A COMPARISON OF THE STANDARD BASE SUPPLY SYSTEM AND THE DISTRIBUTION AND REPAIR IN VARIABLE ENVIRONMENTS MODELS IN DETERMINING A DEPOT WORKING LEVEL

THESIS

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Joseph M. Ferris

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Abstract

The Air Force has adopted a philosophy of logistics operations directed toward improving the products, costs, and responsiveness of the Air Force's reparable pipeline. The philosophy was termed Lean Logistics. This research addressed one problem created through the implementation of Lean Logistics. The problem was determining a depot Working Level. The Air Force Materiel Command needed to determine an appropriate method to use when determining the depot Working Level. To help determine the appropriate method, this research compared the Standard Base Supply System (SBSS) and the Distribution and Repair In Variable Environments (DRIVE) model. Both models were utilized in two different comparisons to set the depot Working Level for all B-1B avionics line replaceable units within similar repair budget. In the first comparison, the SBSS determined the repair budget and DRIVE was forced to perform within the SBSS budget. In the second comparison, DRIVE determined a leaner budget and the SBSS was forced to perform within the lean budget. The models' performances were then assessed using Dyna-METRIC to estimate system-wide aircraft availability. DRIVE performed better than the SBSS in both comparisons. The research concluded that DRIVE was more appropriate than the SBSS for setting the depot Working Level.

A COMPARISON OF THE STANDARD BASE SUPPLY SYSTEM AND THE DISTRIBUTION AND REPAIR IN VARIABLE ENVIRONMENTS MODELS IN DETERMINING A DEPOT WORKING LEVEL

I. Introduction

Chapter Overview

The Air Force has adopted a philosophy of logistics operations directed toward improving the products, costs, and responsiveness of the Air Force's reparable pipeline. The philosophy is termed Lean Logistics (LL). This research addresses one problem created through the implementation of LL. The problem is determining a depot Working Level (WL). The purpose of this chapter is to provide the background information needed to comprehend the importance and relevance of this research.

General Issue

Air Force Materiel Command (AFMC) proposed LL in response to budget cuts and force reductions in order to force the pipeline to be more efficient and cost effective. The Air Force uses the term LL to refer to its adaptation of lean production -- the innovative logistics practices used in commercial logistics. It proposes utilizing fast transportation, consolidating large quantities of supplies at intermediate locations, streamlining repair processes at depots, and involving customers in the process of meeting their own needs (Lynch, 1994, 1).

Many traditional logistics processes within the Air Force are changing due to the implementation of LL. The repair cycle process is one example. The repair cycle is the process that begins when parts are removed from aircraft and ends after they have been repaired and reinstalled on aircraft. The LL repair cycle proposes to be less costly and more responsive than the traditional Air Force repair cycle.

Traditional Repair Cycle. When parts are removed from aircraft and cannot be repaired on the flightline, they are delivered to the component repair shop. If the repair shop determines the parts to be unrepairable locally, or *not repairable this station (NRTS)*, the parts are processed through base supply and transportation and shipped to the depot for repair. Upon receiving the parts, the depot processes them into depot supply where they remain until a certain quantity is reached. This quantity is known as a batch and the repair strategy is known as batch repair. After the parts are repaired, they are transferred to the serviceable depot supply to await transportation back to the base. The entire process averages about 54 days (Ray and others, 1993, 3-4). See graphical depiction of the traditional reparable depot pipeline in Figure 1.1 below.

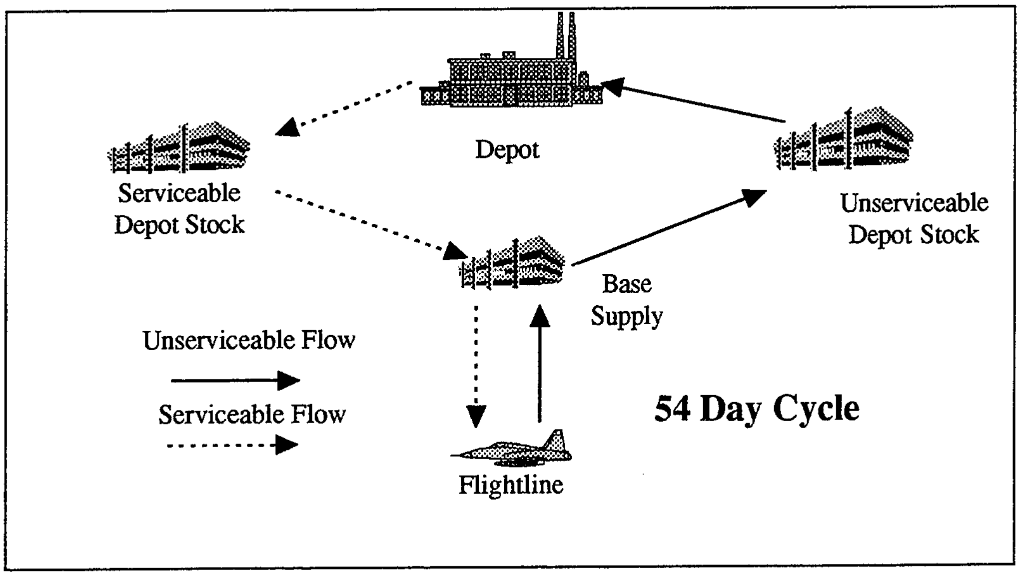

Figure 1.1. Traditional Reparable Depot Pipeline.

Lean Logistics Repair Cycle. The LL process proposes three significant changes to the repair cycle. The first is the implementation of fast transportation. Although more costly than traditional surface transportation modes, air transportation would decrease inventory costs because fewer demands occur during shorter lengths of time than in longer lengths of time. Knowing that inventory is held, in part, to satisfy demands as they occur, one can see that as more demands occur during a specific length of time, more inventory is required to be held to satisfy the demand. Hence, if the transit time is shortened, the inventory will decrease. Inventory costs are calculated by multiplying the annual holding cost percentage by the value of the inventory and by the length of time the inventory is held. Therefore, the longer an item is held, the more inventory cost is created. Because a base can obtain a part from the depot more quickly, it can afford to carry less stock, thus reducing inventory cost (Hill, 1994, 23).

The second proposed change is the process by which the depot repairs parts. Under LL, items are repaired as they arrive at the depot instead of awaiting the traditional batch repair. Traditionally, items are held in depot supply until a sufficient quantity (batch repair quantity) is reached to perform batch repair (Hill, 1994, 15). The LL repair process supports the statement “If you see it, repair it!” (Cohen, 1994, 6).

The third proposed change to the repair cycle is the establishment of a Consolidated Serviceable Inventory (CSI). A CSI is a centralized inventory of serviceable reparables maintained to buffer against demand uncertainties on the depot. It is controlled by a major command in support of bases.

The LL repair cycle would by-pass base level processing at supply after parts are removed from an aircraft. If parts are unable to be repaired on the flightline or in the base repair shop, they would be shipped to the depot via air transportation. They would then by-pass traditional depot batch processing and move directly into repair. Repaired items would move to a CSI until they were requisitioned from a base. When reparables are requisitioned, they would be shipped via air transportation (within 1-2 days in CONUS) to the base. Some have speculated that the entire LL process would average only nine days (Ray and others, 3-4, 1993). Bases would hold only enough safety stock to prevent short term delays while parts are in transit (Cohen, 1994, 5). Refer to Figure 1.3 for a visual depiction of the LL reparable system.

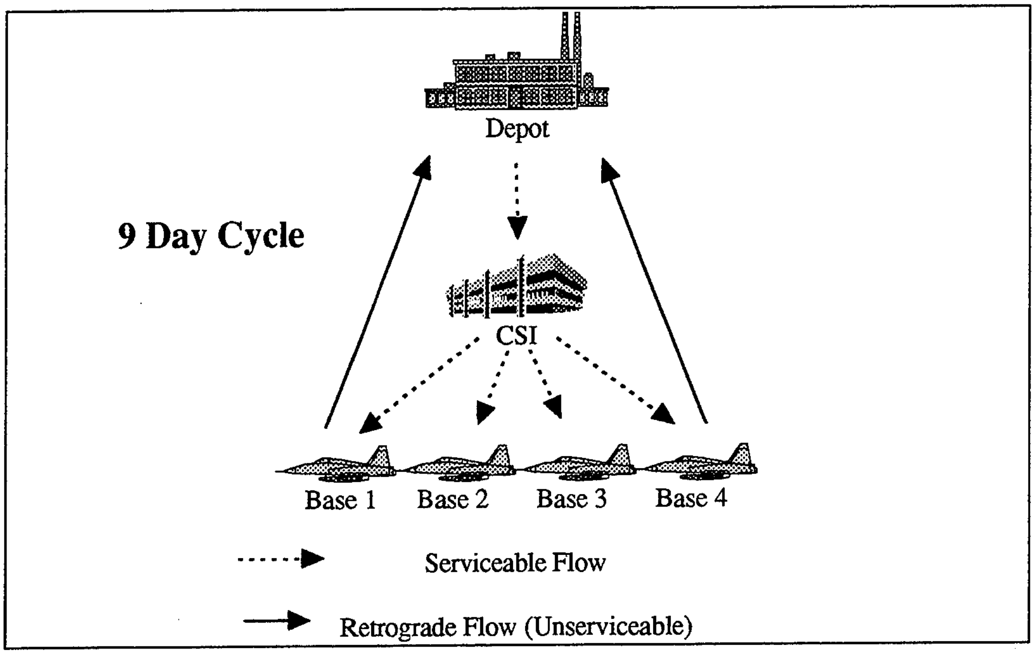

Figure 1.2. LL Reparable Depot Pipeline.

Consolidated Serviceable Inventory

The LL philosophy proposes the consolidation of serviceable assets at a central location or *"buffer"* warehouse. This *buffer* inventory has been called different names, most recently, an Intermediate Supply Point, a Centralized Stockage Facility, or a Consolidated Serviceable Inventory (CSI). The term CSI will be used throughout this research.

The purpose of the CSI is to buffer against depot demand uncertainties to support the bases. For example, if there is only one serviceable asset in a reparable system, the asset should be held at the place that could provide equal support to all bases demanding that asset. It would make sense to hold the asset at some central location so it could be transported to the first base demanding it. Because the asset would be held at a location (CSI) other than the base, transit time between the CSI and the base would have to be short. Transportation costs would increase because of the need for express air shipment.

Recognizing the increased requirement for air shipment, it was proposed by the Defense Logistics Agency (DLA), as an alternative, that some of the CSIs be co-located with the hubs of major commercial air transportation companies such as Federal Express (FedEX). Items would be stored in a government-owned warehouse contracted to FedEX. It would be located in Memphis, Tennessee and operated by FedEX. Upon request, FedEX would express deliver required assets to the bases (Long and others, 1, 1995). No extra time or cost would be involved moving a part from a storage location to the hub for shipment because the part would already be there. Long's report entitled "Analysis of Location Options for LL Consolidated Serviceable Inventories," compared the cost of three different CSI location alternatives. Data from a previous study, which demonstrated LL concepts with the C-5 and CSI, were used. The three location alternatives were Dover AFB, Memphis, and at the source of repair (SOR). The compared costs were inventory cost, transportation cost, and warehousing/ handling costs. The results showed a significant savings in locating the CSI at the source of repair as opposed to the other alternatives. The Air Force is therefore focusing its efforts on locating the CSI at the SOR (depot) as opposed to the other locations.

Depot Working Level

The CSI is one segment of the depot WL. The depot WL is the number of assets required for the "depot process" segment of the repair cycle pipeline to work properly. The WL is used to determine which items must be inducted into repair (Patnode, slide, 1995).

The WL is composed of two segments. The first segment is the repair process segment, sometimes called work-in-process (WIP). It contains all of the unserviceable reparables in repair. The second segment is the CSI. It contains all of the serviceable assets awaiting distribution to the bases. The *actual* WL is determined by adding the number of assets in repair and the number of assets in the CSI at a given time. See Figure 1.3 below.

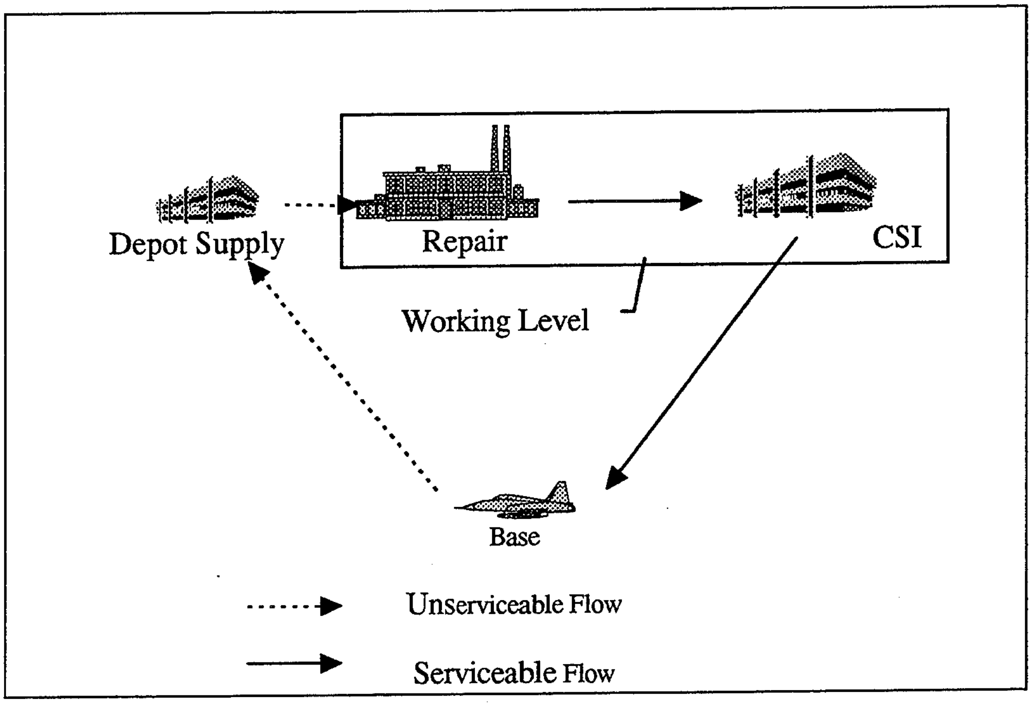

Figure 1.3. Working Level.

Determining the *optimal* WL is important to managing the repair pipeline. If the WL is set too high, more items than needed would be inducted into repair and then held in the CSI. This will increase repair costs and inventory holding costs. If the WL is set too low, the system will be unable to support the bases with sufficient serviceable assets. Once the *optimal* WL is determined, assets would be inducted into repair as the *actual* WL falls below the *optimal* WL.

Stock Leveling Models

As the Air Force adopts LL concepts, supporting procedures for these concepts must be adapted to the new LL environment. Unfortunately, this is not always accomplished in the Air Force. As is often done when introducing new technologies, new concepts are integrated into old operating environments without updating the underlying support systems. This is similar to Hammer and Champy's "paving cow paths" analogy of overlaying obsolete processes with new technology (Hammer and Champy, 1993, 48). The underlying support systems (such as SBSS) can determine the success or failure of the newly implemented concept and therefore, it is paramount the support system be designed to complement the new concepts. To ensure a smooth transition when implementing new concepts, we must design and implement support systems in parallel with the new concepts. This does not, however, rule out using existing support systems if their objectives and methodologies are compatible with the new concept.

To determine the WL, the Air Force can continue using a current system approach for setting inventory levels, such as the SBSS, or it can implement another system such as the Distribution and Repair in Variable Environments (DRIVE). The SBSS manages many items at a single base (Syzdek, 1989, 4). DRIVE, on the other hand, prioritizes repair and recommends the distribution of many items to many different locations to achieve the greatest aircraft availability.

The SBSS, in its stock leveling calculations, uses the Repair Cycle Demand Level model (RCDL). This model calculates overall stock levels and safety stock levels for reparable parts. *It attempts to fill the logistics pipelines as opposed to minimizing cost or units stocked* (Air Force Institute of Technology, 1990, 7-8). Its objective is to recommend sufficient stock to match the quantity of items in repair or in transit from repair. It also recommends additional safety stock to protect against stockouts. In other words, it recommends the quantity of stock needed to ensure against stockouts (Christensen and Ewan, 1985, 4).

The DRIVE model was designed with a systems approach as opposed to an item approach. It recommends allocation of reparables to many different locations as opposed to a single location. DRIVE takes into account projected flying hours, part failure rates, indentured items (items having other reparables as sub-components), repair capabilities at the bases and depots, and the number of serviceables at each location to determine reparable allocations. *The goals of DRIVE are to prioritize repair and to allocate items in such a way as to obtain the greatest weapon system availability rate across the command* (Lindenbach, 1992, 2).

Statement of the Problem

With the implementation of LL and its new concepts comes the need for proper support of these concepts. The Air Force Materiel Command must determine an appropriate method to use when determining the depot Working Level. To help determine the appropriate method, this research will compare two models with level-setting capability to identify which model provides better support in terms of repair cost and system-wide performance.

Research Question

The research question addressed in this thesis is:

Which model offers the greatest aircraft availability percentage at similar repair cost when determining the depot Working Level; the SBSS model or the DRIVE model?"

Conclusion

The Air Force faces new challenges as it implements the philosophy of Lean Logistics. The entire reparable system will change and cause management to make many new decisions. This chapter provided background information on LL, a Consolidated Serviceable Inventory, the depot Working Level, descriptions of the SBSS's RCDL model and the DRIVE model, and the problem addressed by this research. Because LL is a relatively new concept, overviews of LL and a CSI were provided to give the reader a better understanding of the concept. The descriptions of the models were provided to state their objectives. The next chapter will review previous research performed on depot Working Levels.

II. Literature Review

Chapter Overview

This chapter provides a review of literature on setting stock levels for a CSI. Due to the relatively new concept of incorporating buffer stocks into the Air Force reparable supply system, there were a limited number of publications on this subject. Most of the literature reviewed were reports of studies performed to set stock levels for different tests performed by the Air Force on Lean Logistics concepts. The studies discussed setting levels for a CSI. The levels set in the studies were, in actuality, the depot WL.

CSI Level Setting

The Air Force Materiel Command's Warner Robins Air Logistics Center (WR-ALC) performed a shop demonstration to test LL concepts. The shop demonstration examined repair induction, prioritization and distribution using DRIVE, fast transportation, more stringent materiel movement standards, and computer simulation of shop processes. The data used was drawn from 29 Radar Navigation line replaceable units (LRU) and 45 shop repairable units (SRU) (HQ USAF, 1995, 24).

Of specific interest to this thesis was the method the ALC chose to establish lean stock levels at the CSI. Inventory Levels for the WR-ALC Lean Logistics Shop Test by Reynolds and others, 1994, reported the methodology and findings of the study the ALC performed to compute these stock levels (Reynolds and others, 1994, 1). The objective of the study was to determine appropriate stock levels to be used in the Radar-Navigation Shop Test. They used the SBSS RCDL formula to compute stock levels for both the bases and the CSI. The CSI level was computed in two phases.

First, the RCDL model was employed to compute the amount of stock needed to support worldwide demand for the test items. Second, the expected demand was computed for the number of SRUs consumed by the depot in repair of their parent LRUs (Reynolds and others, 1994, 7). Although not stated in the report, it was assumed the results of the two phases of computations were summed together to provide the CSI level.

Twelve of the CSI levels had a value of zero. Reynolds and others recommended the inventory manager (IM) consider placing one unit in the CSI for these items to ensure better customer support. They also recommended this report be used as a baseline for initiating the WR-ALC LL Shop Test.

Similar studies were performed at the ALCs in Oklahoma City and Sacramento (HQ USAF/LGM-2, 1995, Annex G).

Another study performed by Air Force Logistics Management Agency (AFLMA) was the study to determine CSI lean stock levels for C-5 reparables. In the report entitled "AMC Lean Stock Levels," Reynolds and others described the stock leveling methods for different LL supply infrastructures (Reynolds and others, 1994, 1). The objectives of the study were to develop and test various stockage alternatives to use in the Air Mobility Command (AMC) LL Test.

As with the previous ALC studies, the SBSS methodology was used in this study to set levels. The major difference between the studies was the use of alternative stockage policies in the AMC test. AFLMA used three separate variations of the SBSS model. They computed levels for the CSI using the standard model, the standard model eliminating a safety level calculation, and the standard model using only half the safety level (Reynolds and others, 1994, 6).

The results were of no surprise. The standard model computed higher levels than the half-safety level model and the half-safety level model computed higher levels than the model without a safety level. Comparable results were shown to be evident in fill rate computations (Reynolds and others, 1994, 7). The lower number of stocked items produced lower fill rates. The item approach was used in this study as opposed to the systems approach. The performance indicator used was item fill rate. The fill rate provides information on how well an item performed in one test as compared to the other tests. Had the system approach been used, aircraft availability could have been the performance measure used for comparisons. Using aircraft availability as the measure of performance could have assessed the overall logistics system as it was affected by the different stockage alternatives.

Types of Buffer Stock

Ronald W. Clarke, in his white paper entitled "Analysis of Lean Logistics Buffer Stock Levels," described three different types of buffer stock for possible use in a peacetime LL environment (Clarke, 1993, 1). The three types were base level readiness buffer, serviceable pipeline buffer, and reparable depot maintenance buffer. Each buffer would be located at critical points within the reparable cycle. One would be located at base level to support flightline activities. It would buffer against the variance of shipping time from the serviceable pipeline buffer to the base level buffer and against the variance in base repair time. The serviceable pipeline buffer would be located near the depot and support base supply functions. It would buffer against the variance of depot repair time and depot to buffer shipping time. The last buffer would be located at the depot to support the depot maintenance activity. It would buffer against the variation in shipping times of unserviceable assets from the bases to the depot.

In this study, Clarke also computed stock levels for the buffers using DRIVE. He used a three step approach. First, DRIVE was set up to compute the stock levels for the base level buffers using three days as the order and ship time and a production horizon (base repair pipeline) of one day. The "on-hand stock" was set to zero to represent no assets currently at each base. To set the serviceable buffer, DRIVE was set up using three days again as the order and ship time and six days as the production horizon. The quantities recommended for the base level buffers from the first DRIVE run were input as "on-hand stock." Therefore, the amount recommended above the base buffers became the amount located in the serviceable buffer. The last step was to compute the depot maintenance buffer. DRIVE was set up using three days as the order and ship time, ten days as the production horizon (included four days retrograde), and the "on/hand stock" was set at the levels recommended in the first step. The quantity recommended in the second step as the serviceable buffer was input as "on/hand stock" at the depot. The depot priority repair number represents the number of items needed in the depot reparable buffer (Clarke, 1993, 8).

Clarke recommended further analysis be done on stock leveling by DRIVE. He also noted his iterative method as an area for improvement.

Conclusion

This chapter provided a review of previous work performed in the area of Central Serviceable Inventory level setting. It demonstrated how the two models of interest to this thesis had recently been applied. The next chapter will provide the method used to evaluate the performance of the SBSS and DRIVE stock leveling systems.

III. Methodology

Chapter Overview

This chapter addresses the methodology used to address the specific research question. It provides a description of the data, an outline of the research approach, and the expected outcome of the research.

Data Description

The data used in this study was obtained from the B-1B database as maintained by the Oklahoma City Air Logistics Center (OC-ALC). The data file was copied from the database on December 19, 1994 and it included the entire population of B-1B reparable avionics items. However, only the Line Replaceable Units (LRU) were used in this study. The Shop Replaceable Units (SRU) were removed from the DRIVE database to simplify this research.

The data file was created from a combination of the item data contained in Air Force standard systems and scenario data from Air Combat Command. Such data was used by DRIVE to establish the workload at the OC-ALC depot and the Interim Contractor (ICS) repair shops. DRIVE also uses this data to allocate serviceable aircraft components from the depot to the applicable bases.

The bases represented by the data were Ellsworth AFB, South Dakota; Grand Forks AFB, North Dakota; Mountain Home AFB, Idaho (geographically separated unit - aircraft are physically at Ellsworth AFB but were assigned to the 366th Wing at Mountain Home AFB); Dyess AFB, Texas; Edwards AFB, California; McConnell AFB, Kansas; and an Air National Guard unit stationed at McConnell AFB.

Research Approach

To ensure both models utilize identical data, "Desktop DRIVE" performed both the DRIVE calculations and some of the basic SBSS calculations. DRIVE calculated the repair cycle quantity, order and ship time quantity, and the base repair quantity for the SBSS model. A spreadsheet was used to calculate the total repair cycle levels using these quantities.

The next step was to compute stock levels using the item approach. This was accomplished using a modification of the SBSS model for reparables at each base and at the depot. The SBSS used the RCDL model to calculate stock quantities. A description of the RCDL model is provided in APPENDIX B. As stated in Chapter One, the objective of the RCDL model was to fill the reparable pipeline segments with sufficient quantities of items to account for the demand created during the time assets are in each segment of the pipeline (Christensen and Ewan, 1985, 4). The RCDL model was used to create a CSI. The base buffer computation accounted for the demand created during the base repair cycle, the requisition time from the CSI, and a safety level. It did not account for retrograde time and depot repair time. The formula used for the base pipeline segment was:

$$BaseLevel = BRCQ + OSTQ + SLQ \tag{1}$$

Where:

BRCQ = the quantity demanded during the base repair cycle
OSTQ = the quantity demanded during the requisition time
SLQ = the added safety level ($\sqrt{3 * BRCQ + OSTQ}$)

The depot WL was computed using a similar adaptation of the RCDL formula. It accounted for the demand created during the depot repair cycle, the demand created during the depot to the CSI transit time, and an added safety level. The modified formula used for the depot segment was:

$$WL = DRCQ + DTCQ + SLQ \tag{2}$$

Where:

DRCQ = the quantity demanded during the depot repair cycle
DTCQ = the quantity demanded during the depot to CSI transit time
SLQ = the added safety level ($\sqrt{3 * DRCQ + DTCQ}$)

From these computations, the cost of repair was calculated using the following formula:

$$Repair\ Cost = Unit\ Repair\ Cost * Number\ of\ Units\ in\ Pipeline \tag{3}$$

The repair cost for each item was summed to obtain the total repair cost for all reparables. The repair cost was utilized as the comparison baseline as opposed to purchasing cost because it reflected the cost of the system in operation as opposed to the cost of the system at startup. DRIVE was manipulated until it produced a similar repair cost to the SBSS repair cost. This procedure provided a comparison of the two models' performance at a similar repair cost.

The next step was to compute stock levels using the systems approach. Desktop DRIVE was used for this step. Because DRIVE did not at the time consider stock held at a CSI when determining reparable allocations, two different modeling approaches were utilized to compute the depot WL. First, the depot was treated as a pseudo-base. The depot was considered as an additional base having demand for items similar to those items demanded by the true bases. To do this, the depot was created as another base in the scenario file in the DRIVE model. The demand was assigned to the pseudo-base in the form of flying hours because flying hours determine demand for a given item in DRIVE. Based on a part's failure rate, as flying hours increase, so does the probability that a part will fail. As the probability of a part failing increases, so does the demand for that part. For example, suppose part A fails every two flying hours. Knowing that as a part fails it creates demand for repair, one can see that every two flying hours, demand will be created for repair of another part A. The depot can use this failure rate and flying hour information to forecast repair demands for parts.

The flying hours assigned to the pseudo-base were computed by summing the flying hours from all the bases during the planning horizon and multiplying the sum by the fraction of the planning horizon attributed to depot repair. This study used five days as the planning horizon to obtain the pipeline level during the order and ship time of five days. The depot repair cycle was three days. The ratio was thus three to five. In other words, the depot pipeline was three days long and these demands represented three days worth of order and ship time. The formula for the pseudo-base's assigned flying hours was:

$$DepotFlyingHours = \sum_{i=1}^{\infty} flyinghours * \frac{3}{5} \tag{4}$$

Where i is each individual base.

An iterative modeling approach was taken in the second alternative. A variation of the iterative method developed by Clarke was used in this DRIVE alternative (Clarke, 1993, 1). The difference between Clarke's method and the method utilized in this research was the absence of Clarke's third iteration. Clarke used the third iteration to establish a stock level for a depot maintenance buffer. The depot maintenance buffer was not considered in this research and therefore, the third iteration was unnecessary.

DRIVE recommended a quantity for each item and recommended where each item should have been distributed within the system. DRIVE was run using different stopping rules until it recommended an amount of item allocations where total repair cost was similar to the total repair cost of the SBSS computations. For example: If the SBSS recommended a certain number of reparables for the entire system having a repair cost of $300,000, then a comparison of the stock levels recommended by DRIVE would have been made at an investment close to $300,000.

A second comparison was performed to simulate a lean environment (relatively less money available for repair). DRIVE's stopping rule was set so it allocated fewer items to the pipeline. After calculating DRIVE's total repair cost, the SBSS's pipeline levels were then manipulated until it achieved a total repair cost similar to DRIVE's.

The final step was to determine which method would provide the greatest aircraft availability. To assess the performance of the two systems, Dyna-METRIC 4.6 was used. Dyna-METRIC assessed the capability of logistics support to aircraft (Issaacson and others, 1, 1988). Dyna-METRIC is an analytical model that predicts the effect a particular stockage level has on the ability of the bases to meet their flying goals -- aircraft availability. An individual aircraft availability percentage was determined by Dyna-METRIC for both the SBSS and the DRIVE stock level recommendations. Refer to Figure 3.1 for a graphical depiction of the methodology.

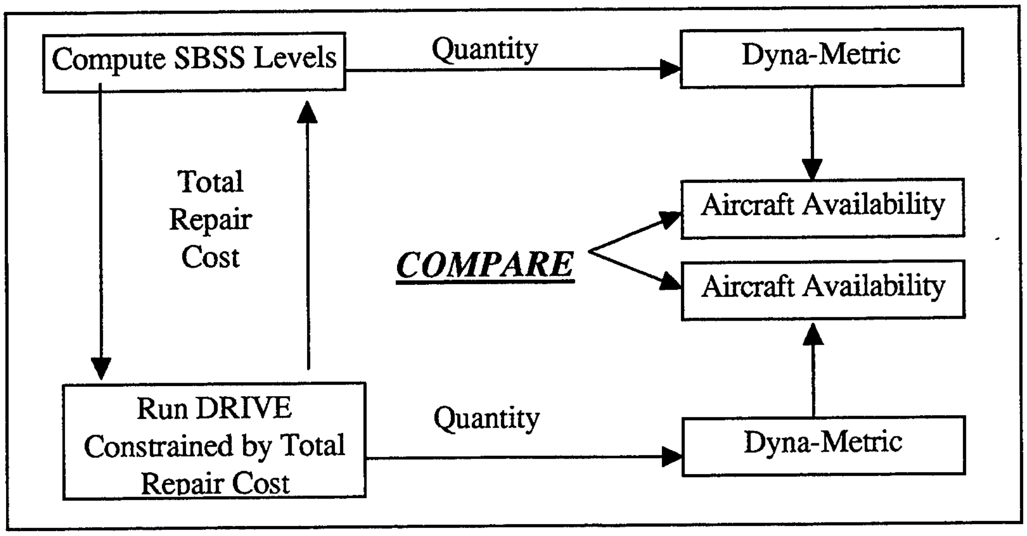

Figure 3.1 Methodology

Expected Results

The DRIVE model was expected to provide better aircraft availability performance at less cost than the SBSS model because it was designed to look at the entire system and not each individual base or location. It strives to achieve maximum aircraft availability goals through prioritizing distribution actions of reparables (Clarke and others, 1994, 1-1). It takes a systems approach to distribution and repair as opposed to an item approach.

The results of this study were provided to the Management Sciences Division of the Air Force Materiel Command.

Conclusion

This chapter provided a description of the data utilized in this research, an outline of the approach to the problem, and the expected outcome of the research. Chapter IV provides the analysis of the results obtained from the research approach.

IV. Results and Analysis

Chapter Overview

The purpose of this chapter is to report the research findings resulting from the test methodology described in chapter three. It will present the data preparation, the SBSS computations, the DRIVE computations, and the Dyna-METRIC assessment of the models.

Data Preparation

As explained in chapter three, the data was obtained from the Oklahoma City Air Logistics Center database. The shop replaceable unit (SRU) information contained in the data file was removed to simplify this research. Only the line replaceable unit (LRU) information was used in this study. The data file was created for DRIVE by combining information contained in the Air Force standard systems and Air Combat Command's scenario data. Some of the information contained in the standard systems included item demand rates, number of parts per aircraft, percentage of base repair, and repair costs. The scenario data contained information on PAA (primary assigned aircraft), flying hours, and the bases that maintained the aircraft. This data file was converted into DRIVE format and added to DRIVE's database.

Standard Base Supply System Calculations

DRIVE was used to calculate the expected demands during the repair cycle pipeline. The DRIVE output was then imported into a spreadsheet. The spreadsheet was used to calculate the daily demand rate from the repair cycle pipeline quantity for each

LRU, the depot repair cycle pipeline quantity, and the base repair cycle pipeline quantity. Using these pipeline quantities and the modified RCDL formula outlined in chapter three, safety levels for each base and a depot WL were calculated. The repair cost was calculated by multiplying each LRU quantity by its associated unit repair cost. The total repair cost was the sum of all LRU repair costs. The resulting number of assets and repair cost for each LRU at each base are presented in Appendix C. Refer to Table 4.1 for the total LRU levels for each base and the depot WL and the total repair cost for the system.

Table 4.1. SBSS Summary of Levels and Repair Cost.

Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total Assets	Repair Cost
30	121	151	37	25	62	455	$1,055,639

DRIVE Computations

Alternative A (Pseudo-Base). The first step in using the pseudo-base method was to create the CSI as an additional base in the DRIVE scenario data file. This was accomplished in the Scenario-Maintenance window in Desktop DRIVE. Scenario information from an existing base was copied and input into a newly assigned base identifying code. The only difference between the existing base and the pseudo-base was the assigned flying hours. As explained in chapter three, flying hours were assigned to the pseudo-base by summing the bases' flying hours (sum = 134.4 hours) and multiplying the sum by the fraction three-fifths (the depot demand per order and ship time demand). This provided the pseudo-base 80.6 flying hours for the planning period. The flying hours represented the demand on the depot during the planning horizon.

The next step was to run the DRIVE model. The order and ship time parameter was set to five days and the production horizon (base repair cycle) was set to three days.

The model was run with different stopping rules until a scenario was reached that resulted in a total repair cost similar to the SBSS method's total repair cost. The DRIVE base level output file was converted to spreadsheet format. The spreadsheet was used to calculate the total repair cost for the system. The resulting number of assets and repair cost for each LRU at each base are presented in Appendix C. The results of the DRIVE alternative A run for base levels and the total repair cost calculations are displayed in Table 4.2.

Table 4.2. DRIVE A Summary of Levels and Repair Cost.

Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total Assets	Repair Cost
60	182	145	63	49	227	726	$1,020,139

<u>Alternative B (Iterative Approach)</u>. The iterative approach to this DRIVE run was based on the research by Clarke. Clarke's method utilized three runs of DRIVE, where each subsequent run built upon the results of the previous run. The approach used in this research required only two runs of DRIVE. The first run set the base levels and the second run set the WL.

The first step in this approach was to set the model parameters equal to the order and ship time pipeline (base level buffer). The order and ship time was set to four days and the production horizon was set to the minimum of one day. Although the order and ship time is considered five days in this research, the first run of the model used only four days. Because DRIVE distributes all assets to the bases, it will effectively set the base level pipeline to five days (order and ship time plus the production horizon). The results of the first run provided base levels for each base. These base levels were manually input into the LRU-base window as on-hand serviceable inventory. The next step was to run the model again taking into account the assets on-hand at each base. The order and ship time parameter for this run was set to five days and the production horizon to three days. The DRIVE base level output from the second model run represented the amount of stock required over and above the amount on-hand at each base. This level represents the depot WL level. The DRIVE base level output file was then converted into a spreadsheet. The spreadsheet was used to calculate the total repair cost for the system. The resulting number of assets and repair cost for each LRU at each base are presented in Appendix C. The results from the base leveling run of DRIVE alternative B and the total repair cost calculations are displayed in Table 4.3.

Table 4.3. DRIVE B Summary of Levels and Repair Cost.

Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	TOTAL ASSETS	REPAIR COST
60	184	149	70	51	85	599	$932,956

Second Comparison Computations

Another approach used to compare DRIVE and SBSS, was to constrain the SBSS calculations to the repair cost achieved by DRIVE. The DRIVE B method was used in this comparison. To simulate levels in a lean environment, DRIVE was set up to calculate lower base levels and WLs. After the DRIVE run, the total repair cost was calculated. The SBSS pipeline levels were then multiplied by 0.85 so that its total repair cost was similar to that of the DRIVE run. The total repair cost and levels from DRIVE and the SBSS are displayed in Table 4.4. An interesting result appears in the WL column of the table. DRIVE recommended only six LRUs for the WL whereas the SBSS recommended 107. Because DRIVE recommends allocations to bases to maximize aircraft availability, the low number recommended for the WL and the relatively high numbers for the bases suggest a greater need for the bases to have more items than the CSI. This contradicts the philosophy of the CSI in which a system with fewer parts could perform better when utilizing a central inventory. Because the results of this test considered were based on only one set of data, one cannot generalize that a lean system would perform better without a CSI. This result should be investigated further by future research.

Table 4.4. Summary of Total System Assets and Repair Cost When Cost is Constrained By DRIVE

BASE ASSET LEVELS							SYSTEM TOTALS	
	Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total Assets	Repair Cost
SBSS	13	79	66	19	14	107	298	$667,000
DRIVE	54	181	143	63	46	6	493	$685,000

Model Performance Assessment

Dyna-METRIC 4.6 was used to assess the system-wide performance of the models. The first step in assessing the performance was to convert the spreadsheet files, containing LRU stock levels, to ASCII files. AFMC/XPS (Management Sciences Division) created a FORTRAN program to convert the ASCII files into the stock files required in Dyna-METRIC. AFMC/XPS also created a FORTRAN program to convert the DRIVE part and scenario files into Dyna-METRIC formats. Dyna-METRIC was run disallowing cannibalization to assess the three models' system performances in terms of aircraft availability. The performance results are reported in terms of aircraft availability across the command and at each base individually. The results of the first assessments are displayed in Table 4.5 and the second assessments in Table 4.6.

Table 4.5. Model Performance (Cost Constrained by SBSS).

Base	SBSS	DRIVE A	DRIVE B
Edwards	40%	55%	50%
Dyess	88%	92%	90%
Ellsworth	86%	92%	91%
Mt. Home	67%	75%	73%
McConnell	85%	90%	88%
System Aircraft Availability	84.0%	89.2%	87.8%

Table 4.6. Model Performance ("Lean Cost").

Base	SBSS	DRIVE B
Edwards	14%	36%
Dyess	74%	83%
Ellsworth	77%	84%
Mt. Home	47%	62%
McConnell	76%	83%
System Aircraft Availability	71.8%	80.5%

Discussion

As can be seen in Tables 4.5 and 4.6, the DRIVE models appear to have performed better than the SBSS in terms of aircraft availability for the entire system. In the first comparison, DRIVE A performed six percent better than did the SBSS model and DRIVE B performed almost five percent better. In the second comparison, DRIVE performed 12.1% better than SBSS.

The next step was to look at the cost of achieving this performance. Tables 4.7 and 4.8 display the total repair cost required by each model to achieve its associated performance. As can be seen in the table, although the DRIVE B model achieved only 3.8% better aircraft availability than did SBSS in the first comparison, it did so at a lower cost than did the other models. It achieved its availability percentage of 87.8, yet cost $122,683 less than SBSS. As can be seen in Table 4.8, DRIVE also achieved a higher level of performance in a lean environment than did SBSS at a similar repair cost.

Table 4.5. Model Cost and Performance (Cost Constrained by SBSS) Summary.

Model	Repair Cost	Aircraft Availability
SBSS	$1,055,639	84.0%
DRIVE A	$1,020,139	89.2%
DRIVE B	$932,956	87.8%

Table 4.6. Model Cost and Performance ("Lean Cost") Summary.

Model	Repair Cost	Aircraft Availability
SBSS	$667,000	71.8%
DRIVE B	$685,000	80.5%

Conclusion

This chapter reported the research findings through a presentation of the data preparation, the SBSS stock leveling computations, both DRIVE stock leveling computations, and the Dyna-METRIC assessment of the models. The discussion pointed out that the DRIVE model achieved better performance at a similar cost than the SBSS model in both normal and lean environments. The next chapter will present the conclusion and some recommendations for further research in this area.

V. Conclusions and Recommendations

Overview

This research undertook a comparison of the performance of the SBSS and DRIVE models in determining a depot Working Level. Chapter One provided background information important to understanding Lean Logistics, the depot Working Level, and CSI concepts. It also outlined the objective of this research. Chapter Two provided a review of the literature published on CSI stock leveling which served as a baseline for the extension to this thesis. Chapter Three outlined the methodology used to answer the research question. It provided a brief description of the models and their objectives and detailed the procedures utilized to compare the models' system-wide performances. Chapter Four presented the results from the test which determined an apparent insignificant difference in aircraft availability between the models and a more significant difference in the cost of achieving that percentage. This chapter will answer the research question and make recommendations for further research in this area of interest.

Research Question Revisited

The question addressed by this research was "which model offers the greatest aircraft availability percentage at similar repair cost when determining the depot Working Level, the SBSS model or the DRIVE model?"

Research Question Answered. The answer to this question is the DRIVE model. It performed better in terms of repair cost and aircraft availability in the comparison where cost was constrained by the SBSS and in the comparison where cost was constrained by

DRIVE. The DRIVE model, utilizing both the A and B alternatives, could achieve a higher aircraft availability percentage at a lower repair cost than could the SBSS method.

Recommendations

Improve Efficiency of Iterative Method. The iterative method designed by Clarke requires some refinement. The second step in his methodology of manually entering base levels is time consuming and prone to operator mistakes. The method should be improved by automating this process.

Apply Methodology Across All Weapon Systems. This research was limited in its ability to generalize the results of its test because it utilized data obtained from only one weapon system -- the B-1B Lancer. Future research should apply this research methodology across a wide range of weapon systems. Applying the methodology across a larger sample size would enable researchers to utilize the resulting statistics to draw conclusions with a given level of confidence, and therefore, generalize their results.

Include SRUs in Comparison. The methodology used in this research was limited in that it did not include all reparable items in the system. Only the line replaceable units (LRU) were utilized in testing the two models in order to simplify the calculations. Future research should include the shop replaceable units (SRU) and other indentured items. Including these items will more accurately depict how the SBSS and DRIVE models will perform in actual operations.

Compare DRIVE to Other Models Using This Methodology. This research was limited because it compared only two models as to their applicability to determining a depot Working Level. Other models should be tested in future research before the Air Force chooses one model for system-wide use. Future research should consider testing, for example, the Aircraft Availability Model and the METRIC model against DRIVE and SBSS in determining a WL.

Conclusion

The Air Force faces new challenges as it implements the philosophy of Lean Logistics. The reparable system will change and require many new decisions. This research provided background information on Lean Logistics, a Consolidated Serviceable Inventory, the depot Working Level, and a comparison of the SBSS and DRIVE models in terms of determining a depot Working Level. More WL research is required before the Air Force establishes a level setting model for operations.

Appendix A. List of Acronyms and Abbreviations

AFB	Air Force Base
AFIT	Air Force Institute of Technology
AFLMA	Air Force Logistics Management Agency
AFMC	Air Force Materiel Command
AFMC/XPS	Air Force Materiel Command/ Management Sciences Division
ALC	Air Logistics Agency
AMC	Air Mobility Command
ASCII	American Standard Code for Information Interchange
BRCQ	Base Repair Cycle Quantity
BRCT	Base Repair Cycle Time
CONUS	Continental United States
CSI	Consolidated Serviceable Inventory
DDR	Daily Demand Rate
DPT	Depot Processing Time
DRCQ	Depot Repair Cycle Quantity
DRCT	Depot Repair Cycle Time
DRIVE	Distribution and Repair in Variable Environments
DTCQ	Depot to CSI Time Quantity
FEDEX	Federal Express
HQ USAF	Headquarters United States Air Force
ICS	Interim Contract Support
IM	Inventory Manager
JIT	Just-in-Time
L2	Lean Logistics
LRU	Line Replaceable Unit
NCT	NRTS/ Condemned Time

NRTS	Not Repairable This Station
OC-ALC	Oklahoma City Air Logistics Center
OSTQ	Order and Ship Time Quantity
PAA	Primary Assigned Aircraft
PBR	Percent Base Repair
RCDL	Repair Cycle Demand Level
RST	Retrograde Cycle Time
SBSS	Standard Base Supply System
SLQ	Safety Level Quantity
SOR	Source of Repair
SRU	Shop Replaceable Unit
WIP	Work in Process
WL	Working Level
WR-ALC	Warner-Robins Air Logistics Center

Appendix B SBSS Pipeline Computation Model

Overview

The Standard Base Supply System computes the demand level within the pipeline using the RCDL (repair cycle demand level) model. The model attempts to fill the repair cycle pipeline with sufficient assets to prevent a stockout. It does not attempt to maximize system performance or to minimize cost (Christensen and Ewan, 1985, 4).

Model Description

The model is divided into three segments -- the order and ship time pipeline (OST), the base repair cycle time pipeline (BRCT), and the NRTS/ condemn time (NCT). Each segment is weighted by their historical demand rates -- percent base repair (PBR) and daily demand rate (DDR) (Reynolds and others, 1994, 23). The base pipeline is calculated using the following formula:

$$BASELEVEL = \left[(DDR * PBR * BRCT) + (DDR * (1 - PBR) * OST) + (DDR * (1 - PBR) * NCT) + SLQ\right] \qquad (5)$$

SLQ is the safety level quantity. It is calculated as:

$$SLQ = \sqrt{3 * (DDR * PBR * BRCT) + (DDR * (1 - PBR) * OST) + (DDR * (1 - PBR) * NCT)} \qquad (6)$$

Where: DDR is the daily demand rate
PBR is the percent of base repair
BRCT is the base repair cycle time
OST is the order and ship time
NCT is the NRTS/ condemned time

The depot pipeline level is calculated using the following formula:

$$WL = \left[(DDR * RST) + (DDR * DRCT) + (DDR * DPT) + SLQ\right] \quad (7)$$

The safety level is calculated using the following formula:

$$SLQ = \sqrt{3 * (DDR * RST) + (DDR * DRCT) + (DDR * DPT)} \quad (8)$$

Where: DDR is the daily demand rate
RST is the retrograde cycle time
DRCT is the depot repair cycle time
DPT is the depot processing time

RST is the retrograde cycle time (shipping time from base to depot), DRCT is the depot repair cycle time, and DPT is the time required to process an asset into the CSI following repair.

To achieve a whole number for the base pipeline and depot WL, 0.5 is added to the calculation and the resulting number is truncated.

Appendix C Level and Cost Totals

First Comparison

SBSS

LRU NSN	Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	TOTAL ASSETS	UNIT REPAIR COST	TOTAL REPAIR COST
1270011573914EK	0	1	1	1	0	2	5	1432	$7,159
1280011590288EK	1	2	1	1	1	2	8	520	$4,160
1280011641411EK	0	0	0	0	0	1	1	275	$275
1280011826304EK	1	2	1	1	0	2	7	1670	$11,692
1280012597101	0	1	1	0	0	1	3	18981	$56,943
1280012601019EK	0	0	1	0	0	1	2	4384	$8,768
1280012654025EK	0	1	0	0	0	1	2	5369	$10,738
1660011433525	1	1	1	1	0	2	6	1100	$6,600
1660011433526	0	1	1	0	0	1	3	488	$1,464
1660011433527	1	2	1	1	1	2	8	574	$4,592
1660011486207	1	2	2	1	1	3	10	876	$8,760
1680011848809EK	0	1	0	0	0	1	2	4996	$9,992
1680012244258EK	0	1	1	0	0	1	3	1615	$4,845
1680012355179EK	0	1	1	0	0	1	3	2260	$6,780
1680012355183EK	0	1	1	0	0	1	3	1590	$4,770
1680012359278EK	0	0	0	0	0	1	1	1266	$1,266
1680012412204EK	0	1	1	0	0	1	3	1561	$4,683
1680012561892EK	0	1	1	0	0	1	3	2474	$7,422
1680012704772EK	0	1	1	0	0	1	3	3579	$10,738
1680012754673EK	0	1	1	0	0	1	3	2215	$6,645
1680013389671EK	0	1	1	0	0	1	3	8806	$26,418
1680013389673EK	0	0	0	0	0	1	1	28408	$28,408
1680013389677EK	0	0	0	0	0	1	1	3579	$3,579
1680013647171EK	0	1	1	0	0	1	3	3579	$10,738
2995012616069	1	2	2	1	1	3	10	620	$6,200
5841011507427EK	1	2	1	1	0	2	7	1114	$7,795
5841011507528EK	1	2	2	1	1	3	10	4176	$41,759
5841012857896EK	1	2	1	1	1	2	8	4772	$38,179
5865011569682EK	0	1	0	0	0	1	2	3818	$7,636
5895011507428EK	1	2	1	1	1	2	8	4175	$33,398
5895011656890EK	0	1	1	0	0	1	3	5359	$16,077
5895012658497NT	0	1	0	0	0	1	2	6551	$13,102
5930012043586EK	0	1	0	0	0	1	2	534	$1,068
5930012575268EK	0	1	1	0	0	1	3	540	$1,620
5985011802117EK	1	2	1	1	1	2	8	4772	$38,179

5985011898118EK	0	1	1	0	0	1	3	3137	$9,411
5985011916814EK	0	1	0	0	0	1	2	2886	$5,772
5998011661330NT	0	1	0	0	0	1	2	616	$1,232
5998011787809NT	0	1	1	0	0	1	3	234	$702
5998011787810NT	0	1	1	0	0	1	3	230	$690
5998011793638NT	0	1	0	0	0	1	2	230	$460
5998011793981NT	0	1	1	1	0	2	5	398	$1,990
5998011793982NT	0	1	0	0	0	1	2	310	$620
5998011796994NT	0	0	0	0	0	1	1	240	$240
5998011799685NT	0	1	0	0	0	1	2	230	$460
5998011806305NT	0	1	1	1	0	2	5	330	$1,650
5998011807496NT	0	1	1	0	0	1	3	270	$810
5998011811313NT	0	1	1	0	0	1	3	530	$1,590
5998012142536NT	0	1	0	0	0	1	2	563	$1,126
6110011791653	0	1	1	0	0	1	3	641	$1,923
6110011848803EK	0	0	0	0	0	1	1	1030	$1,030
6110011848807EK	0	1	0	0	0	1	2	1917	$3,834
6110012185008EK	0	0	0	0	0	1	1	926	$926
6110013516079EK	0	1	1	0	0	1	3	3579	$10,738
6130012144434NT	0	1	1	0	0	1	3	242	$726
6220011756188EK	0	1	1	0	0	1	3	1670	$5,011
6220012823674	0	1	1	0	0	1	3	1100	$3,300
6340012283603	0	0	0	0	0	1	1	3870	$3,870
6605012546944	0	1	1	1	0	2	5	934	$4,670
6610011477221	1	2	1	1	1	2	8	12480	$99,840
6610011479073	0	1	1	0	0	1	3	730	$2,190
6610011802184	0	1	1	0	0	1	3	700	$2,100
6610011807558	0	1	1	0	0	1	3	250	$750
6610011814215	0	0	0	0	0	1	1	371	$371
6610012184287	1	2	1	1	0	2	7	286	$2,002
6610012353510	1	2	2	1	1	3	10	1460	$14,602
6610012594655	0	1	1	0	0	1	3	5756	$17,268
6610012621507	1	2	1	1	1	2	8	1460	$11,682
6610012628319	1	4	3	1	1	5	15	2220	$33,300
6610012630425	1	2	1	1	1	2	8	730	$5,841
6610012695437	1	2	1	1	1	2	8	8240	$65,920
6610013076362	1	3	2	1	1	3	11	2954	$32,494
6610013076363	1	3	2	1	1	3	11	1460	$16,062
6610013449239	0	1	1	0	0	1	3	730	$2,190
6610013451109	1	2	2	1	1	3	10	730	$7,300
6610013451110	0	1	1	0	0	1	3	730	$2,190
6615010351092	1	3	2	1	1	4	12	2295	$27,540
6615010363198	1	3	2	1	1	3	11	1890	$20,790
6615011814191	0	1	1	0	0	1	3	390	$1,170
6615012695439	1	2	6	3	2	6	20	2070	$41,400
6615012719168	1	2	1	1	0	2	7	1650	$11,550
6615012754675	1	3	2	1	1	3	11	2688	$29,568

6615012768318	0	1	1	1	0	2	5	5486	$27,430
6615012788890	0	1	1	0	0	1	3	407	$1,221
6615012828765	1	2	1	1	1	2	8	887	$7,096
6620011644913	0	1	1	0	0	1	3	757	$2,271
6620011670881	0	1	1	0	0	1	3	3150	$9,450
6620011829328	0	0	0	0	0	1	1	462	$462
6620011829763	0	1	0	0	0	1	2	462	$924
6620011853017	0	1	0	0	0	1	2	1792	$3,584
6620012652887	1	4	3	1	1	5	15	2150	$32,250
6680011441284	1	1	1	1	0	2	6	552	$3,312
6680012639938NT	1	3	2	1	1	4	12	230	$2,760
6685012931237	0	1	1	0	0	1	3	510	$1,530
TOTALS	30	121	151	37	25	62	455		$1,055,639

DRIVE A

LRU NSN	Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total	Unit Repair Cost	Total Repair Cost
1270011573914EK	1	2	2	1	1	3	10	1432	$14,317
1280011590288EK	1	3	3	2	1	4	14	520	$7,280
1280011641411EK	0	1	1	0	0	1	3	275	$825
1280011826304EK	1	2	2	1	1	3	10	1670	$16,703
1280012601019EK	0	0	0	0	0	1	1	4384	$4,384
1660011433525	1	3	2	1	1	3	11	1100	$12,100
1660011433526	1	2	1	1	0	2	7	488	$3,416
1660011433527	1	3	2	1	1	4	12	574	$6,888
1660011486207	2	4	3	2	1	5	17	876	$14,892
1680011514986	0	0	0	0	0	1	1	1874	$1,874
1680011848809EK	0	1	0	0	0	0	1	4996	$4,996
1680012244258EK	0	1	1	0	0	1	3	1615	$4,845
1680012355179EK	0	1	1	0	0	1	3	2260	$6,780
1680012355183EK	1	1	1	0	0	1	4	1590	$6,360
1680012359278EK	1	1	1	0	0	1	4	1266	$5,064
1680012412204EK	1	1	1	0	0	1	4	1561	$6,244
1680012561892EK	0	1	1	0	0	1	3	2474	$7,422
1680012704772EK	0	1	1	0	0	1	3	3579	$10,738
1680012754662EK	0	1	0	0	0	1	2	1439	$2,878
1680012754673EK	1	1	1	1	0	2	6	2215	$13,290
1680013389677EK	0	0	0	0	0	1	1	3579	$3,579
1680013647171EK	0	1	1	0	0	1	3	3579	$10,738
2995012616069	1	4	3	2	1	5	16	620	$9,920
5841011507427EK	1	3	2	1	1	3	11	1114	$12,249
5841011507528EK	1	2	2	1	1	3	10	4176	$41,759
5841012857896EK	0	1	1	0	0	2	4	4772	$19,090
5865011569682EK	0	0	0	0	0	1	1	3818	$3,818
5895011507428EK	1	2	1	1	0	2	7	4175	$29,224
5895011642196EK	0	1	0	0	0	1	2	1922	$3,844
5895011656890EK	0	1	0	0	0	1	2	5359	$10,718
5905011646068NT	0	1	1	0	0	1	3	97	$291
5930012043586EK	0	1	1	0	0	1	3	534	$1,602
5930012496118EK	0	1	1	0	0	1	3	1291	$3,873
5930012575268EK	1	2	2	1	1	2	9	540	$4,860
5985011802117EK	1	2	1	1	0	2	7	4772	$33,407
5985011898118EK	0	1	1	0	0	1	3	3137	$9,411
5985011916814EK	0	1	0	0	0	1	2	2886	$5,772
5998011641428NT	0	0	0	0	0	1	1	466	$466
5998011661330NT	0	1	1	0	0	1	3	616	$1,848
5998011787809NT	1	2	2	1	1	3	10	234	$2,340
5998011787810NT	1	2	2	1	1	2	9	230	$2,070
5998011793638NT	0	1	1	0	0	1	3	230	$690

5998011793978NT	0	1	0	0	0	1	2	490	$980
5998011793981NT	1	3	2	1	1	3	11	398	$4,378
5998011793982NT	0	1	1	0	0	1	3	310	$930
5998011796994NT	0	1	1	0	0	1	3	240	$720
5998011799685NT	0	1	1	0	0	1	3	230	$690
5998011799686NT	0	1	0	0	0	1	2	292	$584
5998011803140NT	0	1	0	0	0	1	2	587	$1,174
5998011803141NT	0	1	0	0	0	1	2	399	$798
5998011806305NT	1	2	2	1	1	3	10	330	$3,300
5998011806306NT	0	1	1	0	0	1	3	400	$1,200
5998011807496NT	1	1	1	1	1	2	7	270	$1,890
5998011811313NT	1	1	1	1	1	2	7	530	$3,710
5998012142536NT	0	1	1	0	0	1	3	563	$1,689
5999011829469NT	0	0	0	0	0	1	1	353	$353
6110011791653	1	2	2	1	1	3	10	641	$6,410
6110011848803EK	1	1	1	0	0	1	4	1030	$4,120
6110011848807EK	0	1	0	0	0	0	1	1917	$1,917
6110012185008EK	1	1	1	0	0	1	4	926	$3,704
6110012240847EK	0	0	0	0	0	1	1	2386	$2,386
6110012722138EK	0	1	0	0	0	1	2	520	$1,040
6110013516079EK	0	1	0	0	0	1	2	3579	$7,159
6130012144434NT	0	1	1	1	0	2	5	242	$1,210
6220011756188EK	1	2	1	1	1	2	8	1670	$13,363
6220012823674	1	2	2	1	1	3	10	1100	$11,000
6605012546944	1	3	2	1	1	3	11	934	$10,274
6610011477221	0	1	1	0	0	1	3	12480	$37,440
6610011479073	1	2	1	1	1	2	8	730	$5,840
6610011802184	1	2	2	1	1	3	10	700	$7,000
6610011807558	1	2	1	1	1	2	8	250	$2,000
6610011814215	0	1	1	0	0	1	3	371	$1,113
6610012142537	0	0	0	0	0	1	1	339	$339
6610012184286	0	0	0	0	0	1	1	456	$456
6610012184287	1	3	2	1	1	3	11	286	$3,146
6610012353510	1	4	3	2	1	4	15	1460	$21,903
6610012594655	0	1	0	0	0	1	2	5756	$11,512
6610012621507	1	3	2	1	1	3	11	1460	$16,062
6610012628319	2	5	4	2	2	6	21	2220	$46,620
6610012630425	1	3	3	1	1	4	13	730	$9,491
6610012695437	0	1	1	0	0	1	3	8240	$24,720
6610012927672	0	1	1	0	0	1	3	1380	$4,140
6610013076362	1	3	3	1	1	4	13	2954	$38,402
6610013076363	2	4	3	2	1	5	17	1460	$24,823
6610013449239	1	2	2	1	1	2	9	730	$6,570
6610013451109	2	4	3	2	1	5	17	730	$12,410
6610013451110	1	2	1	1	0	2	7	730	$5,110
6615010351092	1	4	3	2	1	5	16	2295	$36,720
6615010363198	1	4	3	1	1	4	14	1890	$26,460

6615011814191	1	2	2	1	1	2	9	390	$3,510
6615012695439	1	3	7	3	3	11	28	2070	$57,960
6615012719168	1	3	2	1	1	3	11	1650	$18,150
6615012754675	1	3	2	1	1	4	12	2688	$32,256
6615012768318	0	1	1	0	0	1	3	5486	$16,458
6615012788890	1	2	2	1	1	3	10	407	$4,070
6615012828765	1	3	3	1	1	4	13	887	$11,531
6620011644913	1	2	2	1	1	3	10	757	$7,570
6620011670881	0	1	1	0	0	1	3	3150	$9,450
6620011829328	0	1	1	0	0	1	3	462	$1,386
6620011829329	0	1	1	0	0	1	3	463	$1,389
6620011829763	0	1	1	0	0	1	3	462	$1,386
6620011853016	0	1	0	0	0	1	2	462	$924
6620011853017	0	1	1	0	0	1	3	1792	$5,377
6620012652887	2	5	4	2	2	6	21	2150	$45,150
6680011441284	1	3	2	1	1	3	11	552	$6,072
6680012639938NT	2	5	4	2	2	6	21	230	$4,830
6685012931237	0	1	1	1	0	2	5	510	$2,550
Total	60	182	145	63	49	227	726		$1,020,139

DRIVE B

LRU NSN	Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total	Unit Repair Cost	Total Repair Cost
1270011573914EK	1	3	2	1	0	1	8	1432	$11,456
1280011590288EK	1	3	3	2	1	2	12	520	$6,240
1280011641411EK	0	1	1	0	0	0	2	275	$550
1280011826304EK	1	3	2	1	1	0	8	1670	$13,360
1280012601019EK	0	0	1	0	0	0	1	4384	$4,384
1280012654025EK	0	1	0	0	0	0	1	5369	$5,369
1660011433525	1	3	2	1	1	1	9	1100	$9,900
1660011433526	0	1	1	1	0	1	4	488	$1,952
1660011433527	1	3	3	1	1	1	10	574	$5,740
1660011486207	2	4	3	2	2	1	14	876	$12,264
1680011514986	0	0	0	0	0	1	1	1874	$1,874
1680011848809EK	0	1	0	0	0	0	1	4996	$4,996
1680012244258EK	0	1	1	0	0	1	3	1615	$4,845
1680012355179EK	0	1	1	0	0	1	3	2260	$6,780
1680012355183EK	0	1	1	1	0	1	4	1590	$6,360
1680012359278EK	0	1	1	0	0	1	3	1266	$3,798
1680012412204EK	0	1	1	1	0	1	4	1561	$6,244
1680012561892EK	0	1	1	0	0	1	3	2474	$7,422
1680012704772EK	0	1	1	0	0	0	2	3579	$7,158
1680012754662EK	0	0	0	0	0	1	1	1439	$1,439
1680012754673EK	1	1	1	1	0	2	6	2215	$13,290
1680013389677EK	0	1	1	0	0	0	2	3579	$7,158
1680013647171EK	0	1	1	0	0	1	3	3579	$10,737
2995012616069	2	4	3	2	1	2	14	620	$8,680
5841011507427EK	1	3	2	1	1	2	10	1114	$11,140
5841011507528EK	1	3	2	1	1	0	8	4176	$33,408
5841012857896EK	1	2	1	1	1	1	7	4772	$33,404
5865011569682EK	0	1	1	0	0	0	2	3818	$7,636
5895011507428EK	1	2	2	1	1	0	7	4175	$29,225
5895011642196EK	0	1	0	0	0	1	2	1922	$3,844
5895012658497NT	0	0	0	0	0	1	1	6551	$6,551
5895011656890EK	0	1	1	0	0	0	2	5359	$10,718
5905011646068NT	0	1	0	0	0	1	2	97	$194
5930012043586EK	0	1	1	0	0	1	3	534	$1,602
5930012496118EK	0	1	0	0	0	1	2	1291	$2,582
5930012575268EK	1	2	1	1	1	0	6	540	$3,240
5985011802117EK	1	2	2	1	1	0	7	4772	$33,404
5985011898118EK	1	1	1	1	0	2	6	3137	$18,822
5985011916814EK	0	1	1	0	0	0	2	2886	$5,772
5998011661330NT	0	1	1	0	0	0	2	616	$1,232
5998011787809NT	1	2	2	1	1	0	7	234	$1,638
5998011787810NT	1	2	1	1	1	0	6	230	$1,380

5998011793638NT	0	1	1	0	0	1	3	230	$690
5998011793978NT	0	0	0	0	0	1	1	490	$490
5998011793981NT	1	3	2	1	1	0	8	398	$3,184
5998011793982NT	0	1	1	0	0	0	2	310	$620
5998011796994NT	0	1	1	0	0	0	2	240	$480
5998011799685NT	0	1	1	0	0	1	3	230	$690
5998011799686NT	0	0	0	0	0	1	1	292	$292
5998011803140NT	0	0	0	0	0	1	1	587	$587
5998011803141NT	0	0	0	0	0	1	1	399	$399
5998011806305NT	1	2	2	1	1	0	7	330	$2,310
5998011806306NT	0	1	0	0	0	1	2	400	$800
5998011807496NT	1	1	1	1	0	1	5	270	$1,350
5998011811313NT	1	1	1	1	0	1	5	530	$2,650
5998012142536NT	0	1	1	0	0	0	2	563	$1,126
6110011791653	1	2	2	1	1	0	7	641	$4,487
6110011848803EK	0	1	1	0	0	0	2	1030	$2,060
6110011848807EK	0	1	0	0	0	0	1	1917	$1,917
6110012185008EK	0	1	1	0	0	1	3	926	$2,778
6110012240847EK	0	1	0	0	0	1	2	2386	$4,772
6110012722138EK	0	0	0	0	0	1	1	520	$520
6110013516079EK	0	1	1	0	0	0	2	3579	$7,158
6130012144434NT	0	1	1	1	0	1	4	242	$968
6220011756188EK	1	2	1	1	1	0	6	1670	$10,020
6220012823674	1	2	1	1	1	1	7	1100	$7,700
6340012283603	0	1	0	0	0	0	1	3870	$3,870
6605012546944	1	3	2	1	1	1	9	934	$8,406
6610011477221	0	1	1	0	0	0	2	12480	$24,960
6610011479073	1	2	1	1	0	1	6	730	$4,380
6610011802184	1	2	2	1	1	0	7	700	$4,900
6610011807558	1	1	1	1	0	1	5	250	$1,250
6610011814215	0	1	1	0	0	0	2	371	$742
6610012184287	1	3	2	1	1	1	9	286	$2,574
6610012353510	2	4	3	2	1	2	14	1460	$20,440
6610012594655	0	1	1	0	0	0	2	5756	$11,512
6610012621507	1	3	2	1	1	1	9	1460	$13,140
6610012628319	2	6	5	2	2	1	18	2220	$39,960
6610012630425	1	3	3	1	1	2	11	730	$8,030
6610012695437	0	1	1	0	0	2	4	8240	$32,960
6610012927672	0	1	0	0	0	1	2	1380	$2,760
6610013076362	1	4	3	2	1	0	11	2954	$32,494
6610013076363	2	5	4	2	2	0	15	1460	$21,900
6610013449239	1	2	1	1	1	1	7	730	$5,110
6610013451109	2	4	3	2	2	2	15	730	$10,950
6610013451110	1	1	1	1	0	1	5	730	$3,650
6615010351092	2	4	4	2	2	1	15	2295	$34,425
6615010363198	2	4	3	2	1	2	14	1890	$26,460
6615011814191	1	2	1	1	1	1	7	390	$2,730

6615012695439	1	3	8	4	3	2	21	2070	$43,470
6615012719168	1	3	2	1	1	0	8	1650	$13,200
6615012754675	1	3	3	1	1	2	11	2688	$29,568
6615012768318	0	1	1	0	0	2	4	5486	$21,944
6615012788890	1	2	2	1	1	0	7	407	$2,849
6615012828765	1	3	3	1	1	2	11	887	$9,757
6620011644913	1	2	1	1	1	1	7	757	$5,299
6620011670881	0	1	1	0	0	0	2	3150	$6,300
6620011829328	0	1	1	0	0	0	2	462	$924
6620011829329	0	1	0	0	0	1	2	463	$926
6620011829763	0	1	1	0	0	1	3	462	$1,386
6620011853016	0	0	0	0	0	1	1	462	$462
6620011853017	0	1	1	0	0	0	2	1792	$3,584
6620012652887	2	5	4	2	2	3	18	2150	$38,700
6680011441284	1	3	2	1	1	1	9	552	$4,968
6680012639938NT	2	5	4	2	2	3	18	230	$4,140
6685012931237	0	1	1	1	0	1	4	510	$2,040
Total	60	184	149	70	51	85	599		$932,956

Second Comparison

DRIVE

LRU NSN	Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total	Unit Repair Cost	Total Repair Cost
1270011573914EK	1	2	2	1	0	1	7	1432	$10,022
1280011590288EK	1	3	3	2	1		10	520	$5,200
1280011641411EK	0	1	1	0	0		2	275	$550
1280011826304EK	1	2	2	1	0	1	7	1670	$11,692
1660011433525	1	3	2	1	1		8	1100	$8,800
1660011433526	1	1	1	1	0		4	488	$1,952
1660011433527	1	3	2	1	1		8	574	$4,592
1660011486207	2	4	3	2	1		12	876	$10,512
1680011848809EK	0	1	0	0	0		1	4996	$4,996
1680012244258EK	0	1	1	0	0		2	1615	$3,230
1680012355179EK	0	1	1	0	0		2	2260	$4,520
1680012355183EK	0	1	1	0	0		2	1590	$3,180
1680012359278EK	0	1	1	0	0		2	1266	$2,532
1680012412204EK	0	1	1	0	0	1	3	1561	$4,683
1680012561892EK	0	1	1	0	0		2	2474	$4,948
1680012704772EK	0	1	1	0	0		2	3579	$7,159
1680012754662EK	0	1	0	0	0		1	1439	$1,439
1680012754673EK	1	1	1	1	0		4	2215	$8,860
1680013647171EK	0	1	1	0	0		2	3579	$7,158
2995012616069	1	4	3	2	1		11	620	$6,820
5841011507427EK	1	3	2	1	1		8	1114	$8,908
5841011507528EK	1	2	2	1	1	1	8	4176	$33,407
5841012857896EK	0	1	1	0	0		2	4772	$9,545
5895011507428EK	1	2	1	1	0		5	4175	$20,874
5895011642196EK	0	1	0	0	0		1	1922	$1,922
5895011656890EK	0	1	0	0	0		1	5359	$5,359
5905011646068NT	0	1	1	0	0		2	97	$194
5930012043586EK	0	1	1	0	0		2	534	$1,068
5930012496118EK	0	1	1	0	0		2	1291	$2,582
5930012575268EK	1	2	1	1	1		6	540	$3,240
5985011802117EK	0	2	1	1	0	1	5	4772	$23,862
5985011898118EK	0	1	1	0	0		2	3137	$6,274
5985011916814EK	0	1	0	0	0		1	2886	$2,886
5998011661330NT	0	1	1	0	0		2	616	$1,232
5998011787809NT	1	2	2	1	1		7	234	$1,638
5998011787810NT	1	2	1	1	1		6	230	$1,380
5998011793638NT	0	1	1	0	0		2	230	$460
5998011793978NT	0	1	0	0	0		1	490	$490
5998011793981NT	1	3	2	1	1		8	398	$3,184

5998011793982NT	0	1	1	0	0		2	310	$620
5998011796994NT	0	1	1	0	0		2	240	$480
5998011799685NT	0	1	1	0	0		2	230	$460
5998011799686NT	0	1	0	0	0		1	292	$292
5998011803140NT	0	1	0	0	0		1	587	$587
5998011803141NT	0	1	0	0	0		1	399	$399
5998011806305NT	1	2	2	1	1		7	330	$2,310
5998011806306NT	0	1	1	0	0		2	400	$800
5998011807496NT	1	1	1	1	1		5	270	$1,350
5998011811313NT	1	1	1	1	1		5	530	$2,650
5998012142536NT	0	1	1	0	0		2	563	$1,126
6110011791653	1	2	2	1	1		7	641	$4,487
6110011848803EK	0	1	1	0	0		2	1030	$2,060
6110011848807EK	0	1	0	0	0		1	1917	$1,917
6110012185008EK	0	1	1	0	0	1	3	926	$2,778
6110012722138EK	0	1	0	0	0		1	520	$520
6110013516079EK	0	1	0	0	0		1	3579	$3,579
6130012144434NT	0	1	1	1	0		3	242	$726
6220011756188EK	1	2	1	1	1		6	1670	$10,022
6220012823674	1	2	2	1	1		7	1100	$7,700
6605012546944	1	3	2	1	1		8	934	$7,472
6610011477221	0	1	1	0	0		2	12480	$24,960
6610011479073	1	2	1	1	1		6	730	$4,380
6610011802184	1	2	2	1	1		7	700	$4,900
6610011807558	1	2	1	1	0		5	250	$1,250
6610011814215	0	1	1	0	0		2	371	$742
6610012184287	1	3	2	1	1		8	286	$2,288
6610012353510	1	4	3	2	1		11	1460	$16,062
6610012594655	0	1	0	0	0		1	5756	$5,756
6610012621507	1	3	2	1	1		8	1460	$11,682
6610012628319	2	5	4	2	2		15	2220	$33,300
6610012630425	1	3	3	1	1		9	730	$6,571
6610012695437	0	1	1	0	0		2	8240	$16,480
6610012927672	0	1	1	0	0		2	1380	$2,760
6610013076362	1	3	3	1	1		9	2954	$26,586
6610013076363	2	4	3	2	1		12	1460	$17,522
6610013449239	1	2	2	1	1		7	730	$5,110
6610013451109	2	4	3	2	1		12	730	$8,760
6610013451110	1	2	1	1	0		5	730	$3,650
6615010351092	1	4	3	2	1		11	2295	$25,245
6615010363198	1	4	3	1	1		10	1890	$18,900
6615011814191	1	2	2	1	1		7	390	$2,730
6615012695439	1	3	7	3	3		17	2070	$35,190
6615012719168	1	3	2	1	1		8	1650	$13,200
6615012754675	1	3	2	1	1		8	2688	$21,504

6615012768318	0	1	1	0	0		2	5486	$10,972
6615012788890	1	2	2	1	1		7	407	$2,849
6615012828765	1	3	3	1	1		9	887	$7,983
6620011644913	1	2	2	1	1		7	757	$5,299
6620011670881	0	1	1	0	0		2	3150	$6,300
6620011829328	0	1	1	0	0		2	462	$924
6620011829329	0	1	1	0	0		2	463	$926
6620011829763	0	1	1	0	0		2	462	$924
6620011853016	0	1	0	0	0		1	462	$462
6620011853017	0	1	1	0	0		2	1792	$3,584
6620012652887	2	5	4	2	2		15	2150	$32,250
6680011441284	1	3	2	1	1		8	552	$4,416
6680012639938NT	2	5	4	2	2		15	230	$3,450
6685012931237	0	1	1	1	0		3	510	$1,530
Total	54	181	143	63	46	6	493		$685,083

SBSS

LRU NSN	Edwards	Dyess	Ellsworth	Mt.Home	McConnell	WL	Total	Unit Repair Cost	Total Repair Cost
1270011573914EK	0	1	1	0	0	1	3	1432	$ 4,295
1280011590288EK	0	2	1	1	0	2	6	520	$ 3,120
1280011826304EK	0	1	1	0	0	1	3	1670	$ 5,011
1280012597101	0	1	1	0	0	1	3	18981	$ 56,943
1660011433525	0	1	1	0	0	1	3	1100	$ 3,300
1660011433526	0	1	0	0	0	1	2	488	$ 976
1660011433527	0	1	1	0	0	2	4	574	$ 2,296
1660011486207	1	2	1	1	1	2	8	876	$ 7,008
1680011848809EK	0	1	0	0	0	1	2	4996	$ 9,992
1680012355183EK	0	0	0	0	0	1	1	1590	$ 1,590
1680012412204EK	0	0	0	0	0	1	1	1561	$ 1,561
1680012561892EK	0	0	0	0	0	1	1	2474	$ 2,474
1680012704772EK	0	0	0	0	0	1	1	3579	$ 3,579
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1680013389671EK	0	0	0	0	0	1	1	8806	$ 8,806
1680013647171EK	0	1	1	0	0	1	3	3579	$ 10,738
2995012616069	1	2	1	1	0	2	7	620	$ 4,340
5841011507427EK	0	1	1	0	0	2	4	1114	$ 4,454
5841011507528EK	1	2	1	1	1	2	8	4176	$ 33,407
5841012857896EK	0	1	1	0	0	2	4	4772	$ 19,090
5895011507428EK	0	1	1	1	0	2	5	4175	$ 20,874
5895011656890EK	0	1	0	0	0	1	2	5359	$ 10,718
5930012575268EK	0	1	1	0	0	1	3	540	$ 1,620
5985011802117EK	0	1	1	0	0	2	4	4772	$ 19,090
5985011898118EK	0	1	1	0	0	1	3	3137	$ 9,411
5998011787809NT	0	1	1	0	0	1	3	234	$ 702
5998011787810NT	0	1	1	0	0	1	3	230	$ 690
5998011793981NT	0	1	1	0	0	1	3	398	$ 1,194
5998011806305NT	0	1	1	0	0	1	3	330	$ 990
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6110013516079EK	0	0	0	0	0	1	1	3579	$ 3,579
6130012144434NT	0	0	0	0	0	1	1	242	$ 242
6220011756188EK	0	1	1	0	0	1	3	1670	$ 5,011
6220012823674	0	1	1	0	0	1	3	1100	$ 3,300
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6620012652887	1	3	3	1	1	4	13	2150	$ 27,950
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6685012931237	0	0	0	0	0	1	1	510	$ 510
	13	79	66	19	14	107	298		$ 666,638

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Vita

Captain Joseph M. Ferris is from Tucson, Arizona. He graduated from Northern Arizona University in Flagstaff, Arizona in 1991 with Bachelor of Science degree in General Studies. After receiving his commission into the United States Air Force through the Reserve Officers Training Corps, and completing the Transportation Officers' Course at Sheppard AFB, Texas, Captain Ferris was assigned to the 366 Composite Wing at Mountain Home AFB, Idaho.

During his tour at Mountain Home AFB, Captain Ferris performed duties as the Vehicle Maintenance Officer and Combat Readiness and Resources Flight Commander.

Captain Ferris entered the Air Force Institute of Technology at Wright-Patterson AFB, Ohio, and graduated in 1995 with a Masters degree in Logistics Management. He was subsequently assigned to the 623d Air Mobility Support Squadron at Ramstein Air Base, Germany with his wife, Lucy and two daughters, Caitlin and Clancy.

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13. ABSTRACT *(Maximum 200 words)*

The Air Force has adopted a philosophy of logistics operations directed toward improving the products, costs, and responsiveness of the Air Force's reparable pipeline. The philosophy was termed Lean Logistics. This research addressed one problem created through the implementation of Lean Logistics. The problem was determining a depot Working Level. The Air Force Materiel Command needed to determine an appropriate method to use when determining the depot Working Level. To help determine the appropriate method, this research compared the Standard Base Supply System (SBSS) and the Distribution and Repair In Variable Environments (DRIVE) model. Both models were utilized in two different comparisons to set the depot Working Level for all B-1B avionics line replaceable units within similar repair budget. In the first comparison, the SBSS determined the repair budget and DRIVE was forced to perform within the SBSS budget. In the second comparison, DRIVE determined a leaner budget and the SBSS was forced to perform within the lean budget. The models' performances were then assessed using Dyna-METRIC to estimate system-wide aircraft availability. DRIVE performed better than the SBSS in both comparisons. The research concluded that DRIVE was more appropriate than the SBSS for setting the depot Working Level.

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