,200	5,396	5,481
ACC	0.7829	-459,552	4,581	-100
AETC	0.7110	9,525,646	4,247	2,243
AFMC	0.4032	34,165,350	2,334	14,637
AFSPC	0.3175	-12,543,031	19,524	-642
AMC	0.4984	1,835,517	5,697	322
PACAF	0.3368	18,697,490	2,826	6,617

Regression Description	R Square	Y Intercept	X Variable	UCA
Depots	0.8325	-37,811,051	5,868	-6,444
Test/Lab/Product Center	0.7176	19,033,406	5,436	3,501
Fighter Aircraft	0.9292	-4,268,787	5,474	-780
Large Aircraft	0.3198	6,493,908	3,980	1,632
Contract Installations	0.7849	4,665,314	21,398	218

Several data scenarios yield a significantly improved correlation but not a reasonable UCA for COBRA BOS estimating purposes. Several scenarios provide slopes (negative y intercept) that will estimate BOS expenditures at $0 before the base is closed. Other scenarios yield excessively high or low UCAs which are either too aggressive or flat for estimating changes in BOS expenditures.

The data set including all AF data points excluding Bolling AFB is recommended for devcloping an AF UCA. This data set results in a UCA that will estimate changes in BOS costs in a reasonable manner according to changes in population at each installation (see attachment 1). Despite the less than optimal correlation factor, this methodology is recommended as a conservative UCA as it will not overstate projected BOS savings as base populations are reduced, it will not result in any out-of-scope estimating, nor will it overstate cost increases as base populations are increased, and it yields a positive y intercept.

Though not a perfect solution, the proposed AF data sample and methodology is a significant improvement over the 1995 methodology. The 1995 COBRA model employed a curvilinear equation that was more likely to over estimate the savings from reducing populations at installations. This proposed method recognizes the fixed portion of Base Operating Support expenses and also adequately accounts variations in cost due to increases/decreases in population and provides a reasonable estimate of changes to BOS.

AFSAA Concerns with Low R Square:

Based on a COBRA information briefing received, AFSAA felt the BOS approach they developed for AF/IL would improve COBRA BOS estimating. COBRA estimates changes in BOS based on total Air Force population; AFSAA proposed using two additional independent variables, plant replacement value and BOS contractor manpower equivalents. Their approach clearly shows a much higher correlation than population alone. AFSAA presented this method to the Air Force, Army and Navy COBRA JPAT members. All agreed that adding variables would inevitably improve correlation but they pointed out two problems: contractor manpower equivalent data is not certifiable and higher correlation does not necessarily imply a more accurate estimating relationship. JPAT members had examined several different algorithms, including multivariate, but had not found a basis for concluding that other methods would lead to greater confidence. The Army, Navy, and Marine Corps population data all correlate well with BOS cost. While the group recognizes that Air Force data is less uniform it was decided that, within the relevant range of the model, it would be sufficiently accurate and did not justify altering the COBRA model.

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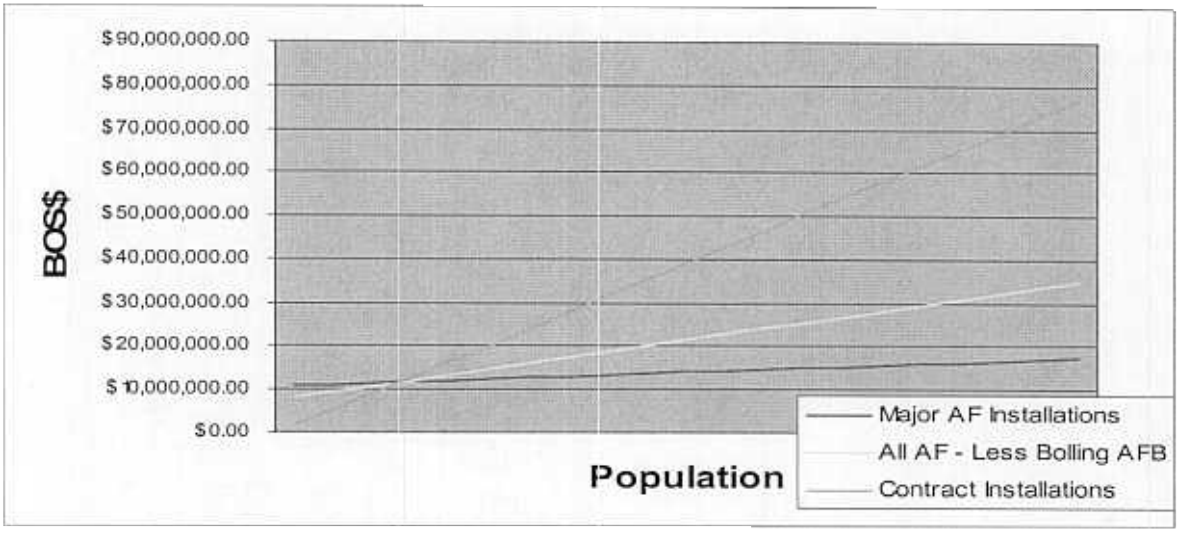
ATTACHMENT 1 - PROJECTED BOS CHANGES BASED ON UCA

	Columbus AFB, MS		
Population	BOS$	BOS$	BOS$
1,342	$11,683,607.43	$11,683,607.43	$11,683,607.43
UCA	16,888	3,032	218
-	$10,823,527.98	$8,099,014.60	$1,632,709.24
500	$11,143,974.87	$9,434,555.89	$5,377,455.21
1,000	$11,464,421.76	$10,770,097.19	$9,122,201.19
1,500	$11,784,868.65	$12,105,638.48	$12,866,947.16
2,000	$12,105,315.53	$13,441,179.77	$16,611,693.13
2,500	$12,425,762.42	$14,776,721.06	$20,356,439.10
3,000	$12,746,209.31	$16,112,262.35	$24,101,185.07
3,500	$13,066,656.20	$17,447,803.64	$27,845,931.04
4,000	$13,387,103.08	$18,783,344.94	$31,590,677.01
4,500	$13,707,549.97	$20,118,886.23	$35,335,422.98
5,000	$14,027,996.86	$21,454,427.52	$39,080,168.95
5,500	$14,348,443.75	$22,789,968.81	$42,824,914.92
6,000	$14,668,890.64	$24,125,510.10	$46,569,660.90
6,500	$14,989,337.52	$25,461,051.40	$50,314,406.87
7,000	$15,309,784.41	$26,796,592.69	$54,059,152.84
7,500	$15,630,231.30	$28,132,133.98	$57,803,898.81
8,000	$15,950,678.19	$29,467,675.27	$61,548,644.78
8,500	$16,271,125.07	$30,803,216.56	$65,293,390.75
9,000	$16,591,571.96	$32,138,757.85	$69,038,136.72
9,500	$16,912,018.85	$33,474,299.15	$72,782,882.69
10,000	$17,232,465.74	$34,809,840.44	$76,527,628.66



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ATTACHMENT 1 - PROJECTED BOS CHANGES BASED ON UCA

	Tinker AFB, OK		
Population	**BOS$**	**BOS$**	**BOS$**
18,575	**$73,035,273.46**	**$73,035,273.46**	**$73,035,273.46**
UCA	**16,888**	**3,032**	**218**
-	**$34,780,658.63**	**$10,248,984.95**	**$847,213.84**
500	$35,810,392.54	$11,939,060.01	$2,790,364.83
1,000	$36,840,126.45	$13,629,135.07	$4,733,515.83
1,500	$37,869,860.36	$15,319,210.13	$6,676,666.83
2,000	$38,899,594.28	$17,009,285.19	$8,619,817.83
15,000	$65,672,675.99	$60,951,236.77	$59,141,743.81
15,500	$66,702,409.90	$62,641,311.83	$61,084,894.81
16,000	$67,732,143.81	$64,331,386.89	$63,028,045.81
16,500	$68,761,877.72	$66,021,461.95	$64,971,196.81
17,000	$69,791,611.63	$67,711,537.01	$66,914,347.81
17,500	$70,821,345.54	$69,401,612.07	$68,857,498.81
18,000	$71,851,079.46	$71,091,687.14	$70,800,649.81
18,500	$72,880,813.37	$72,781,762.20	$72,743,800.81
19,000	$73,910,547.28	$74,471,837.26	$74,686,951.80
19,500	$74,940,281.19	$76,161,912.32	$76,630,102.80
20,000	$75,970,015.10	$77,851,987.38	$78,573,253.80
20,500	$76,999,749.02	$79,542,062.44	$80,516,404.80
24,500	$85,237,620.31	$93,062,662.93	$96,061,612.80
25,000	**$86,267,354.22**	**$94,752,737.99**	**$98,004,763.80**