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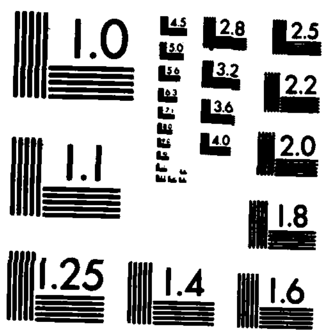
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APPLYING THE DYNA-METRIC INVENTORY MODEL
FOR STRATEGIC AIRLIFT

THESIS

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The importance of strategic airlift in the nation's defense strategy of force projection is paramount. Currently, there is no method of assessing the capability of strategic airlift with respect to reparable spares. The most current inventory model used by the Air Force is Rand's Dyna-METRIC model. Dyna-METRIC was developed to assess the capability of tactical aircraft operating from a single location. In contrast, the strategic airlift scenario is one of aircraft transiting various bases throughout a mission. A methodology for applying Dyna-METRIC to the strategic airlift scenario was developed, modeling the full range of MAC's spares supply concept. Additionally, the HQ MAC method of establishing BLSS and WRSK stock levels was analyzed. The results obtained in this research confirm that Dyna-METRIC has potential for use in capability assessment of MAC's strategic airlift fleet. Specific recommendations for future model applications are given.

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APPLYING THE DYNA-METRIC INVENTORY MODEL TO STRATEGIC AIRLIFT

THESIS

Presented to the Faculty of the School of Systems and Logistics

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In Partial Fulfillment of the

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Master of Science in Logistics Management

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Abstract

The importance of strategic airlift in the nation's defense strategy of force projection is paramount. Currently, there is no method of assessing the capability of strategic airlift with respect to reparable spares. The most current inventory model used by the Air Force is Rand's Dyna-METRIC model. Dyna-METRIC was developed to assess the capability of tactical aircraft operating from a single location. In contrast, the strategic airlift scenario is one of aircraft transiting various bases throughout a mission. A methodology for applying Dyna-METRIC to the strategic airlift scenario was developed, modeling the full range of MAC's spares supply concept. Additionally, the HQ MAC method of establishing BLSS and WRSK stock levels was analyzed. The results obtained in this research confirm that Dyna-METRIC has potential for use in capability assessment of MAC's strategic airlift fleet. Specific recommendations for future model applications are given.

APPLYING THE DYNA-METRIC INVENTORY MODEL

TO STRATEGIC AIRLIFT

I. Introduction

Purpose

The purpose of this research is to develop a means of assessing the combat capability of the strategic airlift fleet relative to the availability of reparable spare parts. Past research has indicated that the limiting strategic airlift factors in a NATO scenario, for example, will be the number of airframes and the supply of spare parts (25). Currently, no scenario-dependent methodology exists that assesses the capability of the airlift fleet when constrained by spare parts. An inventory model known as Dyna-METRIC has been developed by the RAND Corporation for evaluating tactical aircraft unit performance in a wartime environment. However, this model is designed around the single operating location concept inherent to the operations of a tactical fighter unit and is not readily adapted to strategic airlift operations. This research effort will develop a method of assessing strategic airlift wartime capability, with respect to reparable spare parts, using RAND's Dyna-METRIC model. With this capability, airlift logistics managers should be able to adjust their spare parts stockage to improve the wartime capability of the airlift fleet. Such an ability directly supports the goal listed in Air Force doctrine that "Commanders must have a clear view of their logistics capability [56:4-13]."

Background

The shift in national military strategy in the early 1960s from massive retaliation to flexible response has resulted in a major emphasis in the mobility mission of the Air Force. According to the Joint Chiefs of Staff,

> An essential element of US strategy is the ability to deploy combat ready, well-equipped ground, sea, and air forces from the central reserve (of conventional forces located in the continental US) wherever needed [54:5-6].

Flexible response requires that the military have the capability to respond quickly to outbreaks of tension throughout the world. The key ingredient of flexible response is force projection. The United States does not have the resources to permanently position troops and their equipment throughout the world to meet every threat and aggression. We must deploy our forces to areas of conflict to protect and preserve our interests and those of our allies. General Gabriel, USAF Chief of Staff, points out that

> No matter how good our equipment, tactics, and training, our forces are of little value if we cannot get them to the battle in time. Since we cannot control the time and place of combat, we have to be able to move quickly to defend American interests anywhere in the world [17:130].

The overwhelming bulk of the equipment to support a military operation overseas would be supplied by sealift. But during the early days of a conflict, airlift (and prepositioned stock) would be the only means of rapidly deploying and sustaining the combat forces (66:199). The timely delivery of troops, equipment, and supplies by strategic airlift might well make the difference in the outcome of the conflict before sealift could arrive from the United States. An example of the value of timely strategic airlift can be found in the 1973 Arab-Israeli War. Although the first ship to arrive with supplies for Israel from the United States carried more tonnage than the entire Military Airlift Command (MAC) effort, it arrived seven days <u>after</u> the end of the war (44:44).

The requirement for strategic airlift force projection is a cornerstone in the most important area of conflict seen by the Department of Defense:

> The scenario we consider most important in our mobility planning and programming is a U.S. reinforcement of NATO Europe to counter a Warsaw Pact buildup or attack, preceded by a deployment of U.S. forces to Southwest Asia to counter Soviet aggression in that region [66:207].

Major General Estes (Retired), Director of Strategic Analysis at the BDM Corporation, believes a war in Western Europe is unlikely to be a protracted one. He states that the "US should be prepared to fight a short, very intense conventional war which could escalate to a nuclear war at any time [14:2-3]." Current leadership at the highest level in the Air Force also holds that a future conflict in Europe will be a "come-as-you-are" war (17:129). Accordingly, strategic airlift will play a key role in a short conventional NATO or Southwest Asian war.

The logistics resources required to be airlifted to Western Europe, alone, are immense. Within 10 days six Army divisions, a Marine Amphibious Brigade, and 60 tactical fighter squadrons (all with initial support) are needed to augment existing forces (66:209). To meet this demanding requirement, the logistics system must provide a prompt and adequate supply of material essential to support the airlift missions (61:1). In addition to providing material in time of war, AFM 1-1 states that logistics operations "must be as simple as possible and provide the right assets to the right place at the right time [56:4-13 to 4-14]." This research, then, will address a means of assessing reparable spares requirements <u>before</u> the need to help ensure the assets will be available when required.

Holck and Ticknor, in their 1981 thesis, identified spare parts and airframes as limiting factors in the completion of the strategic resupply of NATO (25). Through their simulation of strategic airlift to Europe, it became apparent that the lack of supply support for the airlift fleet would be the factor that brought the NATO resupply effort to a halt. Past Commander-in-Chiefs of MAC have expressed their concern over the spare parts situation and its effect on MAC's mission capability. In April 1981, General Huyser informed Congress that MAC's strategic airlift fleet could meet "only 62% of the surge sortie flying hour objective and 52% of the sustained flying hour objective established by the Secretary of Defense" due to spare parts underfunding (Huyser in 30:34). The following year General James

Allen, CINCMAC, stated that due to a long-standing shortage of spare parts, MAC had been unable to program and plan for the high sustained aircraft utilization rates that would best support the variety of contingencies (53:176).

The core of the spare parts problem has been inadequate funding. Major General Nugteren, Commander of Warner Robins Air Logistics Center (ALC), highlights the funding problem: Spares funding for the C-141 fleet was approximately 12 percent of the necessary total in 1980, 36.5 percent in 1981, nearly 58 percent in 1982, but back down to 25 percent in 1983 (52:94). If sufficient spare parts are not available prior to a major conflict, there will not be time to acquire the necessary supplies from contractors. This is particularly true when a short, intense war is considered. The required spare parts for the airlift fleet must be identified, funded, and in place <u>prior</u> to the outbreak of hostilities.

Air Force Logistics Command (AFLC) has the responsibility of identifying, purchasing, and stocking the required spare parts needed for the Air Force combat and support forces. One type of stock AFLC controls is peacetime operating stock (POS). This stock supports peacetime operations and readiness at any reasonable level (45:32). But when the nation goes to war, the utilization rate of the strategic airlift fleet is expected to increase greatly. For example, the C-141 utilization rate is expected to increase from a 1983 peacetime rate of 3.24 hours per day to over 10 hours per day (2). To cope with a dramatic increase in spares requirements during war, AFLC has a War Reserve Material (WRM) program. War Reserve Material is defined as "that material required, in addition to peacetime assets, to support the planned wartime activities reflected in the USAF war and mobilization plan [64:42]."

War Reserve Material contains three types of material; spares, equipment, and consumables. Spares are parts, assemblies, or subassemblies used to maintain or repair systems, equipment, and nonaircraft items. Equipment includes vehicles and support, communication, and civil engineering equipment. Consumables are expendable items directly related and necessary to a weapon system. Examples of consumables are petroleum, oil and lubricants, munitions, racks, and pylons (7:5).

The spares in WRM, both reparable and expendable, are combined into two major categories: War Readiness Spares Kits (WRSK) and Base Level Self-Sufficiency Spares (BLSS). WRSKs are "an air transportable package of spares and repair parts required to sustain planned wartime or contingency operations of a weapon system for a specified period of time pending resupply [62: Vol 1, Part 1, pp. 14-31]." BLSS, on the other hand, is WRM intended for use as base support for units which will not deploy from their peacetime base.

Currently, the WRSK and BLSS kits of Tactical Air Command are being assessed by the Dyna-METRIC inventory model in the Sustainability Assessment Module (SAM) of AFLC's Weapon System Management Information System (WSMIS). These applications of Dyna-METRIC with tactical aircraft units generally involve the evaluation of either the units' WRSK or BLSS kit, along with the base's POS. POS, WRSK, and BLSS assets are not evaluated concurrently for a single tactical aircraft unit due to the structure of their operations. But since strategic airlift aircraft will operate out of both their home bases and through forward deployed locations in a NATO or Southwest Asia scenario, POS, WRSK, and BLSS must all be considered when assessing airlift units.

AFLC is the responsible agency for Air Force WRSKs and BLSS. The levels for WRSKs are normally negotiated between HQ AFLC, the concerned Air Logistics Center (ALC), and the specific major command. However, the methodology for computing stock levels for the MAC WRSKs is command-unique. The stock levels for the C-141 and C-5 kits are established by HQ MAC/LGSWR, with HQ AFLC's concurrence as a rule, unlike most other Air Force major weapon systems (2; 28). An understanding of the command-specific computation process is a key portion of assessing the strategic airlift WRSK and BLSS capabilities and limitations; thus, it will be discussed in detail in Chapter II.

Justification

The importance of strategic airlift in accomplishing the nation's foreign policy objectives is paramount. The effect of inadequate POS or WRSK and BLSS kits on the strategic airlift effort could be crucial to the outcome of either a short, intense conflict, or a protracted one. Compounding the situation, funding for procurement of spares for the strategic airlift fleet has been deficient over the past several years. A means of measuring combat capability for strategic airlift must be developed to ensure MAC has sufficient and necessary assets to fulfill its wartime commitment.

Problem Statement

There is a need to know the combat capability of the MAC strategic airlift fleet with respect to current levels of reparable spare parts. Additionally, there is a need to evaluate the current procedures for determining spares requirements for strategic airlift resources.

Research Objectives

The objectives of this research are two-fold. First, an assessment of the suitability of RAND's Dyna-Metric inventory model in an application to a strategic airlift scenario will be accomplished. With an input of representative stock levels in a realistic scenario compatable with Dyna-METRIC, a measure of the capability of the MAC's WRSK and BLSS kits would be possible.

Secondly, the command-specific methodology of computing WRSK levels will be reviewed and assessed due to its importance in establishing the wartime capabilities of MAC. The use of Dyna-METRIC in modeling strategic airlift will illustrate the impact of command procedures on setting the levels of WRSKs and BLSS. Also, modeling difficulties particular to the strategic airlift scenario will be identified for consideration in further research endeavors.

Research Questions

1. Given a realistic strategic airlift scenario and authorized levels of POS and WRM, can Dyna-METRIC provide reasonable estimates of airlift combat capability?

2. How sensitive are Dyna-METRIC outputs to changes in key input variables that are determined by MAC's unique methodology for determining spares requirements?

Scope

HQ MAC/LGSWR has provided an unclassified scenario representing an envisioned resupply effort to Southwest Asia. The bases, sortie numbers and lengths will be derived from the scenario. Although the scenario contains many bases, a representative cross section of the strategic airlift scenario and MAC spares positioning policy may be obtained with the modeling of six bases. One CONUS home base will be utilized, with its accompanying POS and BLSS. Segmented WRSKs of different sizes, as suggested by HQ MAC/LGSWR, will be placed at three offshore operating locations. Two additional bases will have augmented stock from the Forward Supply System (FSS), at levels obtained from HQ MAC/LGSWA. This stock is in addition to WRSK assets that will be placed at the locations. One of the bases with FSS stock will be serviced by an intermediate repair facility, representing the current repair pipeline in place.

This research will focus on the C-141B aircraft in Dyna-METRIC analyses. With over 265 in use, the C-141B Starlifter represents the bulk of the strategic airlift fleet. The methodology developed for the C-141B will be applicable for the identical C-5 mission profile, and to a lesser degree, the tactical C-130s. The C-141B WRSK and BLSS listings acquired from AFLC contain 228 and 735 reparable items, respectively. Because a methodology for using Dyna-METRIC is the goal of this research rather than a complete capability assessment, a reduced parts list will accomplish that requirement. From the extensive AFLC listings, a representative sample of 91 parts will be used. This reduced list was obtained through correspondence with MAC and AFLC, coupled with four generic Dyna-METRIC runs. Details on the method of reducing the parts list to a workable level will be covered in Chapter III. To keep the parts list at a manageable level, Economic Order Quantity (EOQ) items contained in the WRSK or BLSS will not be included. For a detailed study of the application of Dyna-METRIC to EOQ items, see reference 7. The WRSK and BLSS parts listings were supplemented with demand, stockage, and flying hour data from HQ MAC and the 438th MAW, McGuire AFB.

II. Literature Review

Introduction

This chapter will begin with a brief discussion of basic inventory theory and policy and their relationship to current Air Force recoverable item management. As mentioned in Chapter I, inventory models concern both consumable and repair cycle assets. While inventory models are available for both types of assets, this study considers reparable (recoverable) items because of the enormous Air Force investment in spare parts ($2.5 billion in FY82) and the fact that 95 percent of that cost is for recoverable items (13:4). Because performance measures are vitally important in the determination of how many spares to buy, they will be discussed followed by a review of inventory models.

The concept of basic reparable inventory theory, the repair cycle, and performance measures form the basis for an introduction to inventory models and will be reviewed first. Most of the discussion centers on the latest model, Dyna-METRIC, because of its application to this research effort. The last section of this chapter will review the spares requirements process at both AFLC and MAC, and MAC's unique Forward Supply Support (FSS) system. Recent efforts to model spares availability in a simulation model used at MAC Headquarters will also be discussed.

II. Literature Review

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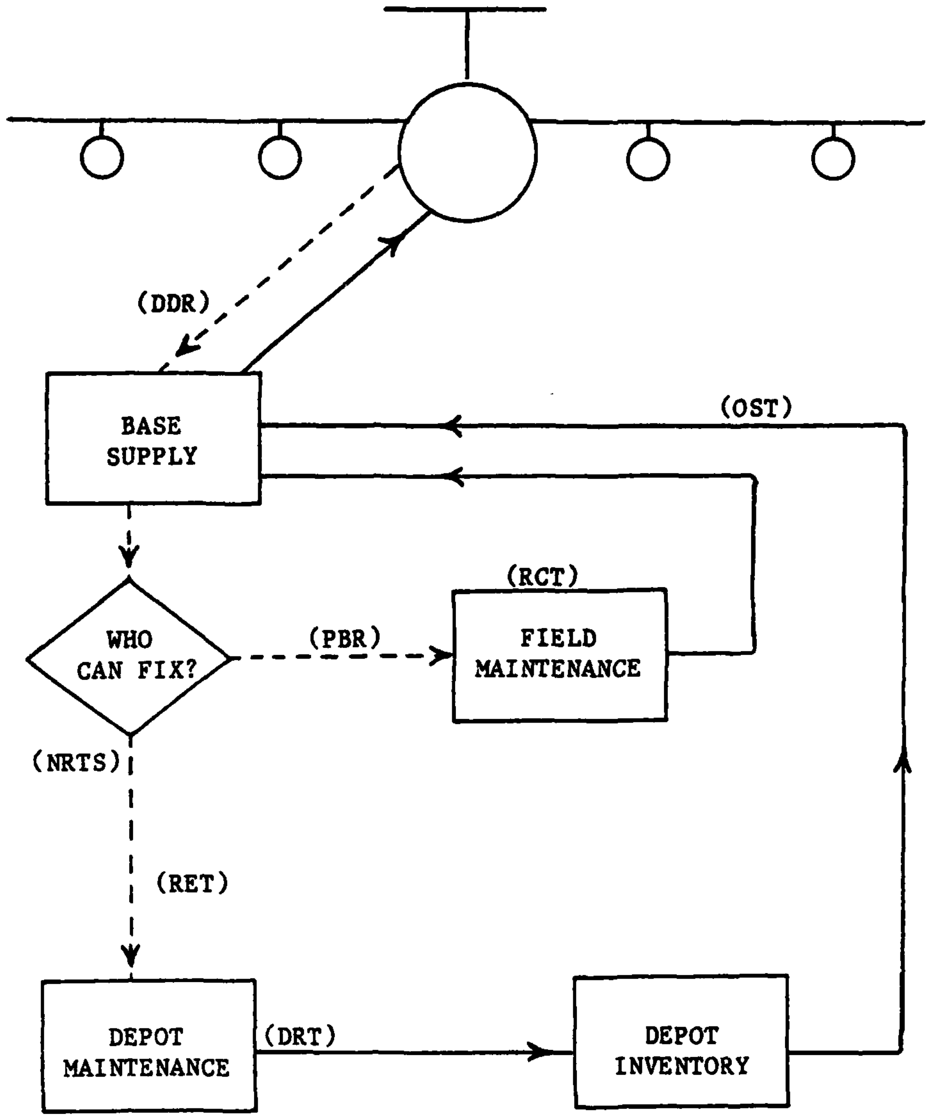
Reparable Inventory Theory

An inventory system is designed to answer two questions: when to order and how much to order. U.S. Air Force inventory procedures are designed to determine levels for both repair cycle assets and consumables. This research will focus only on repair cycle assets, although consumables or EOQ requirements are also important in meeting operational requirements (see reference 7 for details). A typical repair cycle that is based upon a two-echelon system is depicted in Figure 1. Refer to Figure 1 or Appendix A for acronym definitions.

Items that fail at the base level create a demand (DDR) on base supply (echelon 1). If a replacement part is available, an even exchange takes place and the airplane is repaired. Meanwhile, the failed part is either repaired at the base level with probability PBR, or shipped (RET) with probability 1-PBR to a depot level repair facility (echelon 2) if the repair is too complex for base repair. Thus, two pipelines of reparable parts are part of the model, one at the base and one from the base to the depot and back. Each location incurs a certain time for repair: RCT at the base or DRT at the depot. If the depot maintains an inventory of spare parts, it sends a replacement part back to the base (OST), provided that one is available, when a failure occurs. The assets in the depot pipeline would include those parts in transport between the depot and the base (DDR x NRTS x OST) (62: Vol II, Part 2). If the depot does not maintain an inventory level, then those assets in transit to or repair at the depot (DDR x NRTS x DRT) + (DDR x NRTS x RET) will add to the depot pipeline quantity.



Key:
DDR = Daily Demand Rate
PBR = Percentage Base Reparable
NRTS = Not Reparable This Station = 1-PBR
OST = Order and Shipping Time
RCT = Repair Cycle Time (On Base)
RET = Retrograde Time (Shipment to Depot)
DRT = Depot Repair Time
--- = Flow of Broken Parts
—— = Flow of Good Parts

Figure 1. Recoverable Item Management (7:Fig 1)

Parts in the pipeline system, including those in repair or transit to and from repair, do not increase the number of available aircraft. Thus, the number of spares required is at least equal to the number of spares in both pipelines, which is dependent on whether the depot contains stock or not. If everything worked perfectly, then as one part fails on an aircraft, another part would arrive from the depot an order and ship time later or from base repair to replace it. However, repair and transit times are not deterministic and may be described by some probability distribution. Additional stock must be procured to insure that stock is available when the repair or transit time is greater than expected. The inventory policy used in the Air Force in relationship to this concept will be discussed next.

Inventory Policy

The Air Force uses an (S-1,S) policy to order recoverable spare parts (23:10). The (S-1,S) policy is a continuous review inventory policy. This means that the base maintains its inventory position at a fixed level, S. Each time one or more units are demanded, the inventory position drops below S, and an order is placed (15:391). Thus, if the net inventory position (total stock on hand, plus stock on order, minus backorders) is negative, then a backorder condition exists. The decision thus becomes at what level do we set S in order to avoid a backorder.

Feeny and Sherbrooke (15:393) showed that Palm's Theorem could be used to calculate the number of units in resupply. Palm's theorem holds that if the demand process can be described with a Poisson distribution, with rate λ, and if the following three conditions are met:

1) service time is independent of the demand process

2) service time is a random variable having a mean time of τ

3) service capability is always existent

then the steady state probability that X units are in resupply is:

$$P(x) = \frac{e^{-\lambda\tau}(\lambda\tau)^{x}}{X!} \quad X = 0,1,2.... \tag{1}$$

Feeny and Sherbrooke extended the above generalization of Palm's theorem to show that the distribution of outstanding orders continue to be Poisson when demands are generated by stationary compound Poisson demand (15:393). This compound Poisson distribution is the same as the simple Poisson with the exception that batches of demand occur rather than single demands. In both cases the distribution of time between arrivals continues to be exponential (15:393). Complex inventory models have been developed by applying Feeny and Sherbrooke's extension of Palm's theorem under compound Poisson demand, and will be discussed later in this chapter.

System Performance Measures

System measurement criteria are vital to the proper evaluation of inventory systems in the Air Force. Performance measures assist decision makers in assessing inventory and service policies that will ultimately lead to increased overall combat capability. Some of the more important system measurement criteria (used in airlift and inventory models) are Fill Rate, Ready Rate, Not Mission Capable Supply, Cannibalization, and Utilization Rate. Each measurement criteria will be discussed next.

Fill Rate. A fill rate is the percentage of times an item is available from serviceable stock without a delay or backorder (46:291). The fill rate is calculated by dividing the number of units demanded in the same period. Any unfilled demand is a backorder. The fill rate can also be viewed as one minus the probability of being out of stock at a random point in time. Many inventory models use the fill rate as being the probability that a component will be available when a demand is placed (20:16). One major problem with using fill rate as a performance measure is that it ignores the amount of time a backorder exists (3:2).

Ready Rate. The ready rate (sometimes called the Operational Rate), is the probability that there are no backorders at any time for any part that would prevent an aircraft from accomplishing its wartime mission. Brooks, Gillein, and Lu (3:3) point out that ready rates have an advantage over fill rates or backorders because they can be directly related to a management objective, such as aircraft availability. However, ready rates fail to distinguish the number of aircraft with backorders.

Not Mission Capable Supply (NMCS). NMCS is a measure of the number of aircraft that are not mission capable or not operational due to a lack of spares (46:478). An average NMCS rate is calculated by dividing the number of NMCS aircraft by the total number of aircraft. If the maximization of available aircraft is a management goal, then the best measure of that goal is NMCS because the probability of available aircraft is the complement of the NMCS rate (1:5).

Cannibalization. Cannibalization is the act of replacing a defective part with an operable part removed from another aircraft (46:107). Cannibalization is a common practice that will reduce the number of NMCS aircraft by consolidating shortages within the least number of aircraft. However, additional costs involved in performing cannibalization (in manpower or possibility of damage) is less than the benefit gained from having another operational ready aircraft, then cannibalization should be performed (see 7:36-38 for additional discussion). Official Air Force policy on cannibalization is that "cannibalization is not to be considered a source of supply, but rather an emergency last resort means of reducing the mission impact of out of stock conditions [64:13]." However, Pacific Air Forces, in a report on cannibalization, concluded that there is always a "dominant group of critical parts" that controls the NMCS rate and can only be managed through cannibalization (22:1). Overall readiness would be dependent on a unit's ability to cannibalize parts (22:2).

Utilization Rate. Airlift capability is frequently defined in terms of ton-miles, ton-miles per day, closure time (time to complete a movement requirement), or flying hours per day. Because this research is interested in the capability of the strategic airlift fleet, airlift capability will be defined in terms of utilization rate (UTE rate).[†]

[†]While UTE rate is obviously not an inventory system performance measure, it is a measure that is vitally important to the airlift community.

UTE rate is the daily flying hour commitment of the primary aircraft authorization (PAA) airlift force (55:3). PAA is the number of aircraft authorized to a unit to accomplish its mission. For example, MAC has 267 C-141 aircraft, 234 of which are considered PAA. The other aircraft are used for training and backup to the primary aircraft. If the C-141 force has a 10.0 hour UTE rate capability, then the C-141 fleet can be expected to fly 2,340 hours per day (10.0 x 234 aircraft). Each aircraft is not required to fly exactly 10 hours per day. If only 180 C-141 aircraft were flying, then each aircraft must average 13.0 hours per day to achieve the fleet capability. However, if 260 aircraft were available, each aircraft would only have to fly 9.0 hours to meet the goal. The UTE rate is used to determine ton-mile capability and closure times through both simple equations and complex computer programs (9:9). Because many factors will affect the UTE rate, care must be used when equating utilization rate to system productivity (9:10).

Inventory Models

Basic inventory models for recoverable item stockage were first built around the steady state or constant average demand, and the service rate concept discussed earlier. During peacetime, when flying hours are fairly constant, demand and service for the constraint of steady state behavior (24:1). However, the surge of activity during wartime most probably would be anything but steady state. Thus, the assumption of steady state can cause degraded information during wartime conditions (29:10; 38:1). This section will review the evolution of inventory models from the single echelon steady state model to a multi-echelon dynamic model, beginning first with the Conventional Base Model.

Conventional Air Force Base Level Model. The Conventional Air Force Base Level Model is a steady-state model that computes a stock level for the base by first computing S, the pipeline quantity. The pipeline contains the total inventory of parts available. A safety stock level is set at $\sqrt{3S}$ (62: Vol II, Part 2, Chapter 11, pp. 3-13). Assuming a normal leadtime probability distribution, and a variance of 3S, the model achieves an 84 percent service level. The model is not intended to minimize or maximize any measure of supply performance, nor does it consider costs (7:40; 13:19).

METRIC. The METRIC model was developed over a number of years by the RAND Corporation and first reported by Sherbrooke (48). The first version of METRIC was a base stockage model that considered tradeoffs between stock items in order to minimize expected backorders subject to budget constraints (7:41). The base stockage model performed a marginal analysis for all the items at one base and determined which mixture of stock gave the lowest backorder level for a given dollar constraint (29:23). Before the base stockage model could be implemented, it was expanded by Sherbrooke to consider multi-echelons and multi-bases and named the Multi-Echelon Technique for Recoverable Item Control (METRIC).

The primary objective of the METRIC model is to minimize the sum of backorders on all recoverable items at all bases having the same weapon system subject to a given dollar investment in assets (48:123).

Depot backorders are a factor only as they affect base backorders (36:473). Some of the key limitations of the METRIC model are the following (13:26):

1. Steady state behavior, which does not account for surges in demand, is used.

2. Each item is assumed to be essential (subsystems are not separately accounted for).

3. Supply between bases is not considered.

4. There is no allowance for cannibalization.

In 1973, Muckstadt (38:472) extended the METRIC model to the MOD-METRIC model.

MOD-METRIC. Muckstadt found the METRIC model tended to concentrate more heavily on inexpensive components because it was able to decrease the backorder level by buying more of these items (29:28). To compensate in part for this tendency, MOD-METRIC permits two levels of parts to be considered, an assembly or line replaceable unit (LRU), and its components or shop replaceable unit (SRU). MOD-METRIC assumes LRUs will degrade mission capability while SRU backorders only delay repair of LRUs (7:42). Thus, MOD-METRIC does not assume that each part is equally essential. Muckstadt further expanded the MOD-METRIC model in 1976 (37:37) to consider a three echelon supply system: base, depot, and an intermediate repair facility.

The assumption of a steady state, still a part of the MOD-METRIC model, was reported in 1980 by Hillestad and Carrillo (24:1) to be both reasonable and convenient during peacetime. However, the initial surge of wartime scenarios may prove the steady state assumption invalid.

They also concluded that the service rate may differ due to initial deployment constraints and the possible lack of specialized equipment. These inadequacies led to Air Force-sponsored RAND research, resulting in the formulation of the Dyna-METRIC model. But, there were other efforts to address reparable model deficiencies at about the same time.

LMI Availability Model. One of the drawbacks with the METRIC and MOD-METRIC models is that military decision makers need to know how many aircraft are available, not how many backorders there are. The Logistic Management Institute (LMI) was tasked to develop a model that would express capability in terms of availability (33:38). The LMI Availability Model was developed as an expansion of the METRIC model to convert the expected number of backorders to the expected number of NMCS aircraft (33:12). While METRIC has an objective function to minimize the expected number of backorders by minimizing the sum of the probability of a stockout, the LMI Availability Model minimizes the product of the probabilities of a stockout to arrive at the expected number of NMCS aircraft (33:56-58). Because there is no attempt to consolidate backorders into the fewest number of aircraft (equivalent to a no-cannibalization policy), the model will overestimate stock requirements by including estimates for those LRUs which could be cannibalized (23:3).

Dyna-METRIC. Dyna-METRIC is a RAND-developed analytical inventory model designed to answer the question of how many aircraft will be available during wartime for a given stockage level of spares. Because it is analytical, the model can compute stock levels to support an operational scenario or determine performance for a given level of spare parts. Since its initial release in July 1980, Dyna-METRIC has undergone extensive revision. This review will focus on the Air Force standard version 3.04 but will also include discussions on modifications incorporated in later versions.

As pointed out by the developers of the Dyna-METRIC model (23:iv; 24:iv) and confirmed by Graybeal (20:9), the mathematics inherent in the Dyna-METRIC model are complex, requiring a thorough knowledge of integral calculus. The Dyna-METRIC model is a set of analytical mathematical equations describing the dynamic behavior of the component repair queueing systems (23:4). The next few paragraphs will describe the basic equation used in Dyna-METRIC.

The foundation of Dyna-METRIC is the non-steady demand process called the nonhomogeneous Poisson process. Demmy and Hobbs (10:15) summarized the general mathematical model as follows. Let X(t) denote the number of items in the resupply system. Then, if the assumptions required of Palm's Theorem are true (as previously described), X(t) has a Poisson distribution with mean $\lambda(t)$ where:

$$\lambda(t) = \int_{s=0}^{t} [1-F(s,t)]M(s)ds \tag{2}$$

with:

F(s,t) = the probability that a service started at time s is completed by time t

M(s) = the item repair demand rate at time s

Simply stated, "the mean number of items of any one type in resupply at time t is a function of all demands for that item and the capability to repair the items over the elapsed time period [10:15]."

The item demand rate, M(s), considers two periods of time: "peacetime" or steady state where M(s) is assumed to be constant, and "wartime" or dynamic state where demand changes daily (20:9). In both cases, M(s) is a function of many factors: failure per flying hour, flying hours per sortie at time t, number of sorties per day per aircraft at time t, number of aircraft at time t, quantity of the component on the aircraft, and percentage of aircraft with the component (24:8).

Service or repair probability, F(s,t), considers three echelons of repair: a depot, a centralized intermediate repair facility (CIRF), and bases. If the service time is considered constant, then the repair time is deterministic. If the service time is random (the usual case), then the repair time is assumed to be exponential. The user can specify which option will be used (10:15). An expanded discussion of Dyna-METRIC's mathematical basis occurs in references 23 and 24.

In lay terms, the Dyna-METRIC model considers an aircraft to be a collection of spare parts. In all cases, each of those parts is required to be operational, and each part can fail. If a part fails, and a replacement part is not available, the aircraft is considered NMCS until the part becomes available (18:22). If cannibalization is allowed, then the model consolidates shortages into the minimum number of aircraft. The LRU/SRU relationship, described previously, is an important ingredient of the Dyna-METRIC model (1:13; 12:14-15; 18:22; 20:10). The expected resupply time for a LRU depends on the expected waiting time for SRU components at the appropriate repair echelon.

Recent enhancements in Dyna-METRIC version 4.3 provide a significant increase in capability over previous versions such as 3.04. These improvements include (6; 67:2-3):

1. Subcomponents of SRUs (SubSRUs) can be included in the model.

2. Depot treatment was very limited in version 3.04. Only one depot which had an infinite source of stock depot could be modeled. More than one depot can now be modeled at a time, and specific stock levels can be assigned at each depot.

3. Transportation times, both forward and retrograde, can be specified for each depot and CIRF.

4. Condemnation rates can be specified for each part. This allows for easier application for EOQ items which incur 100 percent condemnation.

5. Separate and distinct repair times, NRTS rates, and condemnation rates can be designated for each part at each base, CIRF, or depot.

6. Cannibalization treatment can be designated for each part in the assessment mode. Requirements mode continues to apply full cannibalization for all parts.

7. Two different demand rates can be programmed for each part.

8. Demands can be generated against planned or actual sorties flown.

9. An option is available to make NRTS and condemnation decisions before the part enters the base repair cycle.

10. Nine different types of maintenance capability can be deployed.

11. A minimum quantity per application (QPA) can be used for each part that is less than the normally installed QPA.

Other improvements include smaller memory requirements and improved test equipment features.

The Dyna-METRIC model has much more capability than the MOD-METRIC model, especially in the wide variety of configurations it can handle. Major components that can be modeled range from a single base to a

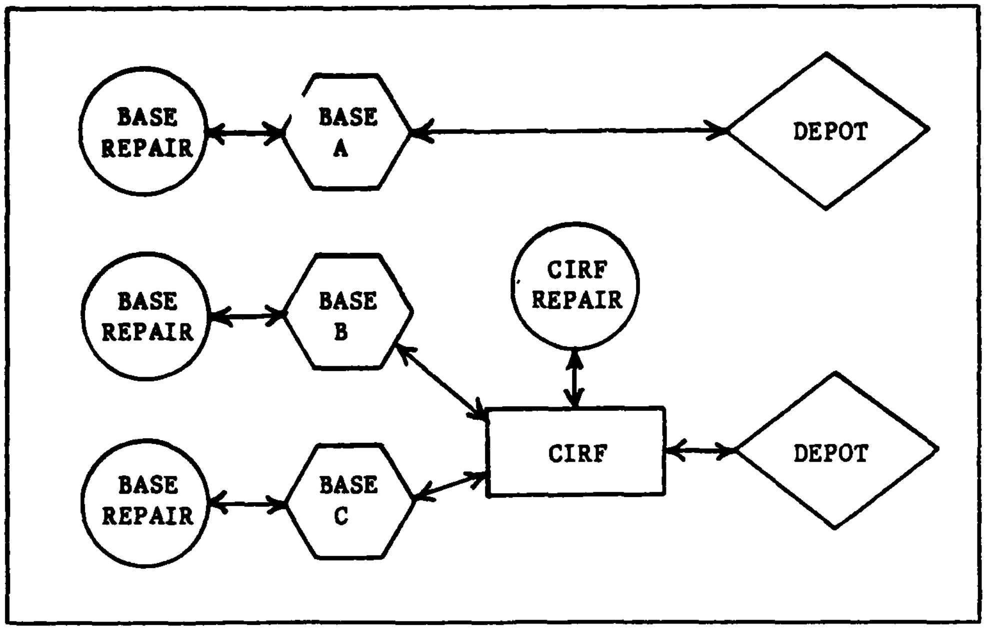


Figure 2. Dyna-METRIC Theater Configuration

multi-base theater (18:22). Graybeal has depicted an example of theater structure (20:Fig 1), as illustrated in Figure 2. The arrows depict the flow of spare parts within the system.

As flexible as Dyna-METRIC is, it is still not without some assumptions and limitations. The limitations and input/output configurations that have an impact on an application of the model to strategic airlift will be discussed in Chapter III.

Dyna-METRIC has been used at HQ TAC for assessment of F-15 supply strategies, and at Ogden ALC to measure F-16 performance at USAFE and PACAF bases (29:52). The first major use of Dyna-METRIC was by the Tactical Air Command in their PACERS (Peacetime Assessment of the Combat Effectiveness of Recoverable Spares) program (5:6). The PACERS system is used to assess the WRSKs of individual units. In another large-scale use, AFLC's Weapon System Management Information System (WSMIS) has been established with Dyna-METRIC as the planned capability assessment tool for sustainability of theater-level capability. The Sustainability Assessment Module (SAM) of WSMIS plans to extend Dyna-METRIC evaluation to a wider variety of aircraft. Version 3.04 has been used to assess the following aircraft: F-4, F-15, F-16, F-111, A-10, and E-3A. The bomber and tanker force of SAC and the C-5 of MAC are currently under consideration for their compatibility with Dyna-METRIC's constraints. Plans are to utilize version 4.3 for this and future efforts (11). This research directly supports AFLC's and SAM's goal of applying Dyna-METRIC to strategic airlift aircraft.

Logistics Requirement Analysis Model (LOGRAM). The LOGRAM model is another weapon system capability model used to determine a daily aircraft availability. LOGRAM is the only tool currently used to evaluate spares capability for strategic airlift (2; 43). The LOGRAM model uses demand data from the D041[†] system. Factors used in the model include peacetime demand rates, NRTS rates, condemnation rates, pipeline quantities, and asset levels. Demands for each asset are computed independently using the D041 data. The asset that is "least supportable for each day determines the total weapon system capability for that day [31:2]." This equates to a 100 percent cannibalization

[†]D041 is used to forecast worldwide replenishment spares requirements (60:1-1). Failure data on recoverable items is collected on a quarterly basis which provides for a time phased forecast of requirements for 25 quarters into the future (49:8).

policy. The end result is a day-by-day or month-by-month percentage of available aircraft (31:3).

The model incorporates a combined asset evaluation. That is, all demands and assets are assumed to be at one location. Thus, reparable assets are assumed to be where they are needed (31:4). Sproul showed (without considering the problem of combined assets) that the LOGRAM model provided significantly higher estimates of F-16 wartime availability than the Dyna-METRIC model (49:36). The surge and sustained flying hour capabilities used by General Huyser (see Chapter I) resulted from an earlier version of this model (43).

Spares Requirements and Strategic Airlift†

This section will review the methodology currently used to determine the level of required spares. First, the process implemented within AFLC will be examined. Next, the airlift system and their two methods used to determine spares will be discussed. The last part of this section will review an effort using simulation at HQ MAC.

AFLC Methodology. Requirements for aircraft spares and repair parts is a dynamic process that needs constant review. The Recoverable Consumption Item Requirements Computation System (D041), described in AFLCR 57-4, is used to determine both peacetime and wartime requirements for recoverable spare parts. The D041 system forecasts

†This discussion draws heavily on interviews with Major Philip Bown, Chief, Readiness Branch (HQ MAC/LGSWR), and his staff and Mr. Jack McWhirt, Forward Supply System Analyst, Airlift Support Branch (HQ MAC/LGSWA).

and computes worldwide requirements on the basis of parts usage and stock level data collected through various other data processing systems (60:1-1). Although the D041 system computes the requirements for an item, the decision whether to buy, repair, redistribute, or dispose of stock is made by the item manager. The wartime spares requirements input to the D041 comes from the WRSK/BLSS Requirements Computation System (D029).

The first step in the WRSK/BLSS computation process is a spares listing developed by the major commands, system managers, item managers, and Air Force Logistic Command (60:1-19). This manual computation process has been thoroughly described by Rasmussen and Stover (42:10-14). Beginning in 1980, a marginal analysis technique was added to the WRSK/BLSS computation system (65:9). The conventional analysis sets the support level by using historical failure rates and wartime flying hours (57:2-1). Using the MOD-METRIC logic discussed earlier, the expected number of backorders is evaluated against the expected number of NMC aircraft. Then, using a marginal analysis technique, the D029 attempts to find a kit having the same level of support but costing less (65:9). D029 computations, run annually, are fed into the D041 system to form the basis for all USAF spares requirements (57:3-1).

MAC Methodology. The requirements determination system just reviewed is an Air Force standard system. However, the nature of strategic airlift dictates deviation from the traditional computation methods (57:2-1). Peacetime support for MAC airlift forces is accomplished through a dual track system. First, peacetime operating stock (POS) at each CONUS homebase supports a remove, repair, and replace (RRR) maintenance concept. The second portion of peacetime stock is a partial extension of POS in a forward supply support system (offshore) that primarily supports a remove and replace (RR) maintenance concept. The POS needed to support flying activities within the CONUS effects the amount of stock in the BLSS while demands within the offshore system effect levels in the WRSK.

The MAC forward supply support (FSS) system is described in AFM 67-1, Vol I, Part 1, Chapter 11, Section B. The FSS system is composed of an interrelated worldwide network of primary supply points (PSPs), forward supply locations (FSLs), central supply/repair points (CSP/CRPs), and forward supply points (FSPs). In wartime, the stocks in the FSS may be augmented with WRSKs.

The primary supply point (PSP) is an activity located at a MAC base which supports strategic airlift aircraft. The PSP acts as the asset manager in supporting the forward supply locations with the required spares. The stock at forward supply locations is an extension of peacetime operating stock at the PSP. The PSP acts as a depot for the forward supply locations, and accomplishes field and intermediate level maintenance of selected FSS reparables. There are four PSPs, two located on the east coast and two on the west coast (16). For example, McGuire AFB acts as the PSP for the C-141 FSLs in Europe and the Middle East. See Figure 3 for a depiction of all locations.

Forward supply locations are key points along airlift traffic routes to provide supply support for worldwide strategic airlift. Currently there are twelve FSLs located at major enroute locations

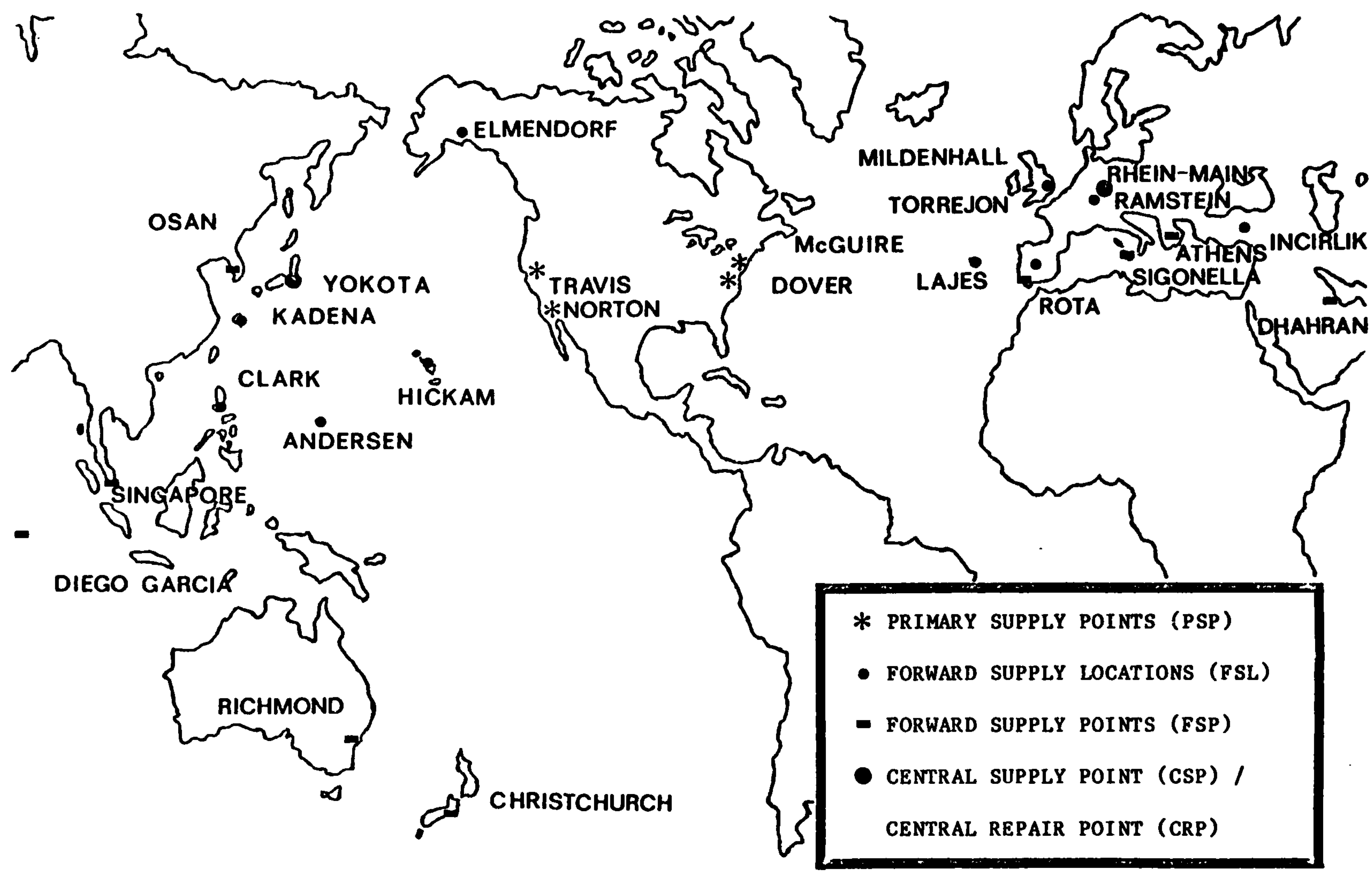


Figure 3. MAC Forward Supply Support System

(16). A central supply/repair point is a specialized C-141 avionics item repair, storage, and distribution point. Currently, about 35 avionics parts are repaired at the CSP/CRP located at Rhein-Main AB. The last component of the MAC supply network is the forward supply point. The FSPs are located at enroute stations which require a minimum of mission essential items. Recoverable items stocked at a FSP are carried on the supply records of a designated FSL. This means that a demand for a specific part at Christchurch, for example, will be reflected in the demand data at Hickam AFB. Stock levels within the FSS are updated monthly based on forecast changes in the number of scheduled landings at each FSL.

Each of MAC's five C-141 wings owns one BLSS kit and maintains one WRSK. An additional C-141 WRSK is maintained at Dover AFB. Each WRSK is the same size and is subdivided into seven segments. The next section will address how stock levels are determined for these two types of kits. A summary of the computation methods are presented in Table I. Acronym definitions are in Appendix A.

BLSS requirements or recommended levels for a MAC Wing are computed in accordance with the standard pipeline concept with a slight modification contained in MAC program Q52 (58). Because DDRs, OSTs, and RCTs will vary for each base, the BLSS at each C-141 base will be different. In order to transition from a peacetime demand level (demands on the POS) to a wartime level of requirements (BLSS and POS), MAC uses a program factor adjustment (PFA). The PFA is the method used by MAC to account for a wartime surge in parts usage. The PFA is also used in the WRSK computation and will be discussed later.

TABLE I

WRSK and BLSS Computation Methods

BLSS (58)		
Factored DDR (FDDR)	=	DDR x PFA
Factored RCQ (FRCQ)	=	FDDR x PBR x RCT
Factored OSTQ (FOSTQ)	=	FDDR x OST x NRTS
Factored NCQ (FNCQ)	=	FDDR x NCT x NRTS
Factored SLQ (FSLQ)	=	$\sqrt{3\ (FOSTQ + FRCQ + FNCQ)}$
Demand Level	=	FRCQ + FOSTQ + FNCQ + FSLQ
Recommended BLSS	=	Demand Level - POS
WRSK (59)		
Wartime DDR (WDDR)	=	DDR x PFA
Wartime Stockage Objective (WSO)	=	WDDR x 30
Wartime Safety Level (WSL)	=	$\sqrt{3WSO}$
Wartime Quantity	=	WSL + WSO + .5

MAC WRSKs fulfill two requirements. First, WRSK augments and expands the peacetime forward supply locations to meet wartime activity at those locations. Second, WRSK is used to support the airlift system at locations without any MAC supply support. Even though each C-141 Wing maintains a WRSK, they do not own that kit. Once deployed, that kit may be used by any C-141. The concept is that each of the six kits are part of one single, large C-141 WRSK. Since each kit contains seven segments, a total of 42 segments are available for deployment. Six of the segments are designed to support 300 landings each (TA segment). Eighteen are designed to support 175 landings each (TB to TD segments). The remaining 18 are designed to support 75 landings each (AA to AC segments). The single (segmented) kit concept was developed by HQ MAC and approved by HQ USAF in 1978.

While stock levels in the BLSS are based on a pipeline concept, stock levels in the WRSK are based on a demand concept. These demands are based on failure data within the overseas FSS only. Reparables returned from offshore areas to the appropriate PSP are treated as non-recurring demands at that PSP. Thus, failure rates that determine WRSK quantities do not affect the demand rate for POS and BLSS quantities at CONUS locations. Failure data at the 12 FSLs are maintained by HQ MAC/LGSWA for 12 months and converted into a daily demand rate. This rate is multiplied times the PFA to determine a wartime demand rate. The wartime demand rate is multiplied times 30[†]

[†]This figure is in the process of being increased to 45. However, current C-141 WRSKs contain spares for 30 days (2).

to determine the stock requirement (including a safety stock) to support (without resupply) a 30 day war. HQ MAC supply personnel then divide the total required quantity into the above mentioned WRSK segments. WRSK levels are updated in this manner once a year during the annual WRSK review. Other changes in WRSK levels are the result of suggestions from base-level WRSK managers and notification of technical modifications.

The Air Force uses a direct-proportionality model (1:1 linear relationship) based on total flying hours to project wartime requirements from peacetime demands (64:12). For example, if there is one demand per 100 flying hours and the wartime requirement is 300 hours, then the forecast wartime demand level is three. A linear method assumes that past failure rates are valid predictors for future time periods (47:35). Recent research has been directed at the related question of the effect of changes in the sortie length on failure rates. Casey and Shaw concluded that increased sortie length for strategic airlift aircraft reduced failures per flying hour (8:27; 47:97). This concept would be important if wartime sortie lengths are significantly greater than peacetime averages. In his study, Shaw suggests sortie lengths are longer during wartime (47:48). If true, the end result would be a proportionally smaller requirement for spare parts. However, Pederson, Persensky, and Triwush concluded that "neither the number of sorties nor average sortie length is a better determinant for aircraft spares requirements than number of flying hours (39:75)."

Instead of a straight linear factor, MAC uses a program factor adjustment (PFA) to transition from peacetime demands to wartime requirements for both WRSK and BLSS quantities. Although the PFA for each type kit is computed in a similar manner, there is one important difference that results in a different PFA for WRSK computations versus BLSS computations. The PFA computation is a three-step process shown below:

Step 1: PEACETIME FLYING HOUR SUMMARY

Total Flying Hours = Offshore Flying Hours + CONUS Flying Hours

Peacetime UTE = Total Flying Hours ÷ (365 x Number of Aircraft)

Peacetime Offshore UTE = Offshore Flying Hours ÷ (365 x Number of Aircraft)

Step 2: WARTIME FLYING HOUR SUMMARY

Wartime Commitment = Wartime UTE x Number of Aircraft x Days Supported

Offshore Wartime Commitment = Wartime Commitment x (Peacetime Offshore UTE ÷ Peacetime UTE)

CONUS Wartime Commitment = Wartime Commitment - Offshore Wartime Commitment

Wartime Offshore UTE = Offshore Wartime Commitment ÷ (Number of Days supported x Number of Aircraft)

Wartime CONUS UTE = CONUS Wartime Commitment ÷ (Number of Days Supported x Number of Aircraft)

Step 3: WRSK/BLSS PFA

WRSK PFA = (Wartime Offshore UTE - Peacetime Offshore UTE) ÷ Peacetime Offshore UTE

BLSS PFA = Wartime CONUS UTE ÷ Peacetime CONUS UTE

After numerous reduction steps, the BLSS PFA simplifies to a ratio of wartime flying hours to peacetime flying hours. This is equivalent to the Air Force linear relationship in determining wartime spares requirements. The WRSK PFA computation is slightly different in that the peacetime utilization rate is subtracted from the wartime utilization before being divided by the peacetime rate. However, the formula used by MAC to derive the total WRSK quantity does not subtract peacetime quantities from computed levels as done in the BLSS computation (see Table I). Therefore, if the stock levels in the FSS are the proper quantity to support the peacetime flying requirement,[†] then the relationship of the BLSS PFA to the WRSK PFA is as follows:

$$\text{BLSS PFA} = \text{WRSK PFA} + 1$$

The derivation of this relationship is shown in Appendix B.

Table II summarizes PFA calculations for three peacetime utilization rates with a varying percentage of onshore and offshore flying hours. With a constant peacetime utilization rate, the PFA is unaffected by changes in the distribution of flying hours. Thus, the relationship of CONUS to offshore flying hours is not a factor in the calculation of the PFA. Increases and decreases in the peacetime utilization rate cause the expected opposite reaction in the PFA. In summary, MAC's PFA is affected by changes in the peacetime UTE rates

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[†]In CY83, the FSS maintained a 95.9 percent fill rate and 95.3 percent of the missions departed within schedule (32).

TABLE II

PFA Calculation Results[†]

Peacetime Utilization Rate	CONUS % Flying Hours	Offshore % Flying Hours	WRSK PFA	BLSS PFA
3.24	60%	40%	2.7	3.7
3.24	50%	50%	2.7	3.7
3.24	40%	60%	2.7	3.7
3.24	25%	75%	2.7	3.7
2.50	60%	40%	3.8	4.8
2.50	50%	50%	3.8	4.8
2.50	40%	60%	3.8	4.8
4.00	60%	40%	2.0	3.0
4.00	50%	50%	2.0	3.0
4.00	40%	60%	2.0	3.0

[†]Wartime utilization rate used is 12.0 hours/day.

and DDRs, not flying hours directly. Next, MAC's effort at simulating the airlift system will be discussed.

M-14 Simulation Model. In order to test and evaluate airlift performance, MAC has developed an extremely large simulation model of the airlift system, M-14. The model consists of more than 20,000 lines of FORTRAN code written in the GASP simulation language (21:20). The M-14 model plans and executes airlift operations by modeling the actual components of MAC's airlift system. The resources modeled include aircraft, aircrews, maintenance personnel, bases, material handling equipment, reparable spares, and others. M-14 models these components individually, and combines them into an overall system view of airlift operations (21:21).

A heuristic spares availability model was developed for M-14 by Mitchell, Patterson, and Olsen (34). A mathematical solution to the problem of what is the probability that a demand for a part in a WRSK will not be satisfied was developed using a negative binomial distribution. A Weibull cumulative distribution function was fitted to the mathematical solution suggested by the negative binomial distribution. Using regression analysis with the ratio of the number of parts in a WRSK to the number of distinct parts in the WRSK, the Weibull shape parameters are estimated. The result is a heuristic model that uses only three inputs to determine whether a part requested is satisfied or not. M-14 does not evaluate the availability of individual spares. The chance that one key spare part could cause NMC aircraft at numerous bases is not a consideration in the M-14 model.

Summary

This chapter initially presented an overall view of recoverable inventory theory and item management in today's Air Force. System performance measures were discussed, followed by a chronological review of inventory stockage models. The early models were simple and tended to build on their predecessors. While the Dyna-METRIC model is the most sophisticated of the inventory models, some of the key assumptions are not inherently compatible with the reparable spares determination process for airlift aircraft. An understanding of the airlift system and the relationship of peacetime to wartime requirements is a key to the use of the Dyna-METRIC model in this research. This relationship will be used as the foundation to build the research methodology in Chapter III.

III. Research Methodology

Overview

The methodology for this thesis required three features to achieve the research objectives. First, an inventory model which would accommodate the dynamic nature of spare part failures on aircraft was required. For this research, RAND's Dyna-METRIC model was chosen. Dyna-METRIC is an Air Force-documented inventory model (63:3) that has been progressively improved upon by RAND since its initial release in 1980. Dyna-METRIC results may be obtained in terms of availability of aircraft, problem spare parts, or spare parts needed to reach a capability goal set by management.

Next, an accurate representation of the MAC strategic airlift system in a wartime resupply effort was required. In support of this requirement, an unclassified scenario was obtained from HQ MAC/LGSWR which depicts the mission profiles that will be flown, the general location of bases to be used, and the location of the spare parts that will be available during a Southwest Asia scenario. After relationships within the MAC supply and operational network were understood, spares data obtained from HQ MAC, HQ AFLC, and the 438 MAW/LGSSA were prepared for input into the most current reparable spares inventory model available.

Finally, an experimental design that would answer the research questions was required. A baseline set of three Dyna-METRIC runs was established to model the six representative supply concepts of strategic airlift aircraft during wartime. The successful establishment of the baseline provided the answer to the first research question: Given a realistic strategic airlift scenario and authorized levels of POS and WRM, can Dyna-METRIC provide reasonable estimates of airlift combat capability? Next, sensitivity analysis, using the baseline Dyna-METRIC results as a control, was performed, answering the second research question: How sensitive are Dyna-METRIC outputs to changes in key input variables that are determined by MAC's unique methodology for determining spares requirements? Results are presented in tabular and graphical form for ease of interpretation and comparison.

Dyna-METRIC

The evaluation tool chosen was RAND's Dyna-METRIC reparable inventory model. Dyna-METRIC is the most current inventory model in a series of models, dating from the middle 1960s (refer to Chapter II). However, Dyna-METRIC is the first to model the dynamic nature of the spares replenishment process. The dynamic queueing equations used by the Dyna-METRIC model accommodate the changing nature of the number of aircraft, flight times, and stock levels. The dynamic nature of a wartime environment makes the model ideally suited for measuring spares capability.

The fact that Dyna-METRIC is an analytic model enhances its value. Unlike a simulation model, Dyna-METRIC gives only one set of output for a set of input variables. This dramatically reduces the computer run time necessary. According to Gordon, in System Simulation,

> The step-by-step nature of the simulation technique means that the amount of computation increases very rapidly as the amount of detail increases. Coupled with the need to make many runs to explore the range of conditions, the extra realism of simulation models can result in a very extensive amount of computing [19:42].

Simulation can be much more detailed in modeling the system network. It can represent "every resource and procedural constraint in a physical system that the modeler can identify and measure [40:9]." An example of simulation applied to MAC is the M-14 simulation discussed in Chapter II. It is so extensive that HQ MAC does not have a computer capable of running the simulation. Runs are accomplished at Kirtland AFB, on the Air Force Weapons Laboratory CRAY-1 computer. But an analytic model can approach the simulation model in accuracy of prediction, according to Pyles, "by incorporating only those details that dramatically affect overall performance [40:10]." An additional feature of analytic models is that they may be 'solved backwards'. Relative to Dyna-METRIC, this means that the logistician may determine the level of spares required to meet a chosen performance level. Such a determination is not possible through simulation.

Model Assumptions

There are assumptions present in any model to keep it mathematically tractable. Dyna-METRIC is no exception. The following assumptions and limitations are applicable to any Dyna-METRIC application:

1. Repair and demand processes are independent of each other (20:12).

2. The model never looks at individual aircraft. Weapon systems are evaluated as a whole (18:23).

3. The sortie rate is not constrained by flight line limitations. For example, maintenance manning levels or weather conditions are not considered (7:53; 40:42).

4. Only a single type of aircraft can be considered at a time (20:12). For example, F-4Cs and F-4Ds can be included in the same input file. However, F-15s and F-16s would require two separate files.

5. User inputed spares requirements comprise all events that might ground an aircraft (18:23).

6. Cannibalization occurs instantly and at no cost to the system (7:54). Additional repair time required for the cannibalization process is not taken into account, thus overstating capability when cannibalization occurs (51). However, the cannibalization time may be included in the repair cycle time, if known.

7. Aircraft are semi-homogeneous. That is, if cannibalization is allowed, then the other aircraft at the base have parts that are interchangeable (7:53; 51).

8. Average repair times of the components are stationary about their means. That is, repair surges and slowdowns are not evaluated (7:52; 51).

9. Daily demands are assumed to be Poisson. This is the same as saying that LRU lifetimes are exponential, showing no wearout after a break-in period. LRUs that wear out more often than in an exponential manner will fail more than Dyna-METRIC predicts, resulting in less capability than the model predicts for these components (51).

10. LRUs and SRUs have a failure rate linearly dependent on the number of hours an aircraft flies. The consumption rates on some items, such as tires, have no correlation with flight times. See references 8, 39, and 47 for further discussion of this topic.

11. All aircraft are Fully Mission Capable (FMC) at the start of the scenario (51). As the entire C-141B fleet is not being modeled, it will be assumed that the modeled aircraft are FMC.

12. All information input by the user is correct (18:23).

13. The user-entered sortie requirement is used to compute the consumption of spares. Thus, the number of planned sorties, not the number of FMC aircraft, will generate demands (40:43).

In addition to the 13 assumptions presented above, the following assumption is particularly applicable to the strategic airlift system:

14. Lateral resupply is not permitted (7:54).

In actual practice, if a strategic airlift aircraft has a component failure while away from home station, a replacement part will be located at a base/depot close to the broken aircraft. This part would then be placed on the next airlift aircraft departing for the location of the breakdown. Order and ship time is decreased dramatically. In general, since MAC 'owns' the resupply fleet, the order and ship times can be reduced significantly when the need arises, as compared to other command's OSTs.

Although the assumptions and limitations of Dyna-METRIC appear extensive, it is the latest and most sophisticated of reparable inventory models used by the Air Force. Improvements to version 3.04 have been numerous and are manifested in Dyna-METRIC version 4.3.

Model Improvements

Dyna-METRIC version 4.3 incorporates 11 new features as identified by references 6 and 67. Seven of these features were not used in this research:

1. Sub-SRUs may be modeled. However, only LRUs were identified in the sample parts listing for this study.

2. Cannibalization of selected LRUs and SRUs is possible with version 4.3.

3. Condemnations of LRUs are possible. For strategic airlift aircraft, battle damage will be less of a factor than for tactical aircraft.

4. The capability exists to deploy one of nine different maintenance capabilities for each LRU. No unique maintenance capability will be modeled for the study.

5. The capability to model test stands is operational in version 4.3.

6. Demands may be based on planned sorties or actual sorties flown. The computer subroutine for this feature was not available for use in this study, but was not necessary for modeling MAC's WRSK concept.

7. Different QPAs for each part may be specified for individual bases. Also, a minimum QPA may be specified by base, allowing for enhanced modeling of redundant aircraft systems. Minimum QPA data for individual LRUs was not obtainable for this study.

Version 4.3 improvements utilized in this application of Dyna-METRIC to strategic airlift include the following:

1. Depot treatment is complete, with the ability to model more than an unlimited supply of stock, as in version 3.04. This feature allows the modeler to isolate performance changes to OSTs, instead of the availability of depot or CIRF stock.

2. Transportation times may be specified as two-way. This allowed for modeler-controlled OSTs.

3. NRTS and condemnation decisions may be made prior to attempting repair.

4. Both onshore and offshore demand rates may be modeled with version 4.3. This feature is necessary for a combined input Dyna-METRIC run of CONUS and overseas flying.

Modeling Strategic Airlift

The mission profiles of airlift missions are vastly different than that of the fighter aircraft for which Dyna-METRIC was designed. A basic premise of Dyna-METRIC is the concept of a unit of aircraft deploying to a single base and operating out of the base for the duration of the conflict. In MAC, only the tactical C-130's mission could approximate that scenario. The strategic airlift profile calls for intermediate stops for uploading cargo or fuel enroute to the final destination. After the disembarkation of cargo at the destination, a depositioning sortie might be flown. The mission profile differences have prevented the application of RAND's Dyna-METRIC model to strategic airlift aircraft up to this point. The method of overcoming this fundamental difference in mission profiles is basic to the research methodology.

To accommodate the single operational location premise of Dyna-METRIC, airlift resources will be allocated to the various bases that the scenario will encompass. A key element in applying Dyna-METRIC to this scenario is spares availability during the flying profile. The disposition of the POS, WRSK, BLSS, and FSS must be depicted realistically to not only obtain valid results from Dyna-METRIC, but also to provide a realistic capability assessment tool for use by the airlift community.

Spare parts will either be stationary in location, as POS, BLSS, or FSS, or deployed as WRSK segments. Aircraft will be allocated to the different bases to be modeled, with sorties flown as 'out-and-backs'. For example, if a base is scheduled to support 10 landings per day, then 10 aircraft at that base, each flying one sortie (out and back) would represent that requirement. Also, five aircraft, flying two sorties each, would represent the same requirement. The length of the sortie into the location multiplied by the number of sorties per day will represent the flying hours required for the wartime utilization rate, generating LRU failures. It is hoped that by modeling the strategic airlift system in segments, an application of Dyna-METRIC will provide useful results to the logistical and operational communities.

Scenario and Research Data Base

HQ MAC/LGSWR provided an unclassified scenario for this study. The scenario is based on a realistic contingency supply operation into Southwest Asia. Aircraft usage rates, flying times, and support base locations were provided in detail. However, utilization rates (flying hours per day per aircraft) were not at a wartime equivalent. From this MAC-provided scenario, a simplified, representative scenario was developed.

Scenario. Six bases were used to represent the various operational concepts and spares positioning policies of MAC. First, a base representing the home station for a wing of C-141Bs will be modeled with authorized levels of POS and BLSS stock. A representative number of aircraft will be flown against the resources in place. Next, a base will be modeled with actual FSS stock supplemented by a TA WRSK segment. The sum of the stock is designed to support 245 landings over a 30 day period. Third, a European base with FSS stock capable of supporting 100 landings will be supplemented by an AA WRSK segment. This will bring the total forecasted landing support capability of the base up to 175 landings. Additionally, this base will represent one of the European bases serviced by the avionics CIRF at Rhein-Main AB, Germany. Several specific C-141 LRUs are serviced at the Rhein-Main facility, instead of being returned to the Primary Supply Point. Thus, ten of the LRUs in the developed parts list will be returned to the Rhein-Main CIRF, also known as the Central Supply/Repair Point (CSP/CRP), for repair. The three remaining bases modeled will represent forward bases with only a TA segment (300 landings), TB segment (175 landings), and an AA segment (75 landings) of the WRSK, respectively. Thus, the six bases represent the spectrum of MAC spares positioning.

Data Base. Specific reparable parts and stock levels for the C-141B were obtained from a variety of sources. Two D029 Computation Lists were made available by HQ AFLC/XRSA on the CREATE computer: WRSK kit serial number 0C141B0Q1800, containing 228 reparable parts and BLSS kit serial number 0C141B0QR470, containing 735 reparable parts. Authorized and actual POS and BLSS levels were obtained from the 438th MAW, McGuire AFB. WRSK stock levels, by segments, were obtained from HQ MAC/LGSWR. Additionally, FSS stock levels were provided by HQ MAC/LGSWA. The task of segmenting the data base into a representative supply network for MAC strategic airlift was a critical step in the realistic scenario portrayal.

Data Preparation/Segmentation/Manipulation

The purpose of this research was to demonstrate the use of Dyna-METRIC as a tool for assessing strategic airlift WRSK and BLSS stock levels, not to provide an actual, comprehensive capability assessment for the strategic airlift fleet. Therefore, there was not a need to evaluate the entire WRSK and BLSS kits. A representative number of parts would accomplish the same goal. With this purpose in mind, problem parts lists were solicited from MAC, AFLC, and

Warner-Robins ALC. Response was received from two agencies at MAC and one at AFLC. Approximately 35 LRUs were identified by this method. To augment the list of parts, three Dyna-METRIC runs were made against the D029 WRSK computation list, and one run made against the BLSS computation list using failure rates contained in the D029 listing. These runs provided an additional 100 items identified as possible problem parts for the data base.

Items were deleted from this listing for a variety of reasons. Any equipment used for the C-141's airdrop mission was deleted, as the 438 MAW is not tasked with this mission. Parts that were not listed in the McGuire POS, BLSS, or D029 WRSK list, but found in the FSS demand data were eliminated, as the FSS system represents peacetime overseas demands, while the BLSS and WRSK stock is anticipated wartime requirements. Some parts were identified by MAC as being concurrently replaced with updated versions, and were therefore eliminated. As a result of this screening process, a representative list of 91 LRUs was selected. No SRUs were identified by the Dyna-METRIC runs or by the applicable agencies for consideration.

The specific individual WRSK segments for each base were identified by HQ MAC/LGSWR, through MAC's D040 listing. As mentioned above, each WRSK segment is designed to support a given number of landings at either an enroute base(s) or at the primary point(s) of disembarkation. The TA WRSK segment is designed to support 300 landings; TB-TD, 175 landings; AA-AC, 75 landings. The individual kits "can provide support for a multitude of locations with the deployed WRSK being redeployed to meet onload, enroute, offload, and recovery requirements [35]." Not all aircraft, however, are dependent on the spare parts contained in the WRSKs as their primary source of supply.

The home station departures of strategic airlift aircraft are dependent on two sources of spare parts: POS and BLSS. The authorized and actual stock levels of both the POS and BLSS for the 438 MAW, a representative unit, were obtained from the 438 MAW through HQ MAC/LGSWR. Authorized levels will be used for the Dyna-METRIC runs, as a capability assessment of current stock levels is not the goal of this research. However, it should be noted that the actual stock levels were extremely short of the authorized level for some items. Refer to Appendix C for a comparison of authorized and actual stock levels for the 438 MAW POS and BLSS. The level of spares in the POS and BLSS will be available for flights only from the home base, in the Dyna-METRIC runs for this study. Aircraft arriving and departing from offstation bases will rely on deployed WRSK segments, and possibly the pre-positioned forward supply stock (FSS).

The availability of spare parts in the FSS system must be accounted for in a valid assessment of strategic airlift spares capability. The level of stock maintained in FSS is determined by the number of peacetime landings a location experiences per month. The effect of FSS may be major, given the volume of sorties that can be expected in a wartime scenario. In the first days of a scenario, the FSS will keep a portion of the aircraft operational, and must be considered a necessary component of the data base. FSS stock levels for the bases represented in the MAC scenario were obtained from HQ MAC/LGSWA (Aircraft Support Branch). Authorized stock levels for the two forward supply support bases modeled in this study are listed in Appendix C.

Demand rates for spare parts may differ depending on the location of the aircraft when the part fails. Strategic airlift aircraft are large, four-engined aircraft, with redundant systems. This feature allows aircraft commanders some latitude in a decision to continue with a broken LRU or to ground the aircraft and have it repaired. Based on the experience of both authors, as operational MAC aircrew members, there is a higher probability that aircrews will proceed with an aircraft with defective LRUs when away from their home station.

The aircrew proceeding on a mission with broken LRUs infers that all parts in a WRSK or BLSS are not mission essential at all times and that the final authority is the aircraft commander. At many offshore locations, some mission essential items are not replaced if they are not available from stock at hand. As a result, onshore demand rates (home station) are generally higher than offshore rates.

MAC onshore (U.S. major base) failure rates were obtained from the 438 MAW for calendar year 1983. Failure rates for the 438 MAW were in the form of a daily demand rate which was converted to demands per flying hour with the following formula:

$$\text{Demands per Flying Hour} = \frac{\text{Number of Demands} \times 365 \text{ Days}}{\text{Flying Hours} \times \text{QPA}} \qquad (3)$$

Calendar year 1983 flying time for arrivals at McGuire AFB was obtained from HQ MAC for the computations (4). The D029 listing provided by AFLC also has demand rates for the same parts, but the D029 demand rate is a world-wide rate. These demand rates are given as demands per flying hour.

Offshore (away from home station) failure rates, in terms of flying hours, were not as easily obtainable. HQ MAC/LGSWA tracks the daily demand rate at each of the 12 FSLs throughout the world. Demands at the FSPs are included in the demand data at the FSLs. A retrieval from MAC's Military Air Integrated Reporting System (MAIRS) was required to determine arrival flying hours for each of the 12 FSLs and seven FSPs for a 12-month period paralleling the failure data obtained from HQ MAC/LGSWA. However, flying hours at other locations within the same theater as the FSS location will also generate demands on the FSS system. Therefore, the flying hour figure used to calculate offshore demand rates includes all flying hours in the theaters supported by the FSS system. A manual computation of failures per flying hour using formula 3 was then accomplished to obtain offshore failure rates.

Utilization rate is the measurement term used to express a wartime activity level for strategic airlift aircraft. In fact, one of the first parameter inputs in MAC's airlift scheduling model (FLOGEN III) is the planned utilization rate (21:61). The expected wartime utilization rates, dramatically different from the peacetime rates, are classified information. The peacetime (FY83) utilization rate for C-141Bs was 3.24 hours per day per aircraft (2). A fictitious wartime utilization rate of 12 hours per day per aircraft was provided by MAC and will be the target rate for this research. Utilization rates coupled with average sortie duration must be converted into flying hours per sortie per aircraft for input in Dyna-METRIC. It is essential that the utilization rates are realistic, and are what MAC expects from its fleet of aircraft, for results of the Dyna-METRIC runs to be representative of a wartime effort.

One of the assumptions of the Dyna-METRIC model mentioned earlier was that all data input by the modeler was correct. Thus, a fundamentally important portion of this research was the acquisition and preparation of C-141 spares data. This proved to be the most time-consuming aspect of the study. But equally important was the development of an accurate model of the strategic airlift scenario.

Experimental Design

The first step in the experimental design of this thesis required the strategic airlift scenario to be modeled in a fashion compatible with Dyna-METRIC, yet still realistic. A baseline scenario was developed which provided a representation of the worldwide supply concept used by MAC. This scenario, as mentioned before, included the concept of aircraft operating out of a CONUS home base, with BLSS and POS assets; aircraft operating out of 'bare bases' with only deployed WRSKs; and aircraft operating out of bases with FSS supplemented by WRSK segments. The primary focus for MAC WRSK assessment centers on the number of programmed landings within the constraint of the wartime utilization rate. On the other hand, MAC BLSS assessment must be developed around a realistic number of aircraft flying the wartime utilization rate.

The development of the representative scenario is portrayed in Figure 4. The scenario is modeled in three Dyna-METRIC version 4.3

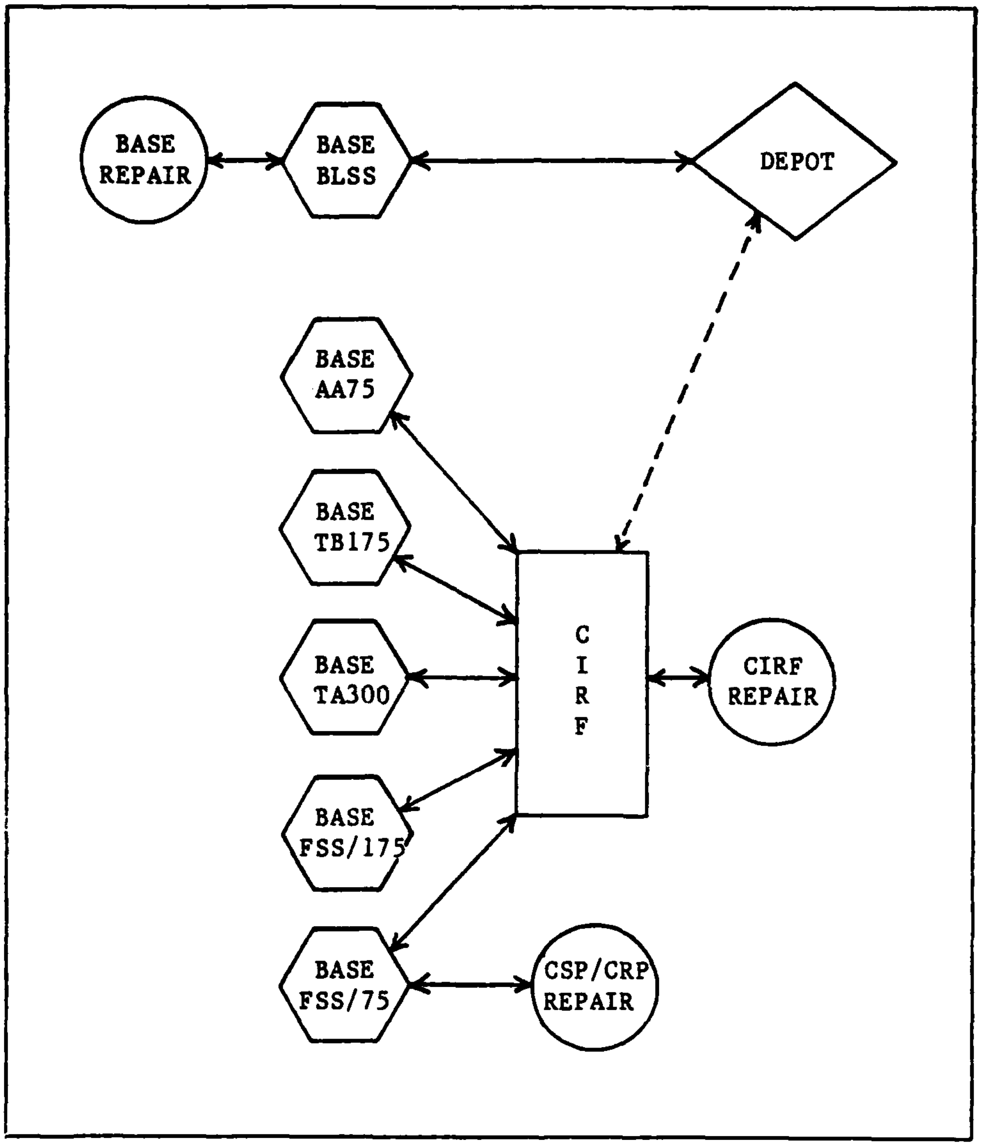

Figure 4. Scenario Representation

runs. First, the home base (Base BLSS) will have RRR repair capability and will be serviced by a depot. Next, four of the WRSK-supported offshore bases will be modeled in one Dyna-METRIC run, and will be serviced by the Primary Supply Point (that is, the CIRF). Base FSS/75 is unique, as a portion of its stock is serviced by a Central Repair Point (CSP/CRP) in Europe. Because Dyna-METRIC cannot apportion stock from a particular base to different CIRFs, Base FSS/75 must be modeled apart from the other four WRSK-supported bases supported 100 percent by one CIRF. However, model results will not be affected by separately modeling Base FSS/75. Note that if stock levels were included at the CRP/CSP or CIRF, equitably available to the five WRSK bases, then all bases would have to be modeled together for valid results. But with this last approach, the modeler would lose the capability of modeling the European CSP/CRP. Again, the purpose of this research was to test the concept of modeling the various supply concepts of strategic airlift with Dyna-METRIC.

Research Questions. The specific results from these initial Dyna-METRIC runs, by themselves, do not fully answer research question 1: Given a realistic strategic airlift scenario and authorized levels of POS and WRM, can Dyna-METRIC provide reasonable estimates of airlift combat capability? The validity of the results obtained from the baseline model runs is an important area which must be addressed before research question 1 may be answered. The issue of the validity of the research results will be discussed in the last section of this chapter.

Table III illustrates the presentation of the Dyna-METRIC baseline runs. The performance measure of expected Not Mission Capable Supply

TABLE III

Expected Rate: NMCS Aircraft Baseline Model

Day	1	3	5	7	10	15	20	25	30
AA75	XX.x	XX.x	XX.x	XX.x	XX.x	XX.x	XX.x	XX.x	XX.x
TB175									
FSS/75									
FSS/175									
TA300									
BLSS/POS									

Note: XX.x represents a value for the expected rate (e.g., 47.3).

(NMCS) will be divided by the number of aircraft at each base to obtain an NMCS rate as the tool for presenting results. NMCS is widely used as the tool for analysis in Dyna-METRIC usage (7:61). Results from these initial Dyna-METRIC runs will provide the baseline for sensitivity analysis of various factors relative to MAC.

Research question 2 will be answered by performing sensitivity analysis against the control baseline model that was developed for research question 1. Figure 5 is the format for the presentation of the comparative results of the sensitivity analysis developed for research question 2: How sensitive are Dyna-METRIC outputs to changes in key variables that are determined by MAC's unique methodology for determining spares requirements? The results for specific LRUs will not be the focus, rather the overall trends resulting from the changes made. The baseline results will be displayed on each figure, with the results of the sensitivity run overlayed for comparison against the baseline. Additionally, tabular results, similar to Table III will be presented in Appendix E. Several key factors will be examined for impact on capability.

First, demand rates will be varied to illustrate the importance of the use of correct representative data. Both the BLSS/POS and WRSK-stocked bases will be run against D029 demand rates obtained from the HQ AFLC D029 listings. This will show the critical importance of applying the proper demand rates in the analysis of MAC aircraft, as offshore and onshore demand rates vary greatly. Refer to Appendix D for a comparison of D029 demand rates and computed offshore demand rates. The redundancy of many aircraft subsystems allow the aircrews

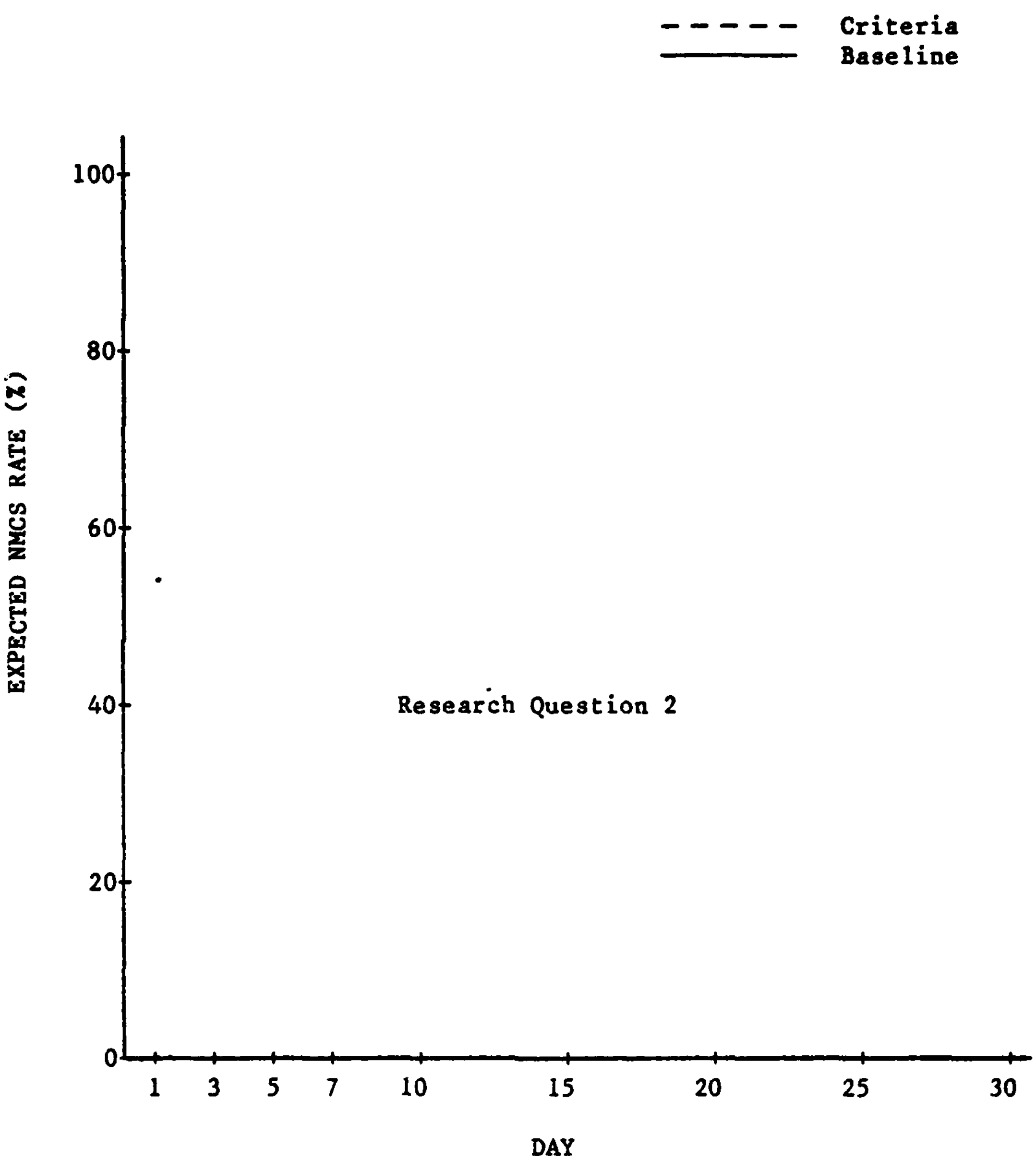

Figure 5. Impact of Selected Changes on Expected NMCS Rate for Specified Bases

greater latitude in decisions which would ground the aircraft, particularly at offshore locations, resulting in lower offshore demand rates.

Next, order and ship time (OST) for all LRUs will be incrementally lowered from the baseline value of 30 days to see the effect of improved transportation capability. The OST will first be lowered to 14 days, then to 7 days, illustrating the capability of improving the effect of WRSKs and BLSS with enhanced OSTs. This is an important variation, given that MAC 'owns' its transportation fleet and will be able to supply replacement parts quicker than other agencies. It has been indicated that offshore OSTs may be as low as four and a half days in some circumstances (32), adding credibility to the sensitivity analysis of OSTs.

The wartime utilization rate will then be varied to show its effect on capability. Although 12 hours is an unclassified target wartime utilization rate, many scenarios would not require such a heavy flying program. Reducing the utilization rate will be accomplished by reducing the sortie length and holding the number of landings constant. Thus, the target landings for each WRSK will not be altered. The performance of the WRSKs and BLSS/POS in these circumstances will be illustrated in comparison to the baseline Dyna-METRIC runs.

Finally, although not considered sensitivity analysis, the Dyna-METRIC model can compute the required stock needed to meet specified goals of the modeler. The performance goal selected for this analysis was not based on a HQ MAC target rate, as HQ MAC has not established a target NMCS rate for their WRSKs or BLSS. A 20 percent

NMCS rate is the target rate used by HQ TAC in their Dyna-METRIC assessments of tactical aircraft. Also, AFR 400-24 establishes the current Air Force target goal of a 20 percent NMCS rate (that is, 5 of 24 aircraft) at a 50 percent confidence level for WRSK and BLSS marginal analysis computations (64:12). The goal of 20 percent NMCS aircraft at a 50 percent confidence level will be used for the requirements mode run. The results from the requirements run will be contrasted with the current stock levels of MAC WRSK segments to illustrate the capability of Dyna-METRIC to establish stock levels. Additionally, HQ MAC/LGSWR may compare their established stock levels to the results of the requirements runs to gain a broader insight into the capability of presently stocked WRSK segments. Stock levels from the requirements mode run will be presented in tabular form, for comparison with the established stock levels of the three segments of MAC's C-141 WRSKs: TA300, TB175, and the AA75. MAC WRSKs, with their objective of supporting a given number of landings for 30 days, are ideally suited for this capability of Dyna-METRIC. In contrast, MAC's BLSS does not have a definite goal like the WRSKs, making a stock requirements run difficult to validate at this point.

Input Parameters. The primary input parameters of the six bases are presented in tabular form in Table IV. Note that the simulated wartime utilization rate of 12.0 hours per day has been maintained throughout the scenario.

TABLE IV

Model Input Parameters

Base Name	Number Aircraft	Planned Sorties	Maximum Turns/Day	Hours/ Sortie	Planned Landings
AA75	1	2.5	2.5	4.8	75
TB175	3	2.0	2.0	6.0	180
TA300	5	2.0	2.0	6.0	300
FSS/175	4	2.0	2.0	6.0	240
FSS/75	3	2.0	2.0	6.0	175
BLSS	27	2.0	3.0	6.0	N/A

As each WRSK segment is designed to support a specific number of landings, these figures provided the objective for WRSK base input parameters. Thus, landings at the first five bases reflect the MAC-specified capabilities of the WRSK segments. Additionally, landings at the two FSS locations include planned peacetime landing support capability, obtained from HQ MAC/LGSWA. Note that landings at the BLSS-served base are not a consideration used by MAC in determining the size of the BLSS.

The average sortie length used in the scenario was based on input from the Operational Plans Directorate at HQ MAC (26). Since Dyna-METRIC multiplies sortie length times the number of sorties per day to determine wartime demands, and the target utilization rate is 12.0 hours per day, the number of sorties per day is 12.0 divided by the average sortie length. The average sortie length of the AA75 WRSK base was shorter than the figure obtained from HQ MAC because of the restriction created by the low number of planned landings for the WRSK segment. The 4.8 flying hour per sortie figure used does not degrade the output from Dyna-METRIC since the demand data is based on overall daily demand, not individual sortie demand.

The number of aircraft selected for use with the WRSK-served bases was a function of the number of landings the WRSK segments supported, the number of days the kit was to support (thirty), and the number of sorties per aircraft. As an example, the TA300 kit should support 300 landings for 30 days, or 10 per day. Since the aircraft will fly two sorties per day to meet the wartime utilization rate, five aircraft will be required for input into Dyna-METRIC. The number of aircraft to position at the BLSS-served base was difficult to determine, as the BLSS is an extension of peacetime demands, which are not tied to a level of aircraft, but to a level of demands. In CY83, approximately 50 percent of the C-141 fleet hours were flown on onshore missions (2). Since these flying hours determine BLSS quantities, the 50 percent figure was used to determine the number of aircraft positioned at the BLSS-served base. Since the 438 MAW is authorized 54 aircraft, 27 aircraft were chosen to be used in the baseline model.

Maximum turn rate is a proxy for the maximum number of hours or sorties flown in a day. If the maximum turn rate is greater than the planned sortie rate, additional landings could be incurred each day. The concept of a MAC WRSK-supported base is that of aircraft transiting the location and not returning for additional sorties. To achieve this notion, maximum turn rate must not be greater than the planned sorties. However, for the BLSS, additional aircraft are normally available at the base, providing extra resources to meet the wartime utilization rate. A maximum turn rate was established at 3.0, which limits daily flying to no more than 18 hours per aircraft.

Although not shown in Table IV, the status of the peacetime spares pipeline must be considered in the modeling of strategic airlift aircraft. The concept of WRSKs suggests no resupply for a 30 day period. It should be noted that the two bases representing combined FSS and a deployed WRSK would have an inplace pipeline for the FSS spares at the start of the war. However, the baseline model for the WRSK-served bases will not include a peacetime pipeline of LRUs. Deployment is not a factor for the BLSS-represented base, and a peacetime pipeline of stock is a necessary component of the modeling effort. The BLSS base will include a 14 day peacetime pipeline based on a peacetime flying program of 3.2 hours per aircraft (2). At the start of the war, the peacetime pipeline will continue to empty and the wartime pipeline will change from the peacetime length of 14 days to 30 days (28).

The maintenance concept modeled for the BLSS was consistent with the capabilities at a CONUS home base for C-141s. If a part was reparable at base level (RRR), then it could be fixed during the baseline run. After the depot was opened with a reduction in OST for sensitivity runs, the depot was able to repair items not reparable at the base. Both base and depot repair time, where applicable, were set to two days. On the other hand, the concept of MAC WRSKs is one of no repair capability deployed with the kits. Therefore, WRSK-served bases were modeled to have the capability for remove and replace maintenance (RR). However, for the sensitivity runs which reduced the OST from a wartime length of 30 days to figures possibly closer to MAC's capabilities, the CIRF became available for repair. Again, the repair time was set at two days.

Associated with the maintenance concepts modeled for strategic airlift aircraft are the NRTS (Not Reparable This Station) rates employed for the various LRUs. For the CIRF and BLSS/POS-served base, the NRTS rates were those obtained from the D029 Computation List. The NRTS rates for the LRUs at the WRSK-served bases were set to 100 percent, to ensure no repair at the deployed base. An exception to this were the 10 LRUs at FSS/75 Base served by the European CSP/CRP. To facilitate their repair, their respective NRTS rates were obtained from HQ MAC/LGSWA and applied in the form of an onbase repair capability. The repair time at the CSP/CRP and transportation time to and from the facility for these ten parts was simulated by setting the onbase repair time to seven days.

The cannibalization policy applied to the WRSK and BLSS/POS bases in the model will be different. The WRSK-served bases are modeled to represent the concept of a different aircraft arriving with each landing. A Dyna-METRIC no-cannibalization policy will best represent the WRSK concept of MAC, as there should not be many aircraft on the ground at one time at a WRSK-served base. Because the BLSS/POS base is a home station, it will tend to have additional aircraft on the ground at one time which supports the concept of cannibalization.

The input parameters are critical for any assessment with Dyna-METRIC, but particularly so with the complications inherent in the MAC aircraft reparable parts supply system. The reader is referred to Appendix G for the exact input files used in this research.

Methodology and Design Limitations

The Dyna-METRIC assumptions relevant to this research have been discussed in this and the previous chapter. There are other limitations associated with the methodology and experimental design which must be discussed also. An understanding of the representative value of the research results is dependent on an appreciation of the previously stated assumptions and the limitations that follow.

Although the FSS stock levels used are very close to actual stock levels, if not exact, the stock levels used for the POS, BLSS, and WRSK segments are the authorized figures. Reference to Appendix C will point out the fact that authorized and actual stock levels are far from the same. This highlights the spares funding deficiency mentioned in Chapter I. Again, the purpose is not to assess the current kit capabilities, but to illustrate the potential for future Dyna-METRIC applications.

Second, the issue of a minimum QPA has not been addressed, although version 4.3 has the capability to model minimum QPA. Currently, there is no clear direction from HQ MAC as to the minimum number of particular items a C-141 must have in order to continue with the mission. This issue is directly related to the judgement exercised by the aircraft commander when an LRU fails. It was not possible to quantify the minimum QPAs for each LRU for this research. Thus, true capability should be somewhat better than depicted results, in this regard.

Third, the flying hour figures used for offshore demand rate computations were the best figures obtainable to accompany the failure data at hand. It must be understood that the flying hours were not tracked concurrently with the demands, and that the offshore demand rates are the best approximations to fact. It is felt that McGuire's hours may be slightly low, resulting in demand rates higher than actual. Conversely, the flying hours obtained for the forward supply system demands may be slightly high, resulting in demand rates lower than actual. Nevertheless, the computed demand rates are a better approximation to the actual figures than the worldwide D029 computation figures.

Fourth, HQ MAC does not adjust the DDRs for non-linear failure rates/sorties, as in main landing gear tires and wheels. All adjustments to the stock levels are accomplished within HQ MAC/LGSWR. Failure rates remain raw rates per flying hour. As MAC manually adjusts the WRSK/BLSS quantities upward, the item would not show up as a problem part in Dyna-METRIC runs, due to the peacetime demand rate driving the Dyna-METRIC computations. Conversely, those items not required to complete the wartime mission would not be stocked as heavily in the WRSK and BLSS. However, the peacetime demand rate will cause the item(s) to show up as a problem part.

Fifth, Raymond Pyles, of the RAND Corporation, states that it is difficult to interpret model results with a small number of assigned aircraft. He indicates that, with a low number of aircraft, it would be more realistic to view the expected NMCS rate as the probability of not being able to launch a FMC aircraft from a deployed location on a given day (41). This difficulty in interpretation is verified by staff at HQ TAC/LGYT, who have modeled E-3A aircraft with its low PAA (50).

Verification and Validation

A fundamental notion which must be answered prior to assessing the results of this study is the verification of Dyna-METRIC version 4.3. That is, does version 4.3, as utilized in this study, provide proper model results? Secondly, external validation of the results must be addressed. That is, do the obtained results represent realistic strategic airlift capability assessments?

Verification. The mathematics of Dyna-METRIC version 3.04 have been verified and documented by the Logistics Management Center (63). However, a documented verification of version 4.3 has not been accomplished. To internally verify Dyna-METRIC version 4.3 for this effort, identical basic Dyna-METRIC runs were made with version 3.04 and version 4.3. NMCS rates were identical for all days requested. New features included in version 4.3 could not be verified in this manner, however. Therefore, the results of this study's Dyna-METRIC runs are limited by the assumption that the new features included in version 4.3 provide designed results.

Validation. Dyna-METRIC version 3.04 has been externally validated in part for tactical aircraft by the Tactical Air Command with their Leading Edge Exercise at Nellis AFB (6). Data from this controlled exercise was input into a Dyna-METRIC scenario modeled to duplicate the actual flying program. The results indicated that Dyna-METRIC accurately represented the actual events. External validation of this study's results with 'real world' data, like TAC's Leading Edge Exercise, is not possible at present. MAC does not exercise their WRSK and BLSS kits to the extent needed for validation these Dyna-METRIC runs simulating a wartime utilization rate. However, in an attempt to validate the peacetime results obtained from the scenario developed in this study, the BLSS/POS base model was run for a 30 day period, with the peacetime utilization rate of 3.2 hours per aircraft and a peacetime pipeline of 14 days. The pipeline length was an average obtained from the D029 BLSS Computation List. The resulting NMCS rate of 4.64 percent is comparable to the peacetime NMCS rate for the 438 MAW C-141 fleet of 5.58 percent for CY83 (2). Thus, the model developed for this thesis provided reasonable results for a peacetime flying program. Again, validation of the wartime NMCS rates obtained in this study is not possible without MAC exercising its WRSKs with a flying program simulating that expected during wartime. It should be noted that the goal of this research is a realistic application of Dyna-METRIC to strategic airlift aircraft. The methodology developed should enhance the efforts of the Sustainability Assessment Module in achieving their goal of incorporating strategic airlift aircraft in AFLC's Weapon System Management Information System.

IV. Results

Overview

The results of the Dyna-METRIC runs for the strategic airlift scenario discussed in Chapter III will be presented in two forms, tabular and graphical, by research question. The tables will show the actual NMCS rate obtained for each base for nine selected days during the 30 day scenario. Graphs will be used as a technique for ease of comparison between individual bases for research question 1 and for selected sensitivity criteria in research question 2. Although NMCS rate is the criteria chosen for comparative evaluation, Dyna-METRIC output includes other information for the user.

Depending on the options selected, output from Dyna-METRIC may consist of the probability of achieving a selected NMCS rate, the expected number of NMCS aircraft (in both full-cannibalization and no-cannibalization modes), the expected number of sorties achieved, the total number of backorders for each day, and a list of problem parts. Additionally, in the requirements mode, Dyna-METRIC will provide the stock level and additional dollar cost necessary to achieve the specified performance goal. For the purposes of this thesis, the evaluation of the performance measure of expected NMCS rate will provide the necessary results to answer the research questions.

The results of the Dyna-METRIC runs will be presented, followed by an interpretation of their significance in answering the research questions. This will be followed by a summary of the results, leading to the conclusions and recommendations in Chapter V.

Methodology Modifications

Cannibalization policy for this research outlined in Chapter III included using a no-cannibalization policy for the WRSK-served bases. However, after several Dyna-METRIC runs and consultation with HQ AFLC Management Science staff, it was confirmed that an error existed in the no-cannibalization subroutine in version 4.3. Only partial results were obtained in the no-cannibalization mode. Therefore, all runs, including the baseline runs, were accomplished using a full-cannibalization policy. This change did not effect the results for base AA75, as only one aircraft was modeled to represent 75 landings during the 30 day period, maintaining a 12 hour UTE rate. However, the other bases served by WRSKs had more parts available as a result of the full-cannibalization policy. Results for these bases would therefore be more optimistic than with a no-cannibalization policy. For example, Table V shows the difference in the expected NMCS rate using full-cannibalization and no-cannibalization on day 7 of the scenario. As the purpose of the research is a demonstration of a methodology, using the full-cannibalization policy with the WRSK-served bases will not seriously degrade the results.

Establishing a 14 day peacetime pipeline, as mentioned in Chapter III, to be used at the start of a war in which the wartime pipeline then becomes 30 days in length for the BLSS/POS base was more difficult than originally planned. The Dyna-METRIC model uses two different

TABLE V

Comparison of Cannibalization Policies

(Expected NMCS Rate)

Base	Full-Cann	No-Cann
TA300	12.2	16.8
TB175	28.7	42.4
FSS/175	21.1	31.2
FSS/75	17.4	21.6

pipelines, one for peacetime operations and the other for the wartime scenario. Each pipeline is treated and tracked separately. However, only one OST value is allowed to establish both pipelines in Dyna-METRIC version 4.3. A new option on version 4.3 should have been available which would have allowed a previously developed peacetime pipeline to start the wartime run. But as this option was not yet operational on HQ AFLC's Dyna-METRIC model used for this study, a method was developed to accomplish the same concept.

The model for the BLSS/POS base was executed two separate times at a peacetime flying hour level. The first run was accomplished with a 14 day OST and the second with a 30 day OST. The difference in the pipeline quantity of stock (30 day pipeline quantity minus 14 day pipeline quantity) represents the additional stock required to simulate a 14 day peacetime pipeline if the model is initially executed with a 30 day wartime pipeline (that is, a 30 day LRU order and ship time).

The differences in pipeline quantities (rounded to the nearest integer value) were added to the BLSS/POS stock levels. The initial 14 day and 30 day runs resulted in a 4.64 and a 18.61 percent NMCS rate, respectively. Another run for a 30 day pipeline, but with the increased stock level, resulted in an NMCS rate of 6.22 percent. The difference is explained due to the rounding required to establish stock levels at integer values. To model a wartime scenario, the peacetime pipelines were shut off after 14 days to simulate the pipeline emptying after that time.

One of the improvements of Dyna-METRIC version 4.3 discussed in Chapter III was that the model would now adjust component demands to reflect previously accomplished FMC sorties. However, the option for this improvement was not operational on the version 4.3 used for this research. Thus, the model behaves as version 3.04, in this respect. It continues to generate demands at the user-entered sortie rate, thus overstating true demands of a fixed-location fleet as the NMCS rate increases (40:43). This may be a deficiency in the results of the Dyna-METRIC runs for the BLSS/POS base, as the aircraft modeled represent a situation similar to a TAC unit's operation. However, as the WRSK-served bases are simulating a daily flow of different aircraft through the location, the generation of LRU demands is best represented by the current AFLC version 4.3 limitation.

Presentation and Analysis of Research Question 1

Table VI presents the baseline model results for the six bases which represent the spectrum of reparable parts supply in the strategic airlift system. The results are presented in the form of the expected NMCS rate for each of the nine selected days in the 30 day scenario. Additionally, the data is presented in Figure 6 in graphical form for comparison.

First, a word of caution is in order. Misinterpretation of Figure 6 and other graphs included in this thesis is possible if the reader attempts to interpolate between the nine days listed on the horizontal axis. Although the specific results for each of the nine days output have been connected with a continuous line for better pictoral presentation, the expected NMCS rate between the requested days cannot be taken to be the value associated with a point on the line. It was possible to make Dyna-METRIC runs to obtain each days' results. However, this would have required three times the computer runs for this level of detail. The purpose of this study did not require such detail.

Analysis of the results, shown in tabular form in Table VI and graphically in Figure 6, is primarily intuitive in nature. It has been stated in Chapter III that MAC does not exercise their segmented WRSKs or BLSS, with the aircraft flying a wartime utilization rate, resulting in the absence of any good base for comparison with the baseline results from this research. The only external validation of the results obtained was a peacetime flying program evaluation of the BLSS/POS base, mentioned in Chapter III. Based on inputs from previous studies, published statements from former MAC Commander-in-Chiefs, and conversations with HQ MAC staff, it was felt that results should show a degraded airlift capability by the end of the 30 day scenario. The

TABLE VI

Baseline Model

(Expected NMCS Rate)

Day	1	3	5	7	10	15	20	25	30
AA75	20.5	50.7	70.1	82.2	92.3	98.3	99.7	99.9	100
TB175	4.2	13.3	21.8	28.7	36.3	46.4	58.3	71.4	82.8
FSS/75	2.4	7.4	12.5	17.4	24.0	32.8	40.2	48.7	58.5
FSS/175	3.4	10.0	16.0	21.1	27.3	36.4	47.4	61.0	74.5
TA300	0.2	2.3	6.6	12.2	20.4	33.8	52.0	71.8	87.2
BLSS/POS	8.2	12.7	17.9	23.8	34.0	55.2	86.6	99.3	100

baseline results reflect that in all six cases, less than 50 percent of the aircraft would be Fully Mission Capable by day 30.

Further indications of the validity of the methodology developed are indicated by trends in the individual bases. Because the simulated BLSS/POS base peacetime pipeline is emptied by day 14, an increase in the NMCS rate after that day in the scenario was expected. Results shown in Figure 6 support this notion. By day 15, the NMCS rate began increasing at a greater rate than the trend established in the first 10 days of the scenario.

Also, although base TB175 and base FSS/75 were designed to support an equal amount of landings, the stock levels at FSS/75 are significantly greater, resulting in an expected improvement in

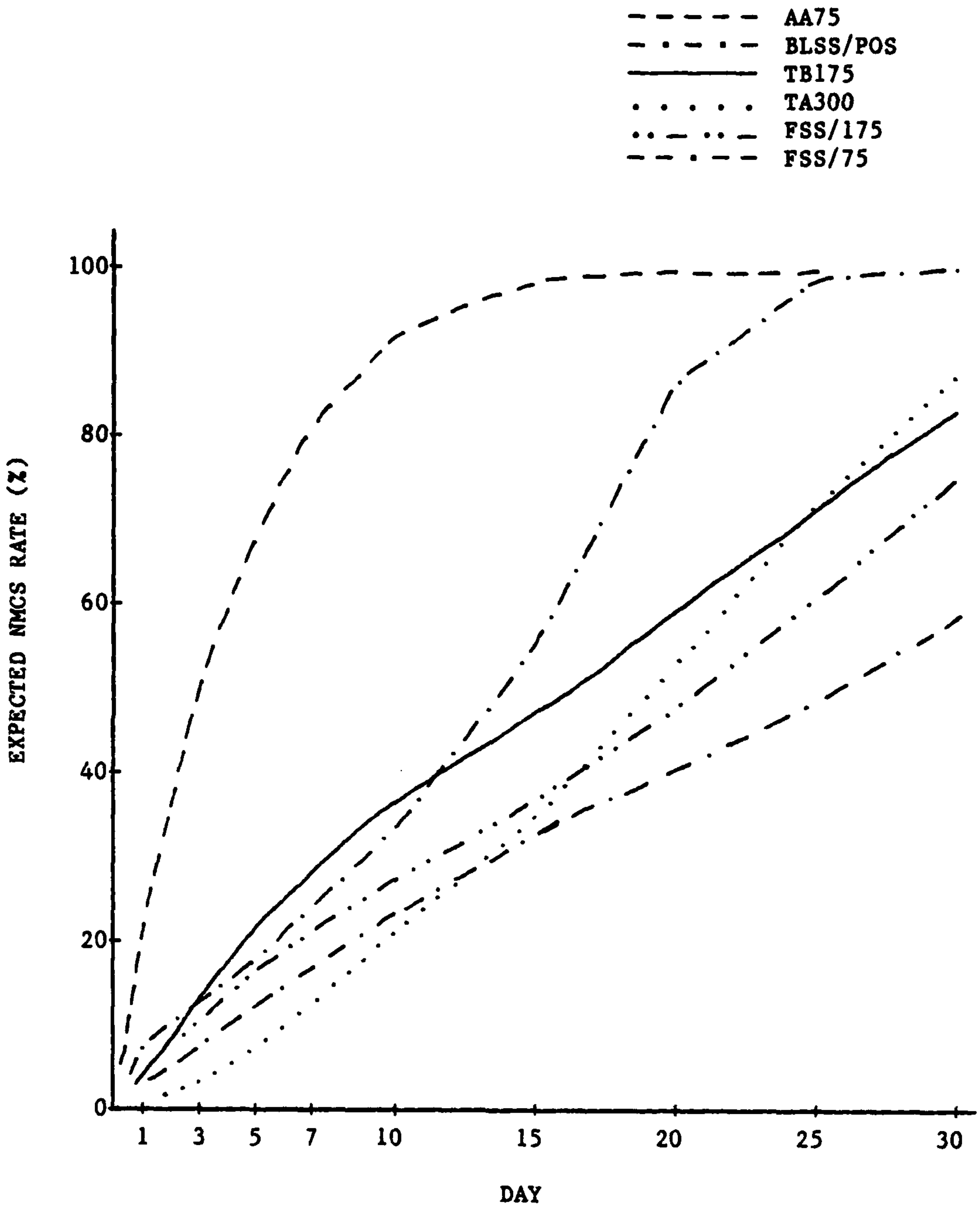

Figure 6. Comparison of Baseline Models

TABLE VII

Comparison of Stock Levels

NSN	TB175	FSS/75
2835008374869	0	1
5821009160057	0	3
6340010557374	0	1
6605010182181	2	4
6615010177736	1	3

capability. For example, Table VII shows the five most critical problem parts resulting from the TB175 base Dyna-METRIC baseline run. Stock levels for these parts are shown for both the TB175 base and the FSS/75 base. Although planned capability is the same (175 landings), the FSS portion of the FSS/75 base stock adds a significant amount of capability.

The results of the AA75-supported base are not favorable, when compared with the other five bases. Two factors would contribute to this WRSK segment's poor performance. First, by comparison, the AA75 kit does not contain all the mission essential items found in the larger kit segments. Since Dyna-METRIC assumes all items to be equally mission essential, the chance of a grounded aircraft are greater, without a representative sample of needed parts. Analysis of the backorder status for problem parts effecting base AA75 supports this notion. No stocked item degraded the performance of this WRSK segment.

This matter will be discussed further in Chapter V. A second factor contributing to the poor performance of base AA75 relative to the other five bases was that with only one aircraft positioned at the base to insure 75 landings with the 12 hour utilization rate, the ability to cannibalize parts is eliminated.

The results from the baseline model of the strategic airlift scenario appear to provide a reasonable estimation of capability within the scope of this research methodology. Even though a selected sample of the LRUs was used in this study, a validation with actual results is beyond the scope of this research. Additionally, MAC does not exercise their WRSKs and BLSS to the extent necessary for comparison. However, five out of the six bases modeled provided logical results in which variations in performance could be explained. The AA75 kit-supported base appeared to be stocked at too shallow a level to support a comparative flying activity similar to the other kits. Further critique of the baseline results will be made as the sensitivity analysis is accomplished for research question 2.

Presentation and Analysis of Research Question 2

The purpose of the sensitivity analysis performed for research question 2 is twofold. First, the general results of the baseline model are supported and the model is partially verified by predictable results obtained from the Dyna-METRIC sensitivity runs. Next, the effect of specific MAC-controlled inputs will be illustrated. This will highlight the importance of establishing correct data bases for input into Dyna-METRIC. The effect of varying controllable command-specific inputs into the computational process for WRSK and BLSS stock levels will be shown. Finally, the important variables on which MAC and AFLC management should focus their efforts may be identified. The results of all sensitivity runs are presented in Appendix E in tabular form. Selected representative graphs of the results will be included in this chapter to highlight the effect of the changes in input parameters.

Demand Rates. The demand rates used for input into Dyna-METRIC are a critical ingredient required for valid capability assessment. The D029 data base maintained by HQ AFLC contained demand data representative of worldwide demands, but it did not adequately represent the actual operation of specific strategic airlift units and the resulting demands for input into a Dyna-METRIC scenario. The methodology for deriving the demand data for inclusion in the baseline model was discussed in Chapter III. A review of the demand data in Appendix D indicates that the computed offshore demand rates are lower than the D029 worldwide rates. Conversely, the computed onshore rates are greater than the D029 worldwide rates. Therefore, it was expected that the capability (measured by changes in the NMCS rate) for the BLSS/POS base would be greater if D029 demand rates were applied. On the other hand, the WRSK results should be degraded with D029 demand rates.

Figure 7 presents the baseline model results and the comparative results with the D029 demand rates for base BLSS/POS. Figure 8 shows the baseline model results and the D029 demand rate results for base FSS/75. In both cases, there is a dramatic difference in the expected

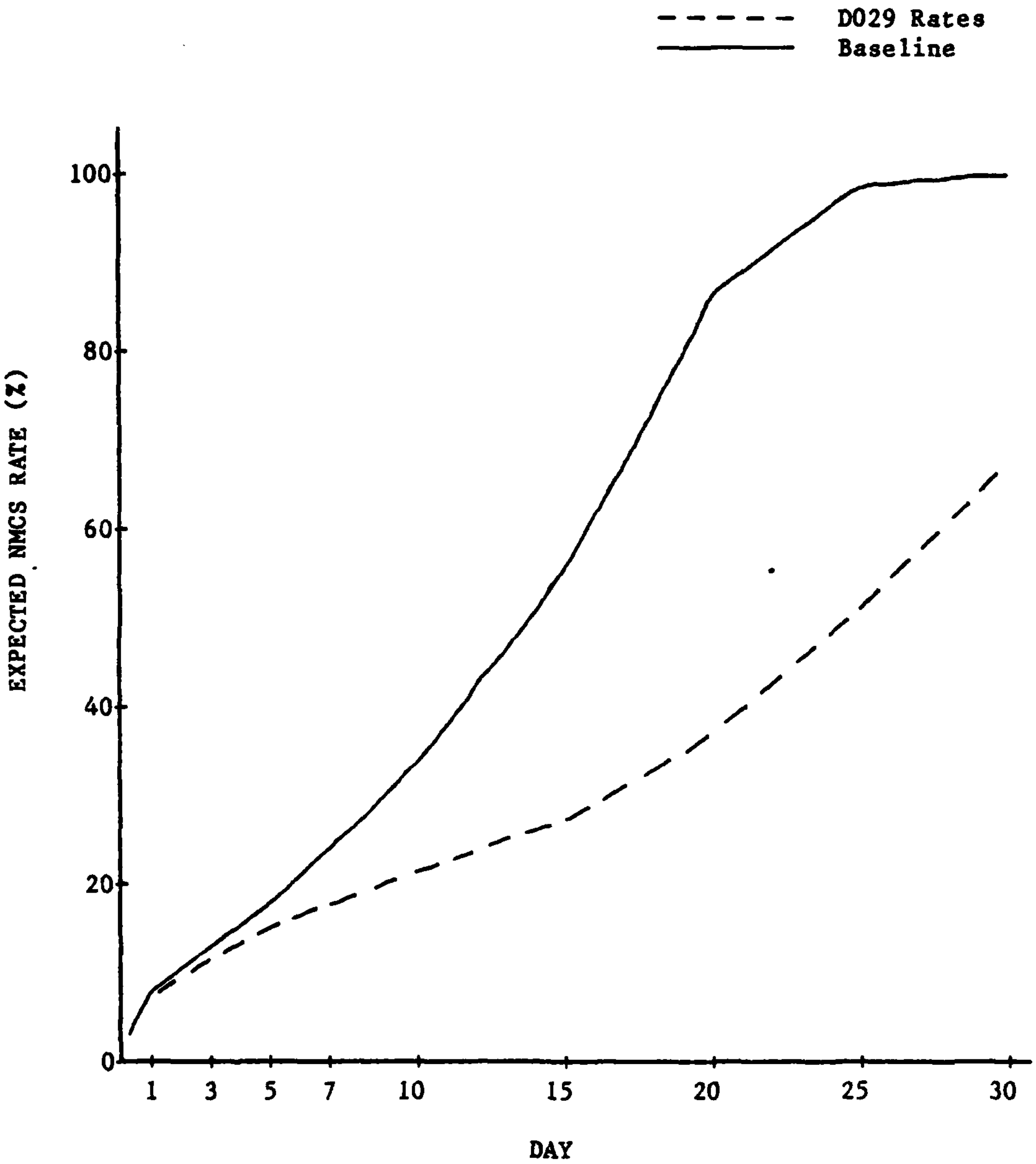

Figure 7. Base BLSS/PCS: Baseline vs. D029 Demand Rates

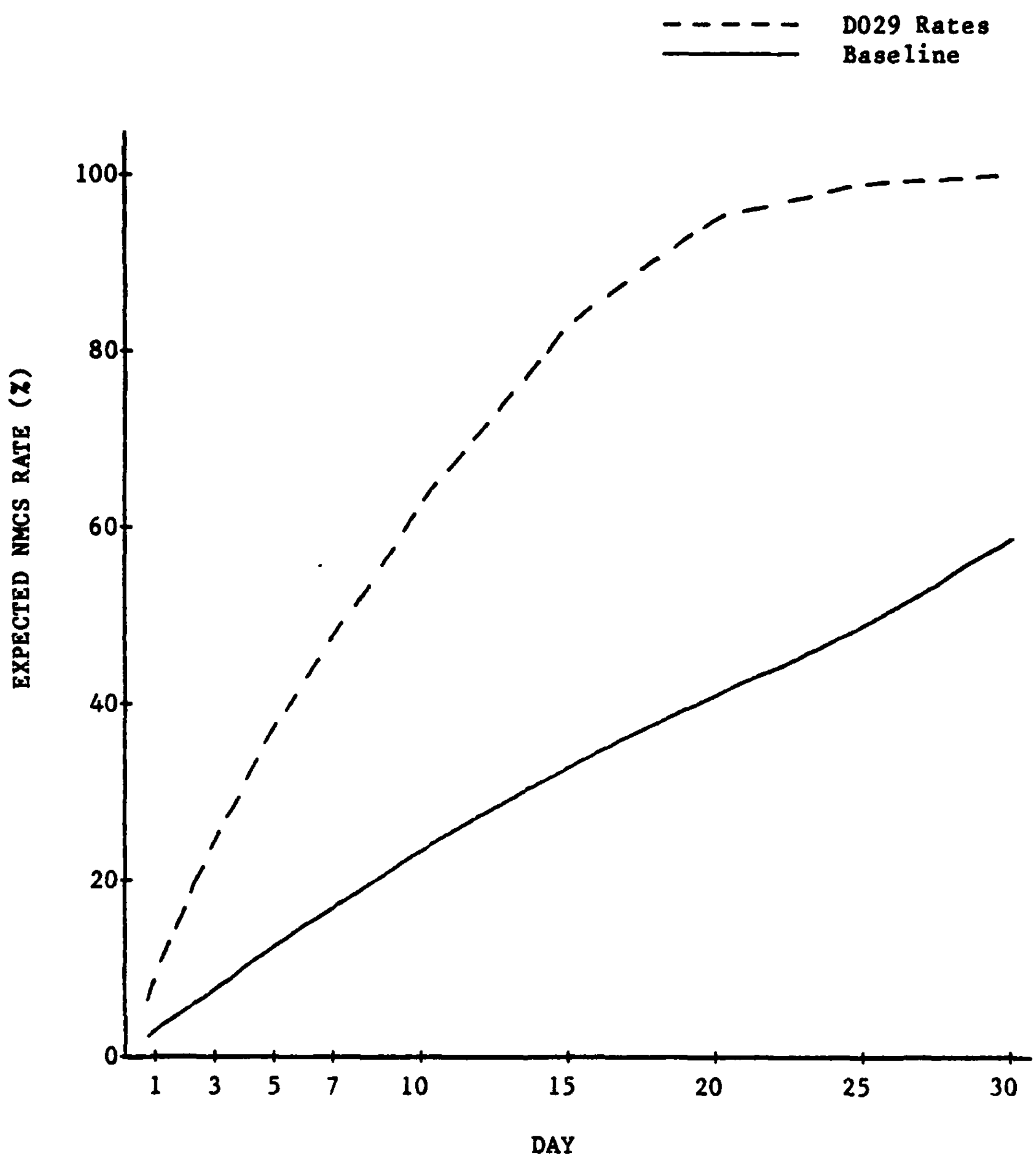

Figure 8. Base FSS/75: Baseline vs. D029 Demand Rates

NMCS rate, as expected. The results for the other four offshore bases are similar to the results shown in Figure 8. By day 15, the expected NMCS rate, using D029 demand data, are at least twice as great (or half the rate for base BLSS) as the baseline demand rate results. The one exception is base AA75, whose results were consistently better at the beginning of the scenario with offshore rates, but approached 100 percent NMCS for both demand rate applications by day 15. The importance of applying the correct demand rates in a Dyna-METRIC analysis of strategic airlift is evident.

Transportation Time. The concept of operating from a WRSK or BLSS is that the kit would provide unresupplied capability for at least 30 days. The baseline model is consistent with that operational concept. However, as discussed previously, MAC operates the air lines of resupply outside the CONUS. It would seem appropriate to decrease the order and ship time to represent MAC's resupply capability. By shortening the pipeline to the Depot/CIRF to 14 and 7 days, incrementally, the effect of decreased OSTs may be derived. Figures 9, 10, and 11 show the effect for the BLSS/POS base and the WRSK-supported bases TB175 and TA300, respectively. The results of decreased OSTs show a significant improvement when comparing the results for the BLSS/POS base with the WRSK-supported base. The results obtained for 14 day OST for the BLSS/POS base are improved as expected, but the 7 day OST results are optimistic. This is because the 14 day peacetime pipeline that was established for the baseline model was overridden by the 7 day OST. Stock levels to simulate a 14 day peacetime pipeline and a 7 day wartime pipeline were not developed. Overall, though, it

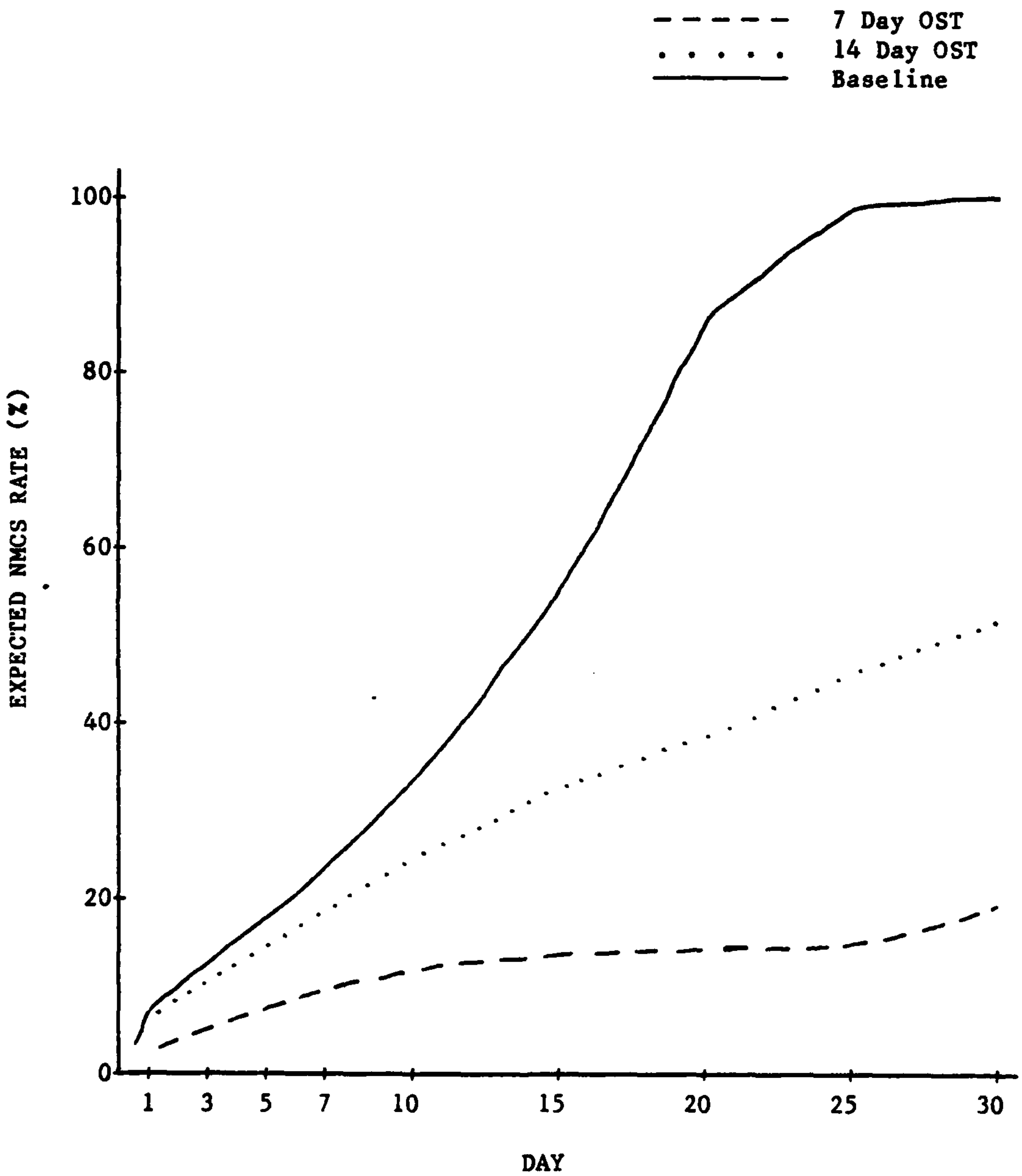

Figure 9. Base BLSS/POS: Baseline vs. 14 and 7 Day OSTs

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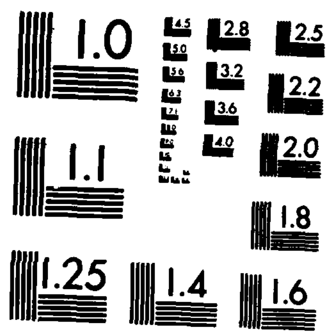
1.0
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.1
1.8
1.25
1.4
1.6

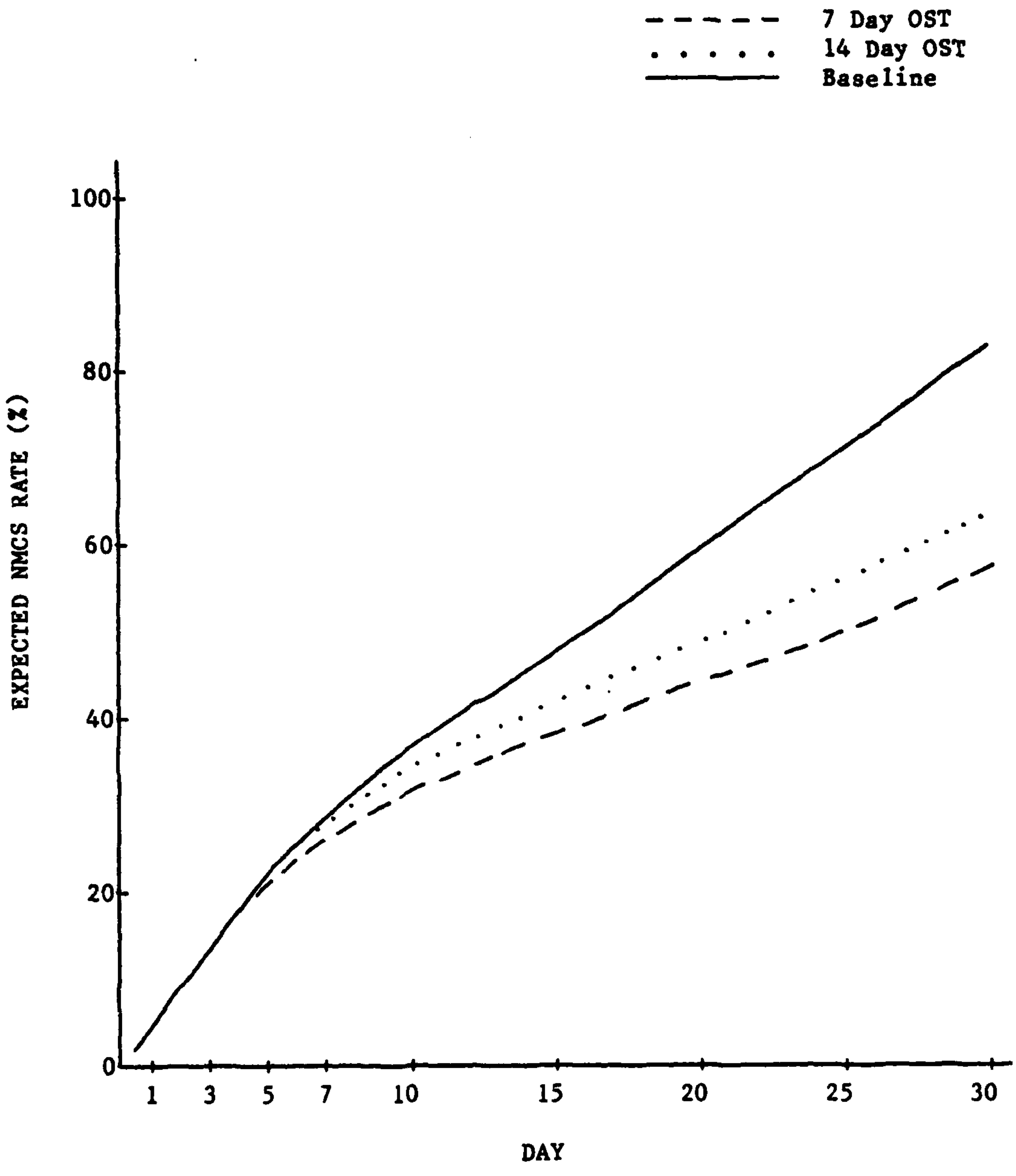

Figure 10. Base TB175: Baseline vs. 14 and 7 Day OSTs

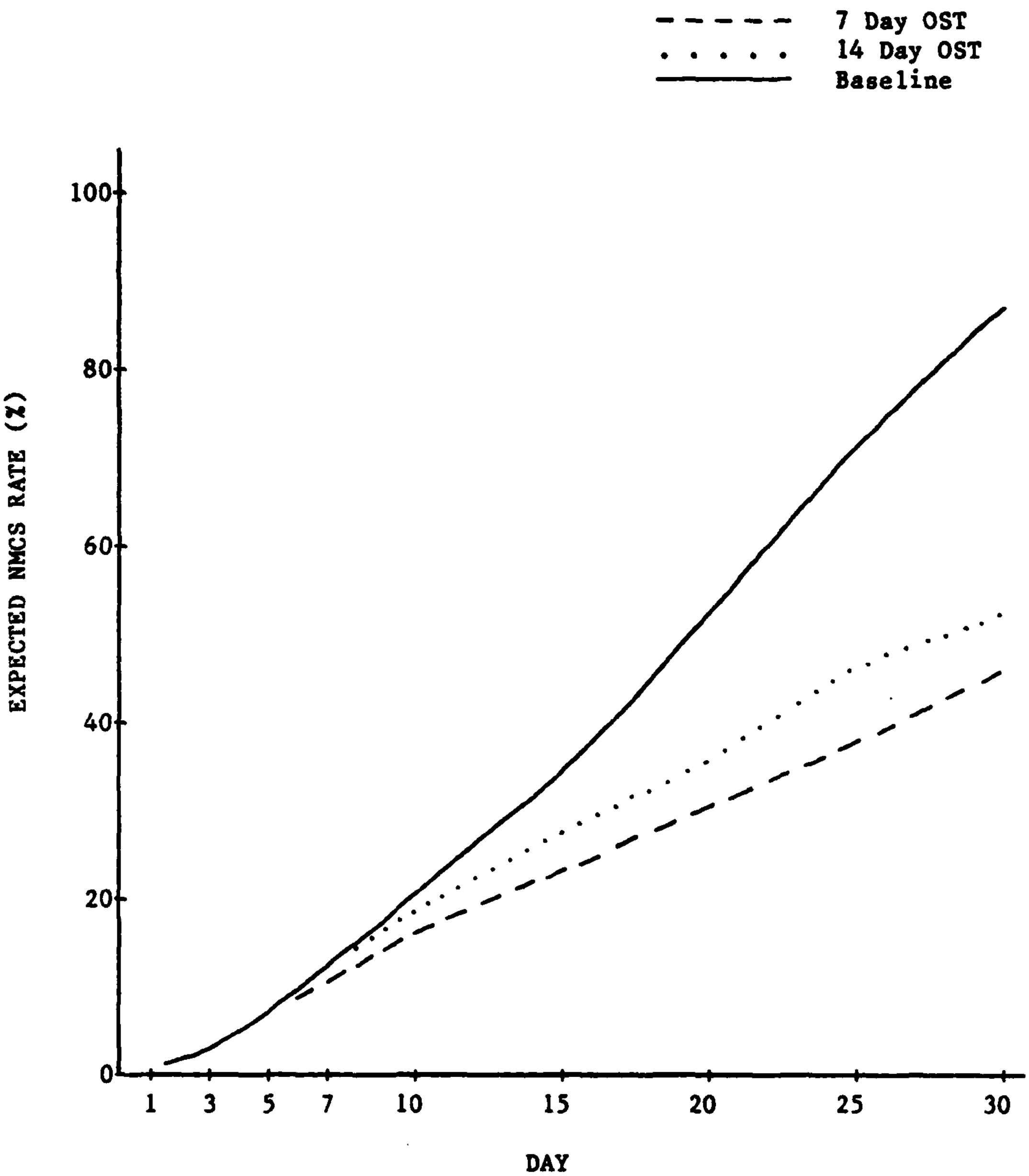

Figure 11. Base TA300: Baseline vs. 14 and 7 Day OSTs

may be concluded that shortening the OST has a significant effect on the POSS/POS results.

Results obtained for the WRSK-served bases for reductions in OSTs are not as significant as the BLSS/POS results. This was because spares not repaired at the primary supply point (the WRSK-supported bases' CIRF) must be sent back to the depot. Thus, the pipeline for WRSK-supported bases is much larger than for the BLSS/POS-supported base. The NRTS rate becomes extremely important with reduced OSTs. Those items with high NRTS rates quickly become problem parts because depot OST was not modeled for the WRSK-served bases. Improved capability for items with high NRTS rates at the PSP can only occur within the constraints of a 30 day scenario if the depot is modeled and the depot to PSP transportation time is significantly less than 30 days. Therefore, the effect of changes in order and ship times would not be as dramatic in the WRSK-served bases as in the BLSS/POS base. The realism in reducing the OST to 7 days for a depot-served CONUS base may be suspect as there was no reliable source found which substantiated a reduction of this magnitude. However, the OST for the WRSK-served bases may be even less than 7 days, when required, according to HQ MAC staff, and based on the authors' operational experience.

Utilization Rate. Although the planned wartime utilization rate is the measure against which WRSK and BLSS assessment should be made, the utilization rate experienced by MAC strategic airlift aircraft in less than all-out war circumstances would be considerably less. Figures 12 and 13 show the effect of a decreased utilization rate of

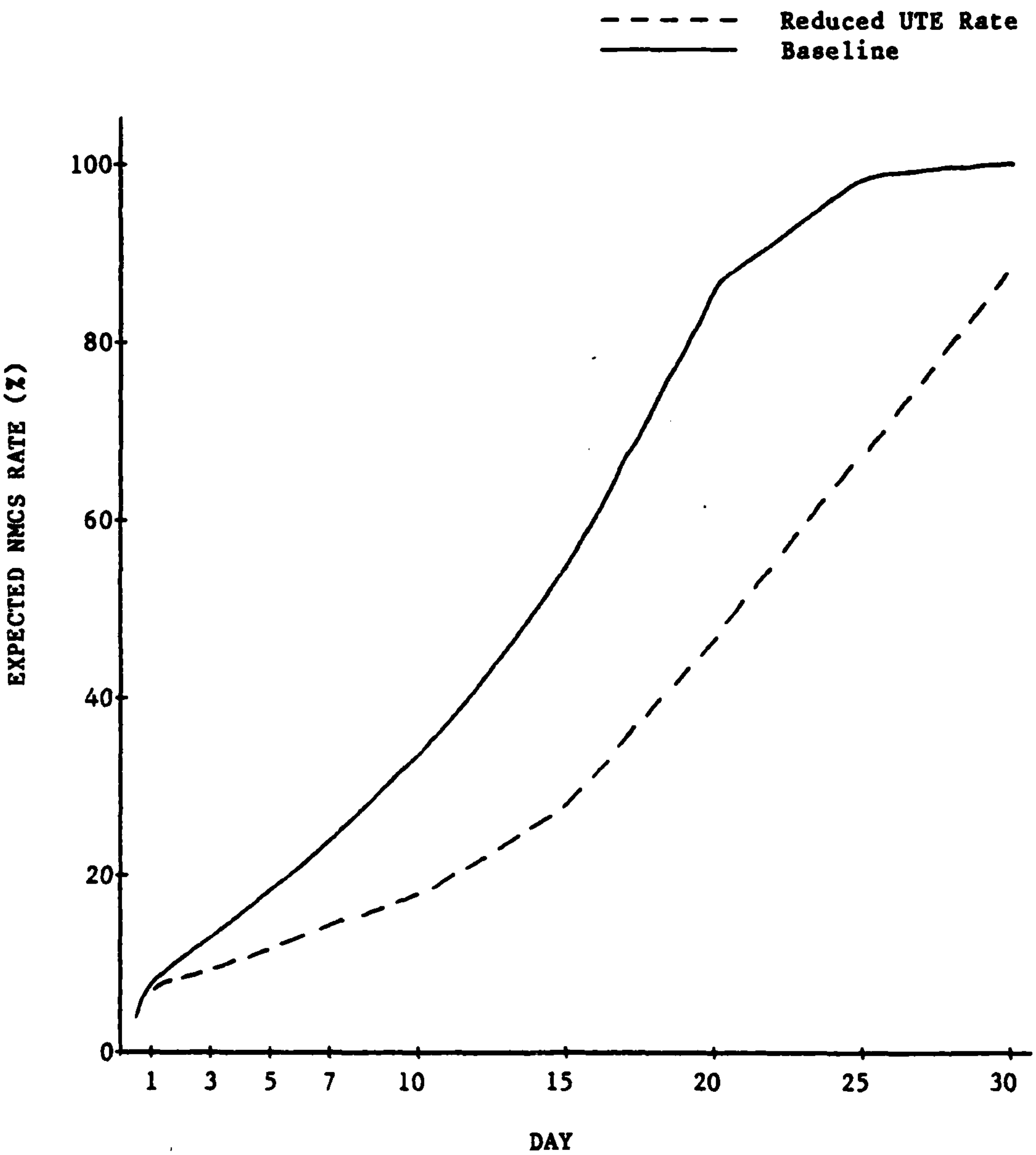

Figure 12. Base BLSS/POS: Baseline vs. Reduced UTE Rate

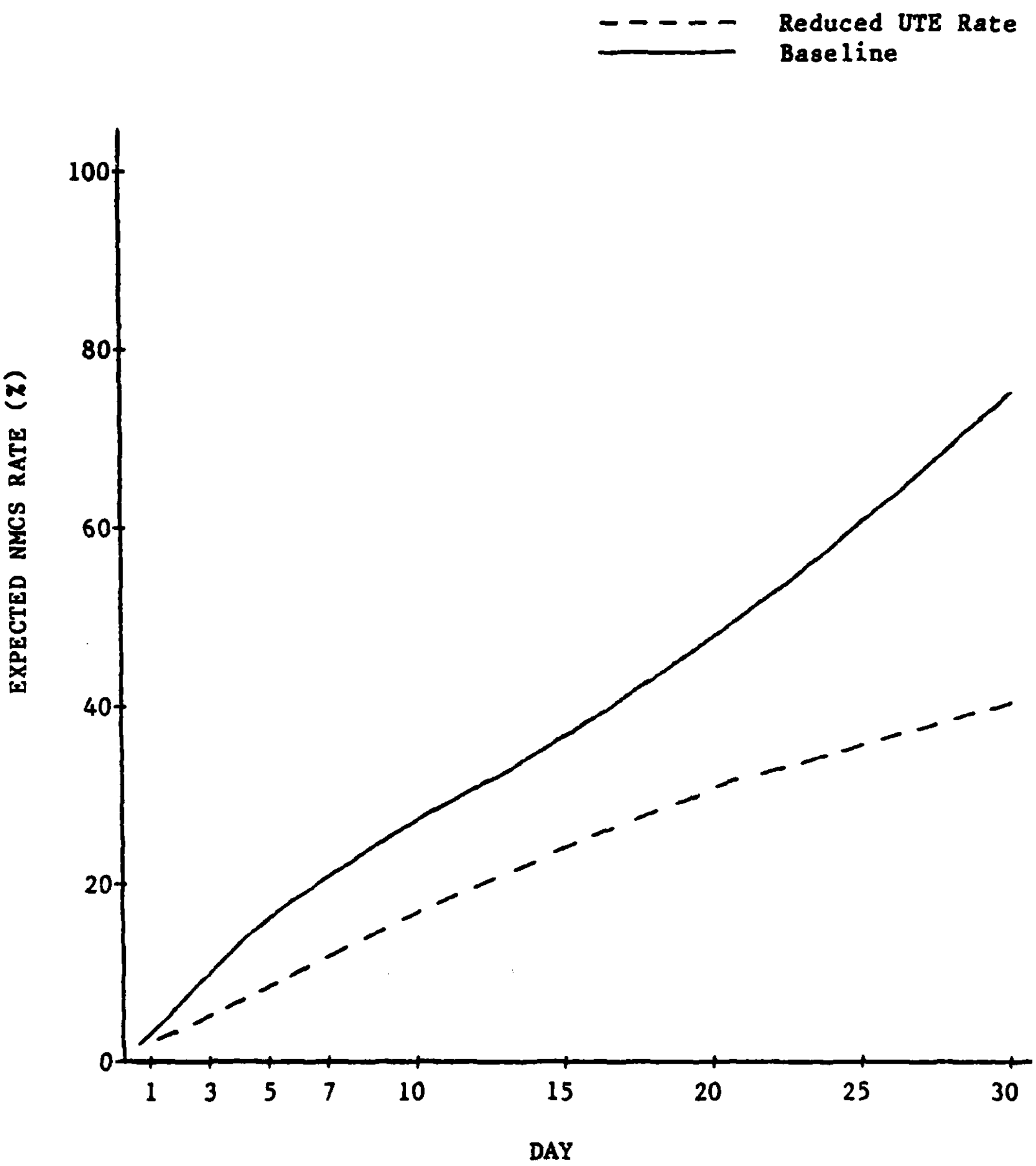

Figure 13. Base FSS/175: Baseline vs. Reduced UTE Rate

eight hours per day per aircraft, as compared with the baseline model UTE rate of 12 hours. Landings were held constant to reflect the concept of MAC WRSK segments. It was expected that performance would get better, and the results of the Dyna-METRIC runs verified that assumption. In fact, for a WRSK base which is not modeled with a peacetime pipeline or base repair capability, there is a one-third reduction in the expected NMCS rate. This is simply because the model generated one-third less demands, based on the reduction in demanded flying hours.

Requirements Mode. Dyna-METRIC has the capability to compute the required stock needed in a WRSK segment to meet specific performance goals. This capability would be of particular value in establishing the levels of the MAC strategic airlift WRSK segments. The three WRSK segments which were positioned without additional repair and pipeline considerations were evaluated using Dyna-METRIC's requirements mode. The complete output from this requirements generation for the three WRSK segments, based on the computed offshore demand rates, is shown in Appendix F (we reiterate our point that the use of correct demand rates is critical in achieving useful Dyna-METRIC results). Of additional significance is the target NMCS level input to the model. If the target NMCS level is significantly greater than 0 percent, Dyna-METRIC will allow aircraft to remain broken as long as the target NMCS level will not be exceeded. This may result in the part not being stocked until the NMCS target is reached.

Results are given for a 20 percent NMCS rate at a 50 percent confidence level (as specified in AFR 400-24) and compared to current

HQ MAC/LGSWR assigned stock levels which have no target performance level. It was discovered that current WRSK stock levels, for all three segments, are significantly understocked at the target NMCS rate of 20 percent. This result is not surprising, considering the NMCS rates obtained in the baseline results. The Dyna-METRIC requirements run suggested that stock levels be increased for 57 percent of the LRUs in WRSK segment TA300, 65 percent of the LRUs in WRSK segment TB175, and 73 percent of the cases for segment AA75. Conversely, stock reductions from the actual MAC levels are suggested for 30 percent of TA300's LRUs and 15 percent of segment TB175's LRUs. However, no reductions in the stock levels of the AA75 segment were proposed. The reader is reminded that results obtained are dependent, in part, on the methodology developed for this study. The computed offshore demand rates, the inability to apply minimum QPAs, and the selected cannibalization policy would provide an impact on results.

The requirements mode of Dyna-METRIC also provides the cost of purchasing suggested stock for the individual WRSKs and segments. Table VIII shows the costs for the current stockage of the study's selected LRUs and the cost of the suggested stock to fulfill a 20 percent NMCS level at a 50 percent confidence level. Additionally, the percentage increase in cost over the current WRSK segment cost is given for each base. Some reductions in stock levels were suggested by the Dyna-METRIC requirement run for WRSK segments TA300 and TB175, and are incorporated in the projected cost increases.

An attempt was made to match MAC's actual WRSK segment quantities with varying target NMCS rates using the requirements mode. Additional

TABLE VIII

WRSK Segment Costs

Segment	Current Cost	Projected Cost	% Inc
TA300	$ 2,272,740	$ 3,302,100	45.3
TB175	1,751,880	2,342,130	33.7
AA75	897,460	1,316,670	46.7

computer runs were accomplished with targets of 30, 40, and 50 percent NMCS (see Appendix F). From the results, there appeared to be no one target NMCS rate goal which would best match MAC's stock levels for all three segments. For example, for the TA300 segment, the 30 percent requirement run was chosen for comparison, as it appeared to have the closest stock levels to actual stock. However, the variability in the stock levels, when compared to actual WRSK segment levels, is significant. Results show a required stock increase for 37 percent and a reduction in 43 percent of the LRUs. Similarly, a 40 percent NMCS run and a 50 percent target were matched against the TB and AA segments, respectively. It was evident that no one target NMCS rate best represents MAC's current WRSK segment stockage policy. The authors feel that MAC's manual adjustments to apportion the WRSK into segments contributes to the variability present when compared against target NMCS goals.

Research question 2 resulted in sensitivity analysis of the baseline model developed for research question 1. In particular, three factors controlled by MAC were varied to determine the extent of their significance in the Dyna-METRIC results. Dyna-METRIC was responsive to changes in demand rates, transportation time, and utilization rate. In particular, the use of exact demand rates appears to be the critical factor for valid assessment of strategic airlift. In contrast, order and ship time reductions did not significantly improve performance at WRSK-supported bases.

Summary

Results obtained from the baseline model for the six MAC spares supply concepts should not be construed as representing actual MAC strategic airlift capability. MAC has not documented kit segment performance or utilized their WRSK segments to the extent required for validation of the study's results. However, by narrowing the focus of interest to individual kit segments, useful conclusions may be drawn from the results of the baseline model runs. In particular, WRSK segment AA may lack sufficient stock to fulfill its tasked 75 landings. Sensitivity of various factors of interest to MAC showed predictable results, as a whole. The disparity of results when using D029 computation rates showed that future applications of Dyna-METRIC should use accurate demand rates which fit the scenario. As a result of the data-gathering process, the assimilation of knowledge about the MAC spares computational process, and the execution of Dyna-METRIC runs, we have reached a number of conclusions and recommendations which will be addressed in Chapter V.

V. Summary, Conclusions, and Recommendations

This chapter will review the key issues which lead to the requirement for an analysis of the strategic airlift reparable spares capability. Conclusions of the two research questions will then be discussed. The main focus of this chapter, however, will be on the additional factors which must be considered before an actual assessment of strategic airlift using Dyna-METRIC can be accomplished. Finally, suggestions for further research will be given.

Summary of Research Effort

Strategic airlift is a key ingredient in the nation's defense philosophy of force projection and flexible response. The capability of airlift to achieve their critical mission is contingent on a logistic resupply system which is unique in the Air Force. The effect of underfunding of spare parts over the past few years is well known. However, the only assessment to date of MAC's reparable spares is the LOGRAM model of HQ AFLC, which combines all spare parts in a pool, assuming distribution is not a factor. Additionally, the deployment of WRSKs in conjunction with MAC's forward supply support system is not considered in this assessment.

Currently, the Air Force uses RAND's Dyna-METRIC inventory model to assess the capability of tactical aircraft units, with respect to reparable spares. The disposition of spares in MAC is more diverse than that of TAC's units. The inclusion of CONUS POS, BLSS, deployed WRSK segments, and overseas FSS is necessary to assess the capability of MAC strategic airlift. To achieve this end, six bases were modeled using the methodology developed in Chapter III.

Each base represented a different concept in MAC spares disposition. One base was modeled to represent a CONUS home base, with spares available in the form of BLSS and POS. Three bases were modeled as WRSK-supported only. Base TA300 was supported by the TA300 segment, designed by MAC to support 300 landings over a 30 day scenario. The TB175 segment supported 175 landings and the AA75 segment should have supported 75 landings over the scenario. One base represented an inplace FSS stock augmented by a TB175 kit, while another offshore FSS base was modeled to be augmented with a AA75 kit. This last base was also modeled to demonstrate avionics support by the European CSP/CRP.

The parts list used for this study included the problem parts identified by HQ MAC and HQ AFLC, and problem parts from initial Dyna-METRIC runs based on D029 data. Compared to the maximum possible D029 parts (228 parts for a MAC WRSK and 735 parts for a BLSS), a list of 91 potentially critical LRUs was established. Demand data for the baseline model was not the worldwide D029 computation rates, but were manually computed rates which required data from many sources and considerable effort. The demand rates used for the BLSS/POS-served base were developed using actual demands plus flying hours for the 438 MAW, McGuire AFB. Offshore rates were obtained for the identified sample of LRUs using the flying hours for the forward supply support network.

A baseline model was established and sensitivity analysis performed, using variables of significance to MAC. D029 computation demand rates were used to show the wide variation obtained in results when using demand rates not representative of the scenario. Next, order and ship time was decreased from 30 days to 14 and then to 7 days. A reduction in utilization rate by one-third was then modeled, holding the number of planned landings constant.

Conclusions

Research Question 1. Research question 1 was general in nature, addressing the question of whether or not Dyna-METRIC could assess the strategic airlift spares support network. With some caution, generalizations may be drawn from the modeling effort to answer research question 1. The approach to the multiple base scenario was to model the different MAC spares capabilities as separate bases. Results obtained from this approach were realistic when executed in a peacetime mode, using an actual peacetime flying hour program. Results obtained in the wartime scenario compared favorably to published expectations that strategic airlift performance would be limited by inadequate spares (30; 52; 53). Although the results were not an assessment of actual strategic airlift capability, only parts identified as possible problem parts were used. The six supply concepts modeled appear to be understocked in each case, as all bases had an NMCS rate over 50 percent by day 30 in the scenario. However, the results obtained in the modeled wartime mode require validation before true comparisons may be drawn.

The results obtained in this research confirm that Dyna-METRIC has potential for immediate use in capability assessment of MAC's strategic airlift fleet and the establishment of MAC WRSK segment stock levels. The approach of modeling the WRSK segments separately provides utility for airlift spares posture improvement. In particular, the demonstrated use of the requirements mode of Dyna-METRIC has potentially significant value to MAC. However, external validation of the results with actual MAC airlift performance data remains a concern.

Research Question 2. The baseline model for research question 1 was varied to assess the impact of factors which are controllable by MAC. Large differences in the expected NMCS rate were experienced when the worldwide D029 demand rates were applied. We demonstrated that the input of accurate demand rates is essential. A full-scale implementation of a Dyna-METRIC capability assessment of strategic airlift will necessitate HQ MAC providing accurate demand rates for both onshore and offshore locations. Any deviations in demand rates which are identified from base to base may require separate Dyna-METRIC runs to ensure useful results.

Next, order and ship time was incrementally decreased from the baseline value of 30 days to 14 and 7 days. Results from this analysis showed a more significant improvement for the BLSS/POS base than for the WRSK-served bases. This was due to the significantly shortened pipeline to and from the depot when compared to the WRSK-CIRF-Depot pipeline. Even though the BLSS/POS base showed better improvements, the wartime OSTs for individual WRSK-served bases should be established by HQ MAC for a realistic capability assessment in the future.

Currently, 30 days is the default value used by HQ TAC and the Sustainability Assessment Module of HQ AFLC. MAC's order and ship times could be significantly shorter than 30 days.

Utilization rate was decreased from a fictitious wartime figure of 12 hours to 8 hours, holding the number of landings constant. Results showed that the expected NMCS rate was simply reduced in a linear fashion by approximately one-third. However, other research has shown that the length of the sortie together with the landings determine the number of failures (8; 47). Thus, a one-third reduction in flying time with the same amount of landings would not necessarily result in one-third less failures. Utilization rate and demand rates were the most significant factors in the sensitivity analysis.

Finally, the requirements mode of Dyna-METRIC was utilized to compare a 20 percent NMCS target stock level goal against established MAC WRSK segment quantities. It was evident, given the limitations of the developed methodology, that significant stock level additions would have to be made to achieve a 20 percent target NMCS rate. The requirements mode of Dyna-METRIC analysis should be implemented now to aid MAC staff in computing WRSK segment levels.

The importance of inputing correct data into Dyna-METRIC cannot be overstated. In particular, demand rates are a demonstrated critical ingredient in any capability assessment. In addition, the effect of decreases in transportation time was shown to have a positive effect on NMCS rates. Given that MAC 'owns' the transportation fleet, realistic wartime OSTs should be developed for future uses of Dyna-METRIC in strategic airlift assessment. Prior to the application of the model to actual capability assessment, certain problem areas, which will be discussed next, should be addressed.

Recommendations

The following areas of concern should be addressed prior to a full-scale application of the Dyna-METRIC model to the strategic airlift scenario. These areas were realized from both the data collection experience and the modeling and execution phase of this research.

Demand Data. Accurate demand data for offshore and onshore MAC operations must be available in an accessible data base prior to an actual application of Dyna-METRIC. HQ MAC/LGSWA currently tracks all demands in the Forward Supply Support system. By concurrently tracking the flying hours associated with those demands, an accurate data base may be established for computing offshore demands. But it must be noted that MAC only retains 12 months of data in the computation process. Thus, major changes in flying activity may have more effect on the daily demand rates than is warranted. By retaining more than one year's data, the variation in demand rates could be smoothed out, resulting in more representative figures for applications. In gathering data for onshore demands, a disparity was noted among the CONUS C-141 wings. Demand rates for a number of LRUs were compared for three wings, each having the same number of authorized aircraft and approximately the same yearly flying hour program. Major differences in the daily demand rates between the bases can be seen in Table IX.

TABLE IX

C-141 CONUS Daily Demand Rates

NSN	McGuire	Charleston	Norton
1650009303160	.5496	.4960	.3324
2915009125993	.1942	.0429	.0476
2925004567627	.2980	.0585	.1648
2995004389890	.2803	.2133	.0503
6610009927976	.4017	.1212	.0734
6620009808040	.8079	.2213	.1299

Prior to an application of the Dyna-METRIC model, HQ MAC should examine this difference in demand rates and determine if a composite demand rate for their BLSS bases is an acceptable assumption. If demand rates are as diverse as shown in Table IX, each BLSS would have to be modeled separately for valid results.

Primary Supply Point Stock. The BLSS/POS base and the CIRF (PSP) of the WRSK-served bases are actually the same unit. There was no attempt to allocate stock levels between the two units. In fact, no stock was assigned to the CIRF, during the separate WRSK evaluations. This was done as there was no guidance as to the partitioning of stock between base requirements and PSP needs. In reality, stock at base BLSS/POS could be available for use as the PSP for resupply of deployed WRSK segments during war. This concept could be modeled by consolidating all stock at the CIRF level, eliminating base repair for base BLSS/POS, and setting the transportation time between base BLSS/POS and the CIRF to zero days. The overall effect of this strategy would be a reduction in BLSS/POS performance and an increase in deployed WRSK capability, dependent on the RET and OST between the WRSKs and the CIRF.

Planning Factor Adjustments. The PFA computation is the factor used by MAC to adjust the peacetime stock levels to planned wartime stock levels. As shown in Table II, Chapter II, changes in the ratio of peacetime flying hours between CONUS and offshore locations have no effect on the PFA figures. If the ratio of onshore and offshore flying hours is the same in peacetime and wartime, then the computed PFA will represent a method to transition from peacetime to wartime utilization at each location. However, if the wartime ratio of onshore and offshore flying hours is different from the peacetime ratio, the PFA does not account for this change. A method of accomplishing this is to change the PFA calculation methodology to reflect wartime ratio of flying hours, not the peacetime ratio of flying hours.

Currently the wartime flying hour summary (step 2 of the PFA computation process as described in Chapter II) uses the peacetime onshore and offshore utilization rates. That is

$$\text{Offshore Wartime Commitment} = \text{Wartime Commitment} \times (\text{Peacetime Offshore UTE} \div \text{Peacetime UTE})$$

The offshore wartime commitment should be computed with the projected wartime offshore utilization rate and the combined wartime utilization rate, instead of the peacetime figures as is currently used. That is to say

$$\text{Offshore Wartime Commitment} = \text{Wartime Commitment} \times (\text{Wartime Offshore UTE} \div \text{Wartime UTE})$$

The resulting WRSK and BLSS PFAs would reflect the planned onshore and offshore flying during war instead of an extension of historical peacetime activity. For example, using the current peacetime utilization rate of 3.24 hours per day per aircraft, Table II shows the WRSK PFA as 2.7, regardless of the ratio of peacetime flying hours between CONUS and offshore locations. However, if the offshore wartime commitment shown in step 2 is computed with the projected wartime utilization rates instead of the historical peacetime rates, the resulting PFA would be different from 2.7 (if the war time ratio is not 50:50). For example, if the wartime ratio of CONUS to offshore hours is 25:75, then the WRSK PFA would increase to 4.6. Since the individual daily demand rates are based on requirements from the FSS locations and would not change in peacetime, an increase in the PFA would result in the requirement for greater stock in the WRSK segments. An increase in the WRSK PFA would result in a corresponding decrease in the BLSS PFA. However, as discussed in Chapter II, the methodology for determining WRSK levels is a demand concept, whereas the BLSS methodology uses a pipeline concept. Stock level changes in the WRSK and BLSS as a result of the changed PFAs would not be proportional.

Minimum Quantity Per Application. One of the options in version 4.3 mentioned in Chapter III was the availability to establish a Quantity per Application (QPA) less than the installed QPA. The availability of redundant systems in a multi-engined aircraft, like the C-141, make this option a viable and useful alternative for more realistic modeling of the strategic airlift scenario. Additionally, the operational experience of the authors as MAC aircrew members substantiates the concept of aircraft proceeding on missions with less than the installed QPA in some cases. Because of the subjective nature of minimum QPAs and the unavailability of a published minimum QPA list, this research did not use this capability of version 4.3. Establishing a minimum QPA list should be accomplished concurrently by the operational and maintenance staff at HQ MAC prior to pursuit of a real-world application of the Dyna-METRIC model to strategic airlift.

Suggestions for Further Research

In addition to an actual application of the developed methodology of this research, there are several related areas which require further study.

Rapid Resupply. The lack of the ability of Dyna-METRIC to adjust shipping times as stock levels are depleted requires further study. Once the stock in a MAC WRSK segment is depleted for a specific LRU, the next demand would cause an aircraft to be grounded. In this situation, a replacement part would be sent to the location of the broken aircraft in a time much shorter than the normal shipping time. This time could be as rapid as 24 hours, based on the authors' experience. A change to Dyna-METRIC's coding to reflect a shift in order and ship time when a part drops to a deficit level should be researched. However, difficulty with this concept exists as Dyna-METRIC is an analytical model, generating non-integer demands. But given the frequency of this situation occurring, especially with smaller WRSK segments, this area deserves further consideration.

Multiple CIRFs. One limitation which prevented the modeling of all six spares concepts together in one run was the fact that Dyna-METRIC only allows a base to be serviced by one CIRF. The primary CIRF for the WRSK-served bases was the primary supply point. The avionics CSP/CRP at Rhein-Main AB services about 35 C-141 LRUs for selected European bases, and is, in effect, an additional CIRF for that theater. A modification to the Dyna-METRIC model to allow multiple CIRFs would enhance the realism of any future applications.

Program Factor Adjustment Sensitivity. We have shown that the PFA computation used by HQ MAC to establish BLSS and WRSK stock levels requires reevaluation. Given that the suggested change is made to the PFA computational process, it deserves an assessment as to its effect on stock levels with changes in the wartime onshore/offshore UTE. WRSK stock levels are computed in a straightforward manner once the PFA is obtained. However, BLSS stock levels are not easily computed. Factors which must be considered when computing BLSS stock levels include the LRU's NRTS rate, condemnation rate, OST, and base repair time. The resulting changes to stock levels may enhance the combat capability of the strategic airlift fleet.

Relationship of Failure Rates to Flying Hours. The HQ MAC approach of using the number of landings without considering the effect of flying hours on demands to determine WRSK component requirements should also be investigated. Shaw showed in his study that C-141 failures increased only 66 percent if the average sortie length doubles. He concluded that there is not a direct linear relationship between failure rates and increasing flying hours. Figures obtained for this research showed a peacetime offshore sortie length of 5.95 hours per sortie (26). Using the regression formula developed by Shaw (47:73), this 37 percent increase in sortie length would result in only a 21 percent increase in failures. Although this does not appear to be a major decrease in failures, this difference would result in an increase in capability. Data gathered for this research at FSS locations supported the concept asserted by Shaw. Research should be accomplished on the time dependent relationship of flying hours to demands using MAC aircraft data. The data available in the FSS network provides an excellent opportunity to further research this relationship.

Final Comments

The reader must realize that the expected NMCS rates obtained in this research do not represent actual MAC strategic airlift capability. Dyna-METRIC is an analytic model, using probability distributions to generate demands and repair times. The data base developed for this research was the best representation of actual figures. However, computed demand rates, authorized stock levels, the inability to apply minimum QPAs, and the inability to apportion stock between a BLSS/POS-served base and the PSP may contribute to potential inaccuracies.

The methodology developed modeled a portion of the complete airlift system. The six bases modeled represent the continuum of MAC strategic airlift spares support. Capability assessments may now be developed for individual bases, each representing a different spares concept in MAC. However, the ability to bring the results together in order to determine the complete airlift system capability remains elusive.

Appendix A: Acronym Definitions

AFLC -- Air Force Logistics Command

AFM -- Air Force Manual

AFR -- Air Force Regulation

ALC -- Air Logistics Center

BLSS -- Base Level Self-Sufficiency Spares

CIRF -- Centralized Intermediate Repair Facility

CRP -- Central Repair Point

CSP -- Central Supply Point

D029 -- WRSK/BLSS Requirements Computation System

D040 -- WRM List/Requirements and Spares Support System

D041 -- Recoverable Item Consumption Requirements System

DDR -- Daily Demand Rate

DRT -- Depot Repair Time

EOQ -- Economic Order Quantity

FMC -- Fully Mission Capable

FSL -- Forward Supply Location

FSP -- Forward Supply Point

FSS -- Forward Supply Support

HQ -- Headquarters

LMI -- Logistics Management Institute

LOC -- Logistics Operations Center

LRU	--	Line Replaceable Unit
MAC	--	Military Airlift Command
MAIRS	--	Military Air Integrated Reporting System
MAW	--	Military Airlift Wing
METRIC	--	Multi-Echelon Technique for Recoverable Item Control
NATO	--	North Atlantic Treaty Organization
NCT	--	NRTS Condemnation Time
NMC	--	Not Mission Capable
NMCS	--	Not Mission Capable Supply
NRTS	--	Not Reparable This Station
NSN	--	National Stock Number
OR	--	Operational Rate
OST	--	Order and Ship Time
PAA	--	Primary Aircraft Authorized
PACAF	--	Pacific Air Forces
PBR	--	Percentage Base Repair
PFA	--	Program Factor Adjustment
PMC	--	Partial Mission Capable
POS	--	Peacetime Operating Stock
PSP	--	Primary Supply Point
QPA	--	Quantity per Application
RCT	--	Repair Cycle Time
RET	--	Retrograde Time
RR	--	Remove and Replace
RRR	--	Remove, Repair, and Replace

SAM	--	Sustainability Assessment Module
SRU	--	Shop Replaceable Unit
TAC	--	Tactical Air Command
USAFE	--	United States Air Forces Europe
UTE	--	Utilization (flying hours per day)
WMP	--	War Mobilization Plan
WRM	--	War Reserve Material
WRSK	--	War Readiness Spares Kit
WSMIS	--	Weapon System Management Information System

Appendix B: PFA Calculations

Let:

OffFH	=	Offshore Peacetime Flying Hours
CoFH	=	CONUS Peacetime Flying Hours
TFH	=	Total Peacetime Flying Hours (OffFH + CoFH)
Acft	=	Numer of Wartime Aircraft
Days	=	Number of Days Supported
Year	=	365 Days
WFH	=	Wartime (Commitment) Flying Hours
WarUTE	=	Wartime Utilization Rate
PeaceUTE	=	Peacetime Utilization Rate
PeaceOff UTE	=	Peacetime Offshore UTE Rate
PeaceCONUS UTE	=	Peacetime Conus UTE Rate

By definition:

$$\text{WarUTE} = \frac{\text{WFH}}{\text{Year} \times \text{Acft}}$$

$$\text{PeaceUTE} = \frac{\text{TFH}}{\text{Year} \times \text{Acft}}$$

$$\text{PeaceOff UTE} = \frac{\text{OffFH}}{\text{Year} \times \text{Acft}}$$

$$\text{PeaceCONUS UTE} = \frac{\text{CoFH}}{\text{Year} \times \text{Acft}}$$

$$\text{Offshore Wartime Commitment} = \frac{\text{WFH} \times \text{PeaceOff UTE}}{\text{PeaceUTE}}$$

$$= \left(\text{WFH} \times \frac{\text{OffFH}}{\text{Year} \times \text{Acft}}\right) \div \frac{\text{TFH}}{\text{Year} \times \text{Acft}}$$

$$\text{CONUS Wartime Commitment} = \frac{\text{WFH} \times \text{PeaceCONUS UTE}}{\text{PeaceUTE}}$$

$$= \left(\text{WFH} \times \frac{\text{CoFH}}{\text{Year} \times \text{Acft}}\right) \div \frac{\text{TFA}}{\text{Year} \times \text{Acft}}$$

$$\text{Wartime Offshore UTE} = \frac{\text{Offshore Wartime Commitment}}{\text{Year} \times \text{Acft}}$$

$$= \frac{\left(\text{WFH} \times \frac{\text{OffFH}}{\text{Year} \times \text{Acft}}\right) \div \frac{\text{TFH}}{\text{Year} \times \text{Acft}}}{\text{Year} \times \text{Acft}}$$

$$\text{Wartime CONUS UTE} = \frac{\text{CONUS Wartime Commitment}}{\text{Year} \times \text{Acft}}$$

$$= \frac{\left(\text{WFH} \times \frac{\text{CoFH}}{\text{Year} \times \text{Acft}}\right) \div \frac{\text{TFH}}{\text{Year} \times \text{Acft}}}{\text{Year} \times \text{Acft}}$$

$$\text{BLSS PFA} = \frac{\text{Wartime CONUS UTE}}{\text{Peacetime CONUS UTE}}$$

Therefore:

$$\text{BLSS PFA} = \left(\frac{\left(\text{WFH} \times \frac{\text{CoFH}}{\text{Year} \times \text{Acft}}\right) \div \frac{\text{TFH}}{\text{Year} \times \text{Acft}}}{\text{Year} \times \text{Acft}}\right) \div \frac{\text{CoFH}}{\text{Year} \times \text{Acft}}$$

$$= \frac{\text{WFH}}{\text{TFH}}$$

By definition:

$$\text{WRSK PFA} = \frac{\text{Wartime Offshore UTE} - \text{Peacetime Offshore UTE}}{\text{Peacetime Offshore UTE}}$$

Therefore:

$$\text{WRSK PFA} = \left[\left(\frac{\left(\text{WFH} \times \frac{\text{OffFH}}{\text{Year x Acft}}\right) \div \frac{\text{TFH}}{\text{Year x Acft}}}{\text{Year x Acft}}\right) - \frac{\text{OffFH}}{\text{Year x Acft}}\right] \div \frac{\text{OffFH}}{\text{Year x Acft}}$$

$$= \frac{\left(\text{WFH} \div \frac{\text{TFH}}{\text{Year x Acft}}\right) - 1}{\text{Year x Acft}}$$

$$= \frac{\text{WFH}}{\text{TFH}} - 1$$

Since:

$$\text{BLSS PFA} = \frac{\text{WFH}}{\text{TFH}}$$

Therefore:

$$\text{WRSK PFA} = \text{BLSS PFA} - 1$$

Appendix C: Stock Levels

NOUN	NSN	McGUIRE POS AUTH/ACT	McGUIRE BLSS AUTH/ACT	FSS QUANT: LPLA	EDAR	WRSK SEGMENTS TA	TB	AA
RADOME NOSE	1560000744238JH	0/0	10/0	0	0	1	0	0
FAIRING	1560007597083JH	1/1	1/1	0	0	0	0	0
RAMP ASSY	1560007601714JH	1/0	3/3	0	0	0	0	0
RAMP ASSY	1560007905780JH	1/1	1/1	0	0	0	0	0
ARTFEEL AIL	1560008716282JH	2/0	2/1	0	0	1	0	0
FAN DUCT ASSY	1560009071969JH	0/0	3/0	0	0	0	0	0
ARTFEEL ELE	1560009184010JH	1/3	4/4	0	0	1	0	0
POSITIONER ML	1620009825059	2/6	4/4	1	1	1	1	0
NLG WHEEL	1630000816687	10/6	5/5	2	6	6	6	4
BRAKE ASSY	1630008810815	7/0	14/3	1	1	2	2	1
MLG WHEEL	1630011326400	13/2	42/0	6	12	12	12	4
VALVE LINEAR	1650008326780	0/0	4/0	0	0	1	0	0
DRIVE ASSY	1650009303160	0/0	17/1	1	2	2	1	0
HYD GEN MOTOR	1650009374099	0/1	1/1	0	1	1	0	0
PITCH TRM ACT	1650009995350	2/1	2/2	0	0	1	0	0
CONT PWR SUP	1660000215439	2/1	2/0	0	1	1	1	0
ACTUATOR	1680006889991	8/0	14/9	1	1	1	1	1
ACTUATOR	1680009481024	7/13	18/18	1	2	3	2	0
CONTROL PANEL	1680010747678	2/2	1/1	0	1	1	1	1
COMPRESSOR	2835000697490	2/0	1/0	0	0	0	0	0
OIL PUMP	2835000766465	3/0	6/0	0	0	0	0	0
ADAPTER	2835000766472	4/0	8/5	0	0	0	0	0
SHUTOFF VALVE	2835000766499	4/0	10/4	0	1	1	1	0
APU SWITCH	2835008374869	6/0	12/1	0	1	1	0	0
FUEL CONTROL	2910009081429YP	8/0	17/0	0	1	1	0	0
FUEL VALVE	2915000740439	1/0	3/0	0	0	1	0	0
FUEL CONTROL	2915009125993RV	0/0	6/0	1	2	1	1	0
IGNIT EXCIT	2925004567627RV	0/0	4/0	1	1	1	1	1
CABLE ASSY	2925009391473RV	0/0	2/2	0	0	0	0	0
HEAT EXCHANG	2935005731750	13/0	39/31	1	1	1	1	0
ANTI-ICE VLV	2995000707372	10/0	14/7	0	2	2	1	1
CONT ASSY	2995000879914RV	0/0	16/8	0	1	2	0	0
CONTROL LH	2995002321491RV	0/0	17/0	1	2	3	2	1
ANTI-ICE CONT	2995004356898RV	0/0	15/1	1	0	2	1	1
ANTI-ICE ACT	2995004389890RV	0/0	10/0	1	2	1	1	1
ENGINE STARTER	2995004921489	0/1	13/13	1	1	2	1	1
ENGINE VALVE	2995007565840	8/0	11/0	0	2	1	1	0
STARTER VALVE	2995009742847	10/0	20/12	1	1	2	2	1
HYD PUMP	4320000513137HS	9/0	20/0	1	1	2	1	0
FUEL PUMP	4320006314859FS	0/0	5/1	0	0	0	0	0
THRST REV PUMP	4320007020269YQ	6/11	13/13	0	1	0	0	0
MAIN G PUMP	4320009438325RV	0/2	4/4	1	0	1	0	0
HYD PUMP	4320009995363HS	5/0	19/14	1	1	1	1	1
BLEED VALVE	4810007961672TP	4/0	7/6	1	1	3	1	0
CABIN VALVE	4810007961683TP	3/0	5/0	1	1	1	1	0
BLEED VALVE	4810008686547TP	3/0	2/0	0	0	0	0	0
PRESS REG VLV	4820007596907YQ	14/0	36/32	1	1	0	0	0

NOUN	NSN	McGUIRE POS AUTH/ACT	McGUIRE BLSS AUTH/ACT	FSS QUANT: LPLA	EDAR	WRSK SEGMENTS TA	TB	AA
ANTENNA COUP	5821000192704	5/7	4/3	0	1	1	1	1
RCVR XMTR	5821006015131	3/0	4/3	1	2	2	2	1
RT UNIT T2	5821008932906	13/0	14/9	3	6	10	8	4
RCVR XMTR	5821009160057	0/0	5/3	0	3	1	0	0
CONT RCVR	5821009812468	1/3	1/1	0	1	1	1	0
RECEIVER	5826009300076	1/9	0/2	0	0	2	1	0
RADIO RCVR	5826009731916	5/0	8/1	1	1	3	3	0
CONTROL TAC	5826010121919	1/3	9/9	1	1	1	1	0
RCVR XMTR	5826010121938	2/3	10/10	1	1	3	2	1
DA ADAPTER	5826010124864	2/4	12/12	1	1	1	1	0
INTRCPT CONTR	5831005235328	0/8	4/0	0	1	2	1	0
RADAR INDIC	5841001687659	6/14	-/-	0	1	2	1	0
XCVR ALTIM	5841004120447	3/0	-/-	0	2	2	1	0
IFF RCVR XMTR	5895000894521	0/0	-/-	1	3	6	5	3
HF COUPLER	5985007236740CX	-/-	-/-	1	3	3	3	0
GENERATOR	6115007723552UH	10/0	19/15	1	2	2	1	0
FLT COMPARATOR	6340010557374	2/3	2/2	1	1	1	0	0
COMPUTER TE	6605004583854JH	9/0	18/0	1	3	3	3	2
INDIC BEARING	6605008745772	0/0	29/0	0	3	2	1	0
INS	6605010182181	6/0	9/5	1	2	3	2	2
DISPLAY CNTRL	6605010352009	2/0	5/0	1	1	2	1	1
FLT DIR COMP	6610002517062JH	4/0	3/0	1	1	2	1	0
IND HORIZONTAL	6610005600303	0/0	25/0	0	2	2	2	2
ADI	6610008303587JH	9/7	14/14	1	3	2	2	1
CADC	6610009063062	13/0	10/0	2	5	12	12	6
POWER SUPPLY	6610009150577	0/12	4/4	0	0	1	1	0
INDICATOR	6610009927976	0/0	10/0	1	2	2	2	1
INDICATOR	6610009927978	0/0	34/0	1	1	4	1	1
YAW COMP	6615001187635	6/0	10/1	1	3	5	5	2
AILERON COMP	6615001187636	6/0	12/9	1	4	4	4	2
RATE GYRO	6615007635228	13/11	21/21	0	2	3	2	1
ACTUATOR	6615008670344	4/6	15/15	0	1	1	1	0
CNTRL AUTO	6615008815068	3/0	7/5	1	2	2	2	1
DISPL GYRO	6615010177736	8/0	10/0	1	2	5	1	1
AMP ELECTRONIC	6615010181635	4/0	9/1	1	1	2	1	1
COUPLER AUTO	6615011297151	0/0	19/0	1	3	6	6	2
ELEV COMP	6615011297152	0/0	19/0	1	4	6	6	2
IND EPR	6620009421033	0/0	36/0	1	3	3	2	1
IND TAC	6620009808040	15/0	32/25	1	2	3	2	1
IND RATE	6620009808046	11/4	32/32	1	2	3	1	1
FUEL XMTR	6620009879076	11/0	43/26	1	2	3	2	1
TEMP SENSOR	6685007581575TP	1/2	1/1	0	0	2	0	0
TEMP IND	6685008776593NT	0/0	24/0	1	1	2	1	1
TEMP IND	6685009454979	0/0	7/0	0	1	1	1	0

Appendix D: Demand Rates

NOUN	NSN	D029 DEMAND RATE	McGUIRE ONSHORE RATE	FSS OFFSHORE RATE	QPA
RADOME NOSE	1560000744238JH	.00125	.00459	.00011	1
FAIRING	1560007597083JH	.00013	.00015	.00013	4
RAMP ASSY	1560007601714JH	.00023	.00034	.00023	1
RAMP ASSY	1560007905780JH	.00018	.00029	.00018	1
ARTFEEL AIL	1560008716282JH	.00015	.00054	.00004	1
FAN DUCT ASSY	1560009071969JH	.00023	.00020	.00023	4
ARTFEEL ELE	1560009184010JH	.00018	.00037	.00018	1
POSITIONER ML	1620009825059	.00043	.00186	.00019	2
NLG WHEEL	1630000816687	.00328	.00635	.00117	2
BRAKE ASSY	1630008810815	.00046	.00126	.00010	8
MLG WHEEL	1630011326400	.00189	.00101	.00069	8
VALVE LINEAR	1650008326780	.00021	.00026	.00021	1
DRIVE ASSY	1650009303160	.00066	.00257	.00013	4
HYD GEN MOTOR	1650009374099	.00013	.00016	.00006	1
PITCH TRM ACT	1650009995350	.00015	.00066	.00001	1
CONT PWR SUP	1660000215439	.00060	.00095	.00041	1
ACTUATOR	1680006889991	.00021	.00053	.00011	8
ACTUATOR	1680009481024	.00141	.00430	.00076	1
CONTROL PANEL	1680010747678	.00057	.00005	.00023	1
COMPRESSOR	2835000697490	.00049	.00000	.00049	1
OIL PUMP	2835000766465	.00137	.00153	.00137	1
ADAPTER	2835000766472	.00488	.00533	.00488	1
SHUTOFF VALVE	2835000766499	.00231	.00022	.00002	9
APU SWITCH	2835008374869	.00441	.00434	.00073	1
FUEL CONTROL	2910009081429YP	.00531	.00550	.00029	1
FUEL VALVE	2915000740439	.00006	.00008	.00003	4
FUEL CONTROL	2915009125993RV	.00026	.00091	.00009	4
IGNIT EXCIT	2925004567627RV	.00041	.00140	.00012	4
CABLE ASSY	2925009391473RV	.00017	.00015	.00017	4
HEAT EXCHANG	2935005731750	.00054	.00163	.00008	4
ANTI-ICE VLV	2995000707372	.00041	.00166	.00020	4
CONT ASSY	2995000879914RV	.00017	.00004	.00005	4
CONTROL LH	2995002321491RV	.00082	.00208	.00050	4
ANTI-ICE CONT	2995004356898RV	.00075	.00051	.00028	4
ANTI-ICE ACT	2995004389890RV	.00019	.00066	.00011	8
ENGINE STARTER	2995004921489	.00039	.00110	.00014	4
ENGINE VALVE	2995007565840	.00041	.00128	.00014	4
STARTER VALVE	2995009742847	.00063	.00178	.00031	4
HYD PUMP	4320000513137HS	.00046	.00138	.00010	4
FUEL PUMP	4320006314859FS	.00051	.00149	.00002	1
THRST REV PUMP	4320007020269YQ	.00025	.00105	.00021	4
MAIN G PUMP	4320009438325RV	.00006	.00009	.00001	4
HYD PUMP	4320009995363HS	.00065	.00135	.00036	2
BLEED VALVE	4810007961672TP	.00031	.00092	.00016	4
CABIN VALVE	4810007961683TP	.00026	.00085	.00032	2
BLEED VALVE	4810008686547TP	.00019	.00052	.00008	2
PRESS REG VLV	4820007596907YQ	.00058	.00272	.00091	4

NOUN	NSN	D029 DEMAND RATE	McGUIRE ONSHORE RATE	FSS OFFSHORE RATE	QPA
ANTENNA COUP	5821000192704	.00067	.00272	.00026	2
RCVR XMTR	5821006015131	.00135	.00215	.00040	2
RT UNIT T2	5821008932906	.00250	.00984	.00398	2
RCVR XMTR	5821009160057	.00776	.00139	.00074	1
CONT RCVR	5821009812468	.00060	.00060	.00005	1
RECEIVER	5826009300076	.00092	.00031	.00046	2
RADIO RCVR	5826009731916	.00086	.00378	.00050	2
CONTROL TAC	5826010121919	.00042	.00080	.00012	2
RCVR XMTR	5826010121938	.00099	.00149	.00052	2
DA ADAPTER	5826010124864	.00038	.00080	.00022	2
INTRCPT CONTR	5831005235328	.00026	.00081	.00010	9
RADAR INDIC	5841001687659	.00161	.00161	.00047	1
XCVR ALTIM	5841004120447	.00323	.00323	.00125	1
IFF RCVR XMTR	5895000894521	.00277	.00644	.00367	1
HF COUPLER	5985007236740CX	.00108	.00054	.00072	2
GENERATOR	6115007723552UH	.00055	.00179	.00011	5
FLT COMPARATOR	6340010557374	.00139	.00227	.00049	1
COMPUTER TE	6605004583854JH	.00558	.01108	.00308	1
INDIC BEARING	6605008745772	.00116	.00127	.00047	3
INS	6605010182181	.00153	.00252	.00145	2
DISPLAY CNTRL	6605010352009	.00123	.00046	.00021	9
FLT DIR COMP	6610002517062JH	.00086	.00521	.00108	1
IND HORIZONTAL	6610005600303	.00242	.00414	.00091	2
ADI	6610008303587JH	.00128	.00765	.00188	1
CADC	6610009063062	.00458	.00878	.00447	2
POWER SUPPLY	6610009150577	.00040	.00083	.00009	2
INDICATOR	6610009927976	.00145	.00376	.00072	2
INDICATOR	6610009927978	.00132	.00118	.00067	2
YAW COMP	6615001187635	.00401	.00777	.00269	1
AILERON COMP	6615001187636	.00294	.00769	.00198	1
RATE GYRO	6615007635228	.00164	.00544	.00040	2
ACTUATOR	6615008670344	.00080	.00177	.00017	2
CNTRL AUTO	6615008815068	.00152	.00413	.00089	1
DISPL GYRO	6615010177736	.00145	.00421	.00147	1
AMP ELECTRONIC	6615010181635	.00094	.00252	.00104	1
COUPLER AUTO	6615011297151	.00561	.01182	.00390	1
ELEV COMP	6615011297152	.00511	.00424	.00342	1
IND EPR	6620009421033	.00193	.00243	.00095	2
IND TAC	6620009808040	.00118	.00378	.00049	4
IND RATE	6620009808046	.00147	.00492	.00065	2
FUEL XMTR	6620009879076	.00061	.00204	.00037	4
TEMP SENSOR	6685007581575TP	.00055	.00008	.00012	1
TEMP IND	6685008776593NT	.00079	.00067	.00047	2
TEMP IND	6685009454979	.00098	.00027	.00032	1

Appendix E: Sensitivity Analysis Results

TABLE X

D029 Demand Rates

(Expected NMCS Rate)

Day	1	3	5	7	10	15	20	25	30
AA75	54.4	91.1	98.4	99.7	100.0	100.0	100.0	100.0	100.0
TB175	22.0	47.3	64.7	78.4	91.2	98.7	99.9	100.0	100.0
FSS/75	7.7	23.9	36.5	47.0	62.2	83.7	95.1	99.0	99.9
FSS/175	19.3	42.6	61.2	76.2	90.5	98.8	99.9	100.0	100.0
TA300	4.6	24.4	42.5	59.6	80.5	96.9	99.8	100.0	100.0
BLSS/POS	6.9	12.0	15.4	18.0	21.4	27.3	37.6	51.2	68.2

TABLE XI

14 Day OST

(Expected NMCS Rate)

Day	1	3	5	7	10	15	20	25	30
AA75	20.5	50.5	69.4	81.0	90.6	96.9	98.9	99.6	99.9
TB175	4.2	13.3	21.5	34.8	34.8	42.2	48.9	55.9	62.9
FSS/75	2.4	7.4	12.2	22.4	22.4	29.4	34.1	37.9	41.5
FSS/175	3.4	9.9	15.7	26.0	26.0	32.3	38.0	44.2	50.7
TA300	0.2	2.3	6.4	18.7	18.7	27.5	35.5	43.8	52.0
BLSS/POS	6.6	10.8	15.2	25.2	25.2	33.2	39.0	43.1	52.0

TABLE XII

7 Day OST

(Expected NMCS Rate)

Day	1	3	5	7	10	15	20	25	30
AA75	20.5	49.8	67.4	78.1	87.2	94.4	97.5	99.0	99.9
TB175	4.2	13.0	20.7	26.5	32.5	38.9	44.5	51.0	58.0
FSS/75	2.4	7.2	11.6	15.3	19.8	25.7	30.6	34.7	38.4
FSS/175	3.4	9.8	15.1	19.2	23.8	29.1	33.9	39.6	46.0
TA300	0.2	2.2	6.0	10.3	16.3	23.8	30.4	38.0	46.0
BLSS/POS	2.6	5.3	7.8	9.9	12.1	13.9	14.6	14.9	18.9

TABLE XIII

Reduced UTE Rate

(Expected NMCS Rate)

Day	1	3	5	7	10	15	20	25	30
AA75	14.2	37.2	54.5	67.4	80.6	92.3	97.1	99.0	99.7
TB175	2.8	8.8	14.8	20.5	27.7	36.3	42.9	50.1	57.9
FSS/75	1.6	4.9	8.2	11.6	16.5	23.9	30.1	35.3	40.0
FSS/175	2.3	6.7	11.0	15.0	20.3	27.3	33.3	39.7	47.1
TA300	0.1	1.0	2.9	5.8	11.2	20.4	30.0	39.4	51.4
BLSS/POS	7.2	9.4	11.8	14.4	18.4	27.4	46.4	68.6	88.1

Appendix F: Actual vs. Suggested WRSK Segment Quantities

NSN	Segment TA			Segment TB			Segment AA		
	Actual	Suggested 30 %	Suggested 20 %	Actual	Suggested 40 %	Suggested 20 %	Actual	Suggested 50 %	Suggested 20 %
1560000744238JH	1	0	1	0	0	0	0	0	1
1560008716282JH	1	0	0	0	0	0	0	0	1
1560009184010JH	1	1	2	0	1	1	0	0	1
1620009825059	1	1	2	1	1	2	1	1	2
1630000816687	6	8	9	6	6	7	4	3	4
1630008810815	2	0	0	2	0	0	1	0	1
1630011326400	12	5	10	12	3	7	4	1	4
1650008326780	1	0	1	0	0	0	0	0	1
1650009303160	2	0	0	1	0	0	0	0	0
1650009374099	1	0	0	0	0	0	0	0	1
1650009995350	1	0	0	0	0	0	0	0	1
1660000215439	1	2	2	1	2	2	0	1	1
1680006889991	1	0	0	1	0	0	1	0	1
1680009481024	3	3	4	2	3	3	0	1	2
1680010747678	1	1	2	1	1	1	1	0	2
2835000766499	1	0	0	1	0	0	0	0	1
2835008374869	1	4	5	0	4	4	0	2	3
2910009081429YP	1	1	2	0	2	2	0	1	1
2915000740439	1	0	0	0	0	0	0	0	0
2915009125993RV	1	0	0	1	0	0	0	0	0
2925004567627RV	1	0	0	1	0	1	1	0	1
2935005731750	1	0	0	1	0	1	0	0	1
2995000707372	2	0	1	1	0	2	1	0	1
2995000879914RV	2	0	0	0	0	0	0	0	1
2995002321491RV	3	3	6	2	2	5	1	1	3
2995004356898RV	2	0	2	1	0	2	1	0	1
2995004389890RV	1	0	0	1	0	0	1	0	1
2995004921489	2	0	0	1	0	0	1	0	1
2995007565840	1	0	0	1	0	1	0	0	1
2995009742847	2	2	4	2	1	4	1	1	2
4320000513137HS	2	0	0	1	0	0	0	0	1
4320009438325RV	1	0	0	0	0	0	0	0	0
4320009995363HS	1	1	2	1	1	2	1	0	1
4810007961672TP	3	0	1	1	0	2	0	0	1
4810007961683TP	1	3	4	1	2	3	0	1	2
5821000192704	1	2	3	1	1	2	1	1	2
5821006015131	2	2	3	2	2	3	1	1	2
5821008932906	10	20	22	8	14	15	4	6	7
5821009160057	1	2	3	0	1	2	0	0	1
5821009812468	1	0	1	1	1	1	0	0	1
5826009300076	2	4	5	1	3	4	0	2	3
5826009731916	3	2	4	3	2	3	0	1	2
5826010121919	1	0	1	1	1	2	0	0	1
5826010121938	3	2	3	2	2	3	1	1	2
5826010124864	1	1	2	1	1	2	0	1	2
5831005235328	2	0	0	1	0	0	0	0	1

	Segment TA			Segment TB			Segment AA		
	Actual	Suggested		Actual	Suggested		Actual	Suggested	
		30 %	20 %		40 %	20 %		50 %	20 %
5841001687659	2	2	3	1	2	2	0	1	2
5841004120447	2	4	5	1	3	4	0	1	2
5895000894521	6	10	10	5	7	7	3	3	3
5985007236740CX	3	5	6	3	4	5	0	2	3
6115007723552UH	2	0	0	1	0	0	0	0	1
6340010557374	1	2	2	0	2	2	0	0	1
6605004583854JH	3	8	8	3	5	6	2	2	3
6605008745772	2	3	5	1	2	4	0	1	2
6605010182181	3	4	5	2	3	4	2	1	2
6605010352009	2	0	1	1	1	2	1	0	1
6610002517062JH	2	4	5	1	3	3	0	1	2
6610005600303	2	5	6	2	4	5	2	2	3
6610008303587JH	2	6	7	2	5	5	1	2	3
6610009063062	12	20	21	12	13	14	6	5	6
6610009150577	1	1	2	1	1	2	0	1	2
6610009927976	2	4	5	2	3	4	1	1	2
6610009927978	4	3	5	1	3	4	1	1	2
6615001187635	5	6	7	5	4	4	2	1	2
6615001187636	4	4	5	4	3	3	2	1	2
6615007635228	3	1	3	2	1	2	1	1	2
6615008670344	1	1	2	1	1	2	0	1	2
6615008815068	2	3	4	2	2	3	1	1	2
6615010177736	5	4	5	1	3	3	1	1	2
6615010181635	2	4	5	1	3	3	1	1	2
6615011297151	6	10	11	6	7	7	2	3	3
6615011297152	6	9	10	6	6	7	2	3	3
6620009421033	3	6	7	2	4	6	1	2	3
6620009808040	3	4	6	2	3	5	1	2	3
6620009808046	3	5	6	1	4	5	1	2	3
6620009879076	3	2	4	2	1	4	1	1	2
6685007581575TP	2	0	1	0	1	1	0	0	1
6685008776593NT	2	3	4	1	3	4	1	2	3
6685009454979	1	2	3	1	2	2	0	1	2

Appendix G: Dyna-METRIC Input Files

```
BASELINE RUN FOR FOUR BASES: TA300, TB175, AA75, FSS/TB175
 1 0.   0.           VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     14
     15
     18
CIRF
KHRI                                  30.000 0.   30.   1.0001.00 2.001      30.00
BASE
A300KHRI30.0030.0030. 0030.00 0.  30.000 0.   30.   1.0031.00 1.000 0.   30.00  10
B175KHRI30.0030.0030.  030.00 0.  30.000 0.   30.   1.0031.00 1.000 0.   30.00  10
LPLAKHRI30.0030.0030.  030.00 0.  30.000 0.   30.   1.0031.00 1.000 0.   30.00  10
AA75KHRI30.0030.0030.  030.00 0.  30.000 0.   30.   1.0031.00 1.000 0.   30.00  10
ACFT
A300  0.   1  5.9999  0.
B175  0.   1  3.9999  0.
LPLA  0.   1  4.9999  0.
AA75  0.   1  1.9999  0.
SRTS
A300 0.    1 2.09999 0.
B175 0.    1 2.09999 0.
LPLA 0.    1 2.09999 0.
AA75 0.    1 2.59999 0.
FLHR
A300 0.    1 6.09999 0.
B175 0.    1 6.09999 0.
LPLA 0.    1 6.09999 0.
AA75 0.    1 4.89999 0.
ATTR
A3000.      10.   99990.
B1750.      10.   99990.
LPLA0.      10.   99990.
AA750.      10.   99990.
TURN
A300 1.0   1 2.09999 0.
B175 1.0   1 2.09999 0.
LPLA 1.0   1 2.09999 0.
AA75 0.5   1 2.59999 0.
LRU
1560000744238JH       1 1  1  1 1 .00125 .00011  2.0 1.00        2.0 1.00
1560000744238JH   2.0 0.21       2.0   30      14.0 30.0   12283. 11FA#
1560008716282JH       1 1  1  1 1 .00015 .00004  2.0 1.00        2.0 1.00
1560008716282JH   2.0 0.76       2.0   30      14.0 30.0    2711. 14AB&
1560009184010JH       1 1  1  1 1 .00018 .00018  2.0 1.00        2.0 1.00
1560009184010JH   2.0 0.91       2.0   30       7.0 30.0    3309. 11EB&
1620009825059         1 1  2  2 1 .00043 .00019  2.0 1.00        2.0 1.00
1620009825059     2.0 0.02       2.0   30      14.0 30.0     790. 13AB,
1630000816687         1 1  2  2 1 .00328 .00117  2.0 1.00        2.0 1.00
1630000816687     2.0 0.02       2.0   30      14.0 30.0    1600. 13GB
1630008810815         1 1  8  8 1 .00046 .00010  2.0 1.00        2.0 1.00
1630008810815     2.0 0.13       2.0   30      13.0 30.0    1483. 13DB
1630011326400         1 1  8  8 1 .00189 .00069  2.0 1.00        2.0 1.00
1630011326400     2.0 0.29       2.0   30      17.0 30.0    4509. 13GA
1650008326780         1 1  1  1 1 .00021 .00021  2.0 1.00        2.0 1.00
1650008326780     2.0 0.88       2.0   30      14.0 30.0   25616. 14GC$
1650009303160         1 1  4  4 1 .00066 .00013  2.0 1.00        2.0 1.00
1650009303160     2.0 0.80       2.0   30      14.0 30.0   52997. 23SQ;
1650009374099         1 1  1  1 1 .00013 .00006  2.0 1.00        2.0 1.00
1650009374099     2.0 0.84       2.0   30      14.0 30.0    5880. 45FA
1650009995350         1 1  1  1 1 .00015 .00001  2.0 1.00        2.0 1.00
1650009995350     2.0 0.76       2.0   30       7.0 30.0     561. 14FC+
1660000215439         1 1  1  1 1 .00060 .00041  2.0 1.00        2.0 1.00
1660000215439     2.0 0.66       2.0   30      17.0 30.0    5403. 41AA&
1680006889991         1 1  8  8 1 .00021 .00011  2.0 1.00        2.0 1.00
1680006889991     2.0 0.66       2.0   30      14.0 30.0    4017. 23HO%
1680009481024         1 1  1  1 1 .00141 .00076  2.0 1.00        2.0 1.00
1680009481024     2.0 0.94       2.0   30      14.0 30.0    6283. 14ED
1680010747678         1 1  1  1 1 .00057 .00023  2.0 1.00        2.0 1.00
1680010747678     2.0 0.09       2.0   30      14.0 30.0    2581. 13CA
2835000766499         1 1  1  1 1 .00231 .00002  2.0 1.00        2.0 1.00
2835000766499     2.0 0.98       2.0   30      14.0 30.0    2153. 24EA%
2835008374869         1 1  1  1 1 .00441 .00073  2.0 1.00        2.0 1.00
2835008374869     2.0 0.43       2.0   30      14.0 30.0     807. 24(AS
2910009081429YP       1 1  1  1 1 .00531 .00029  2.0 1.00        2.0 1.00
2910009081429YP   2.0 0.80       2.0   30       7.0 30.0    2086. 24AA
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2915000740439          1 1  4  4 1 .00006 .00003  2.0 1.00       2.0 1.00
2915000740439      2.0 0.49         2.0   30        14.0 30.0    1177. 46FA
2915009125993RV        1 1  4  4 1 .00026 .00009  2.0 1.00       2.0 1.00
2915009125993RV    2.0 0.94         2.0   30        14.0 30.0   43518. 23HA,
2925004567627RV        1 1  4  4 1 .00041 .00012  2.0 1.00       2.0 1.00
2925004567627RV    2.0 0.96         2.0   30        25.0 30.0    4223. 23KA
2935005731750          1 1  4  4 1 .00054 .00008  2.0 1.00       2.0 1.00
2935005731750      2.0 0.86         2.0   30         9.0 30.0    2575. 23JQ
2995000707372          1 1  4  4 1 .00041 .00020  2.0 1.00       2.0 1.00
2995000707372      2.0 0.91         2.0   30        12.0 30.0    5823. 23LQ'
2995000879914RV        1 1  4  4 1 .00017 .00005  2.0 1.00       2.0 1.00
2995000879914RV    2.0 0.98         2.0   30         9.0 30.0    1643. 23LAS
2995002321491RV        1 1  4  4 1 .00082 .00050  2.0 1.00       2.0 1.00
2995002321491RV    2.0 0.45         2.0   30        14.0 30.0    2277. 23LA(
2995004356898RV        1 1  4  4 1 .00075 .00028  2.0 1.00       2.0 1.00
2995004356898RV    2.0 0.54         2.0   30        12.0 30.0    9303. 23LA#
2995004389890RV        1 1  8  8 1 .00019 .00011  2.0 1.00       2.0 1.00
2995004389890RV    2.0 0.91         2.0   30        14.0 30.0    2293. 23LR'
2995004921489          1 1  4  4 1 .00039 .00014  2.0 1.00       2.0 1.00
2995004921489      2.0 0.93         2.0   30        14.0 30.0   12590. 23KR
2995007565840          1 1  4  4 1 .00041 .00014  2.0 1.00       2.0 1.00
2995007565840      2.0 0.96         2.0   30        11.0 30.0    3808. 23TR#
2995009742847          1 1  4  4 1 .00063 .00031  2.0 1.00       2.0 1.00
2995009742847      2.0 0.93         2.0   30        14.0 30.0    1037. 23KR#
4320000513137HS        1 1  4  4 1 .00046 .00010  2.0 1.00       2.0 1.00
4320000513137HS    2.0 0.91         2.0   30        10.0 30.0    5253. 45AC
4320009438325RV        1 1  4  4 1 .00006 .00001  2.0 1.00       2.0 1.00
4320009438325RV    2.0 0.95         2.0   30        11.0 30.0    3082. 23JB#
4320009995363HS        1 1  2  2 1 .00065 .00036  2.0 1.00       2.0 1.00
4320009995363HS    2.0 0.96         2.0   30        12.0 30.0   16490. 45CC
4810007961672TP        1 1  4  4 1 .00031 .00016  2.0 1.00       2.0 1.00
4810007961672TP    2.0 0.74         2.0   30        10.0 30.0    2372. 41DB
4810007961683TP        1 1  2  2 1 .00026 .00032  2.0 1.00       2.0 1.00
4810007961683TP    2.0 0.43         2.0   30        14.0 30.0     711. 41AB-
5821000192704          1 1  2  2 1 .00067 .00026  2.0 1.00       2.0 1.00
5821000192704      2.0 0.10         2.0   30        11.0 30.0    1757. 61AAS
5821006015131          1 1  2  2 1 .00135 .00040  2.0 1.00       2.0 1.00
5821006015131      2.0 0.03         2.0   30        14.0 30.0    5333. 63CA0
5821008932906          1 1  2  2 1 .00250 .00398  2.0 1.00       2.0 1.00
5821008932906      2.0 0.11         2.0   30        14.0 30.0    4290. 61AB0
5821009160057          1 1  1  1 1 .00776 .00074  2.0 1.00       2.0 1.00
5821009160057      2.0 0.17         2.0   30        13.0 30.0   30540. 63AB0
5821009812468          1 1  1  1 1 .00060 .00005  2.0 1.00       2.0 1.00
5821009812468      2.0 0.18         2.0   30        18.0 30.0     646. 63AA£
5826009300076          1 1  2  2 1 .00092 .00046  2.0 1.00       2.0 1.00
5826009300076      2.0 0.15         2.0   30        10.0 30.0     720. 71EA#
5826009731916          1 1  2  2 1 .00086 .00050  2.0 1.00       2.0 1.00
5826009731916      2.0 0.14         2.0   30        14.0 30.0    6490. 71AC0
5826010121919          1 1  2  2 1 .00042 .00012  2.0 1.00       2.0 1.00
5826010121919      2.0 0.31         2.0   30        12.0 30.0    1337. 71ZD0
5826010121938          1 1  2  2 1 .00099 .00052  2.0 1.00       2.0 1.00
5826010121938      2.0 0.16         2.0   30        12.0 30.0   13030. 71ZA0
5826010124864          1 1  2  2 1 .00038 .00022  2.0 1.00       2.0 1.00
5826010124864      2.0 0.20         2.0   30        13.0 30.0    2132. 71ZB0
5831005235328          1 1  9  9 1 .00026 .00010  2.0 1.00       2.0 1.00
5831005235328      2.0 0.08         2.0   30        14.0 30.0     776. 64AA
5841001687659          1 1  1  1 1 .00161 .00047  2.0 1.00       2.0 1.00
5841001687659      2.0 0.85         2.0   30         8.0 30.0    2935. 72JB0
5841004120447          1 1  1  1 1 .00323 .00125  2.0 1.00       2.0 1.00
5841004120447      2.0 0.07         2.0   30        14.0 30.0    7394. 72JA0
5895000894521          1 1  1  1 1 .00277 .00367  2.0 1.00       2.0 1.00
5895000894521      2.0 0.05         2.0   30        14.0 30.0   17301. 65BB0
5985007236740CX        1 1  2  2 1 .00108 .00072  2.0 1.00       2.0 1.00
5985007236740CX    2.0 0.06         2.0   30         9.0 30.0    2166. 61AC0
6115007723552UH        1 1  5  5 1 .00055 .00011  2.0 1.00       2.0 1.00
6115007723552UH    2.0 0.42         2.0   30        10.0 30.0    3111. 42DA
6340010557374          1 1  1  1 1 .00139 .00049  2.0 1.00       2.0 1.00
6340010557374      2.0 0.19         2.0   30        14.0 30.0    9647. 51EA0
6605004583854JH        1 1  1  1 1 .00558 .00308  2.0 1.00       2.0 1.00
6605004583854JH    2.0 0.19         2.0   30        14.0 30.0   27147. 56DG0
6605008745772          1 1  3  3 1 .00116 .00047  2.0 1.00       2.0 1.00
6605008745772      2.0 0.98         2.0   30        10.0 30.0     961. 71GA(
6605010182181          1 1  2  2 1 .00153 .00145  2.0 1.00       2.0 1.00
6605010182181      2.0 0.39         2.0   30        14.0 30.0  102884. 73BA0
6605010352009          1 1  2  2 1 .00123 .00021  2.0 1.00       2.0 1.00
6605010352009      2.0 0.25         2.0   30        14.0 30.0    5820. 73BB0
6610002517062JH        1 1  1  1 1 .00086 .00108  2.0 1.00       2.0 1.00
6610002517062JH    2.0 0.30         2.0   30        14.0 30.0    7364. 56AE0
6610005600303          1 1  2  2 1 .00242 .00091  2.0 1.00       2.0 1.00
6610005600303      2.0 0.94         2.0   30         9.0 30.0    7428. 51BG,
6610008303587JH        1 1  1  1 1 .00128 .00188  2.0 1.00       2.0 1.00
6610008303587JH    2.0 0.97         2.0   30        10.0 30.0    5511. 56AA0
6610009063062          1 1  2  2 1 .00458 .00447  2.0 1.00       2.0 1.00
6610009063062      2.0 0.26         2.0   30        14.0 30.0   15728. 51AA
6610009150577          1 1  2  2 1 .00040 .00009  2.0 1.00       2.0 1.00
6610009150577      2.0 0.98         2.0   30        11.0 30.0     123. 51AA=
6610009927976          1 1  2  2 1 .00145 .00072  2.0 1.00       2.0 1.00
6610009927976      2.0 0.95         2.0   30         9.0 30.0    7000. 51AAS
```

```
6610009927978              1 1  2  2 1 .00132 .00067  2.0 1.00        2.0 1.00
6610009927978         2.0 0.95        2.0   30       10.0 30.0   7100. 51AA#
6615001187635              1 1  1  1 1 .00401 .00269  2.0 1.00        2.0 1.00
6615001187635         2.0 0.11        2.0   30       14.0 30.0  46019. 52EB0
6615001187636              1 1  1  1 1 .00294 .00198  2.0 1.00        2.0 1.00
6615001187636         2.0 0.13        2.0   30       14.0 30.0  45881. 56EC0
6615007635228              1 1  2  2 1 .00164 .00040  2.0 1.00        2.0 1.00
6615007635228         2.0 0.88        2.0   30        8.0 30.0  11105. 52AA$
6615008670344              1 1  2  2 1 .00080 .00017  2.0 1.00        2.0 1.00
6615008670344         2.0 0.73        2.0   30        8.0 30.0   1957. 52AC
6615008815068              1 1  1  1 1 .00152 .00088  2.0 1.00        2.0 1.00
6615008815068         2.0 0.05        2.0   30       14.0 30.0  11845. 52AA
6615010177736              1 1  1  1 1 .00145 .00147  2.0 1.00        2.0 1.00
6615010177736         2.0 0.85        2.0   30       14.0 30.0  24101. 52FA0
6615010181635              1 1  1  1 1 .00094 .00104  2.0 1.00        2.0 1.00
6615010181635         2.0 0.38        2.0   30       12.0 30.0   7890. 52FB0
6615011297151              1 1  1  1 1 .00561 .00390  2.0 1.00        2.0 1.00
6615011297151         2.0 0.12        2.0   30       14.0 30.0  23238. 52EE0
6615011297152              1 1  1  1 1 .00511 .00342  2.0 1.00        2.0 1.00
6615011297152         2.0 0.15        2.0   30       14.0 30.0  16632. 52EA0
6620009421033              1 1  2  2 1 .00193 .00095  2.0 1.00        2.0 1.00
6620009421033         2.0 0.97        2.0   30       11.0 30.0   3094. 23GD
6620009808040              1 1  4  4 1..00118 .00049  2.0 1.00        2.0 1.00
6620009808040         2.0 0.97        2.0   30       10.0 30.0    950. 23GB
6620009808046              1 1  2  2 1 .00147 .00065  2.0 1.00        2.0 1.00
6620009808046         2.0 0.98        2.0   30        9.0 30.0   1320. 23HR.
6620009879076              1 1  4  4 1 .00061 .00037  2.0 1.00        2.0 1.00
6620009879076         2.0 0.96        2.0   30       12.0 30.0   1421. 23HR-
6685007581575TP            1 1  1  1 1 .00055 .00012  2.0 1.00        2.0 1.00
6685007581575TP       2.0 0.05        2.0   30       21.0 30.0   1595. 41AA'
6685008776593NT            1 1  2  2 1 .00079 .00047  2.0 1.00        2.0 1.00
6685008776593NT       2.0 0.96        2.0   30       10.0 30.0   1740. 23GC
6685009454979              1 1  1  1 1 .00098 .00032  2.0 1.00        2.0 1.00
6685009454979         2.0 0.96        2.0   30       14.0 30.0    916. 24GA
```

```
D029 DEMAND RATE RUN FOR FOUR BASES: TA300, TB175, AA75, FSS/TB175
 1 0.   0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
     1 80
     8 25 0.80
    11  5
    14
    15
    18
CIRF
KHRI                                30.000 0.  30.    1.0001.00 2.001      30.00
BASE
A300KHRI30.0030.0030. 0030.00 0.   30.000 0.  30.    1.0031.00 1.000 0.  30.00  11
B175KHRI30.0030.0030.  030.00 0.   30.000 0.  30.    1.0031.00 1.000 0.  30.00  11
LPLAKHRI30.0030.0030.  030.00 0.   30.000 0.  30.    1.0031.00 1.000 0.  30.00  11
AA75KHRI30.0030.0030.  030.00 0.   30.000 0.  30.    1.0031.00 1.000 0.  30.00  11
ACFT
A300  0.   1  5.9999  0.
B175  0.   1  3.9999  0.
LPLA  0.   1  4.9999  0.
AA75  0.   1  1.9999  0.
SRTS
A300 0.    1 2.09999 0.
B175 0.    1 2.09999 0.
LPLA 0.    1 2.09999 0.
AA75 0.    1 2.59999 0.
FLHR
A300 0.    1 6.09999 0.
B175 0.    1 6.09999 0.
LPLA 0.    1 6.09999 0.
AA75 0.    1 4.89999 0.
ATTR
A3000.      10.   99990.
B1750.      10.   99990.
LPLA0.      10.   99990.
AA750.      10.   99990.
TURN
A300 1.0   1 2.09999 0.
B175 1.0   1 2.09999 0.
LPLA 1.0   1 2.09999 0.
AA75 0.5   1 2.59999 0.
```

```
14 DAY OST, 4 BASE RUN: TA300, TB175, AA75, FSS/TB175
 1 0.   0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
       1 80
       8 25 0.80
      11 20
      14
      15
      18
CIRF
KHRI                                30.000 0.   30.    1.0001.00 2.001      30.00
BASE
A300KHRI 6.00 4.0000. 0030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
B175KHRI 6.00 4.0000.  030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
LPLAKHRI 6.00 4.0000.  030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
AA75KHRI 6.00 4.0000.  030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
ACFT
A300  0.   1  5.9999  0.
B175  0.   1  3.9999  0.
LPLA  0.   1  4.9999  0.
AA75  0.   1  1.9999  0.
SRTS
A300 0.    1 2.09999 0.
B175 0.    1 2.09999 0.
LPLA 0.    1 2.09999 0.
AA75 0.    1 2.59999 0.
FLHR
A300 0.    1 6.09999 0.
B175 0.    1 6.09999 0.
LPLA 0.    1 6.09999 0.
AA75 0.    1 4.89999 0.
ATTR
A3000.      10.   99990.
B1750.      10.   99990.
LPLA0.      10.   99990.
AA750.      10.   99990.
TURN
A300 1.0   1 2.09999 0.
B175 1.0   1 2.09999 0.
LPLA 1.0   1 2.09999 0.
AA75 1.0   1 2.59999 0.
```

```
7 DAY OST, 4 BASE RUN: TA300, TB175, AA75, FSS/TB175
 1 0.   0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
       1 80
       8 25 0.80
      11 20
      14
      15
      18
CIRF
KHRI                                30.000 0.   30.    1.0001.00 2.001      30.00
BASE
A300KHRI 3.00 2.0000. 0030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
B175KHRI 3.00 2.0000.  030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
LPLAKHRI 3.00 2.0000.  030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
AA75KHRI 3.00 2.0000.  030.00 0.    30.000 0.   30.    1.0031.00 1.000 0.   30.00  10
ACFT
A300  0.   1  5.9999  0.
B175  0.   1  3.9999  0.
LPLA  0.   1  4.9999  0.
AA75  0.   1  1.9999  0.
SRTS
A300 0.    1 2.09999 0.
B175 0.    1 2.09999 0.
LPLA 0.    1 2.09999 0.
AA75 0.    1 2.59999 0.
FLHR
A300 0.    1 6.09999 0.
B175 0.    1 6.09999 0.
LPLA 0.    1 6.09999 0.
AA75 0.    1 4.89999 0.
ATTR
A3000.      10.   99990.
B1750.      10.   99990.
LPLA0.      10.   99990.
AA750.      10.   99990.
TURN
A300 1.0   1 2.09999 0.
B175 1.0   1 2.09999 0.
LPLA 1.0   1 2.09999 0.
AA75 1.0   1 2.59999 0.
```

```
FOUR BASE RUN:  REDUCED UTILIZATION RATE
 1 0.    0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1    3    5    7  10  15  20  25  30
OPT
       1 80
       8 25 0.80
      11 20
      14
      15
      18
CIRF
KHRI                                     30.000 0.   30.    1.0001.00 2.001      30.00
BASE
A300KHRI30.0030.0030.  000.0030.  30.000 0.   30.   30.0030.0030.000 0.   30.00  10
B175KHRI30.0030.0030.  000.0030.  30.000 0.   30.   30.0030.0030.000 0.   30.00  10
LPLAKHRI30.0030.0030.  000.0030.  30.000 0.   30.   30.0030.0030.000 0.   30.00  10
AA75KHRI30.0030.0030.  000.0030.  30.000 0.   30.   30.0030.0030.000 0.   30.00  10
ACFT
A300  0.   1  5.9999  0.
B175  0.   1  3.9999  0.
LPLA  0.   1  4.9999  0.
AA75  0.   1  1.9999  0.
SRTS
A300 0.    1 2.09999 0.
B175 0.    1 2.09999 0.
LPLA 0.    1 2.09999 0.
AA75 0.    1 2.59999 0.
FLHR
A300 0.    1 4.09999 0.
B175 0.    1 4.09999 0.
LPLA 0.    1 4.09999 0.
AA75 0.    1 3.29999 0.
ATTR
A3000.       10.   99990.
B1750.       10.   99990.
LPLA0.       10.   99990.
AA750.       10.   99990.
TURN
A300 1.0   1 2.09999 0.
B175 1.0   1 2.09999 0.
LPLA 1.0   1 2.09999 0.
AA75 0.5   1 2.59999 0.
```

```
BASELINE RUN FOR BASE FSS/AA75
 1 0.    0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1    3    5    7  10  15  20  25  30
OPT
       1 80
       8 25 0.80
      11  5
      14
      15
      18
CIRF
KHRI                                     30.000 0.   30.    1.0001.00 2.001      30.00
BASE
EDARKHRI30.0030.0030.  030.00 0.  30.000 0.   30.    1.0000.00 1.000 0.   30.00  10
ACFT
EDAR  0.   1  3.9999  0.
SRTS
EDAR 0.    1 2.09999 0.
FLHR
EDAR 0.    1 6.09999 0.
ATTR
EDAR0.       10.   99990.
TURN
EDAR 1.0   1 2.09999 0.
```

```
DO29 DEMAND RATES RUN FOR BASE FSS/AA75
 1 0.    0.         VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     14
     15
     18
CIRF
KHRI                                      30.000 0.   30.   1.0001.00 2.001     30.00
BASE
EDARKHRI30.0030.0030.  030.00 0.  30.000 0.   30.   1.0000.00 1.000 0.   30.00  11
ACFT
EDAR  0.   1  3.9999  0.
SRTS
EDAR 0.    1 2.09999 0.
FLHR
EDAR 0.    1 6.09999 0.
ATTR
EDAR0.      10.   99990.
TURN
EDAR 1.0   1 2.09999 0.
```

```
14 OST, BASE FSS/AA75
 1 0.    0.         VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11 20
     14
     15
     18
CIRF
KHRI                                      30.000 0.   30.   1.0001.00 2.001     30.00
BASE
EDARKHRI 6.00 4.0000.  030.00 0.  30.000 0.   30.   1.0000.00 1.000 0.   30.00  10
ACFT
EDAR  0.   1  3.9999  0.
SRTS
EDAR 0.    1 2.09999 0.
FLHR
EDAR 0.    1 6.09999 0.
ATTR
EDAR0.      10.   99990.
TURN
EDAR 1.0   1 2.09999 0.
```

```
7 OST, BASE FSS/AA75
 1 0.    0.         VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11 20
     14
     15
     18
CIRF
KHRI                                      30.000 0.   30.   1.0001.00 2.001     30.00
BASE
EDARKHRI 3.00 2.0000.  030.00 0.  30.000 0.   30.   1.0000.00 1.000 0.   30.00  10
ACFT
EDAR  0.   1  3.9999  0.
SRTS
EDAR 0.    1 2.09999 0.
FLHR
EDAR 0.    1 6.09999 0.
ATTR
EDAR0.      10.   99990.
TURN
EDAR 1.0   1 2.09999 0.
```

```
BASE FSS/AA75 WITH REDUCED UTILIZATION RATE
 1 0.   0.          VERSION 4.3  HT1HT2HT3HT4HT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11 20
     14
     15
     18
CIRF
KWRI                                30.000 0.  30.   1.0001.00 2.001     30.00
BASE
EDARKWRI30.0030.0030.  030.00 0.  30.000 0.  30.   1.0000.00 1.000 0.  30.00  10
ACFT
EDAR  0.   1  3.9999  0.
SRTS
EDAR 0.    1 2.09999 0.
FLHR
EDAR 0.    1 4.09999 0.
ATTR
EDAR0.      10.   99990.
TURN
EDAR 1.0   1 2.09999 0.
```

```
BASELINE RUN FOR BASE BLSS/POS
 1 0.   0.          VERSION 4.3  HT1HT2HT3HT4HT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     15
     18
DEPT
POT1                                0.  1999.0 0.   1.   1.   1.  1      1.
BASE
BLSS     0.   0.   0.  099.00 0.   1.00030.00 0.   1.00 1.00 1.001 0.   0.00  10
ACFT
BLSS 27.   1 27.9999  0.
SRTS
BLSS 1.    1 2.09999 0.
FLHR
BLSS 3.2   1 6.09999 0.
ATTR
BLSS0.      10.   99990.
TURN
BLSS 1.0   1 3.09999 0.
TRNS
BLSS POT1  14.0  14.0 1   1.0  15.   16.0
```

```
D029 DEMAND RATES FOR BASE BLSS/POS
 1 0.   0.          VERSION 4.3  HT1HT2HT3HT4HT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     15
     18
DEPT
POT1                                0.  1999.0 0.   1.   1.   1.  1      1.
BASE
BLSS     0.   0.   0.  099.00 0.   1.00030.00 0.   1.00 1.00 1.001 0.   0.00  11
ACFT
BLSS 27.   1 27.9999  0.
SRTS
BLSS 1.    1 2.09999 0.
FLHR
BLSS 3.2   1 6.09999 0.
ATTR
BLSS0.      10.   99990.
TURN
BLSS 1.0   1 3.09999 0.
TRNS
BLSS POT1  14.0  14.0 1   1.0  15.   16.0
```

```
14 DAY OST FOR BASE BLSS/POS
 1 0.   0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     15
     18
DEPT
POT1                                  0.  1999.0 0.   1.   1.   1.  1      1.
BASE
BLSS     0.   0.   0.  099.00 0.   1.00030.00 0.   1.00 1.00 1.001 0.   0.00  10
ACFT
BLSS 27.    1 27.9999  0.
SRTS
BLSS 1.     1 2.09999 0.
FLHR
BLSS 3.2    1 6.09999 0.
ATTR
BLSS0.       10.   99990.
TURN
BLSS 1.0    1 3.09999 0.
TRNS
BLSS POT1   0.0  12.0 1   1.0  30.    1.0
```

```
7 DAY OST FOR BASE BLSS/POS
 1 0.   0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     15
     18
DEPT
POT1                                  0.  1999.0 0.   1.   1.   1.  1      1.
BASE
BLSS     0.   0.   0.  099.00 0.   1.00030.00 0.   1.00 1.00 1.001 0.   0.00  10
ACFT
BLSS 27.    1 27.9999  0.
SRTS
BLSS 1.     1 2.09999 0.
FLHR
BLSS 3.2    1 6.09999 0.
ATTR
BLSS0.       10.   99990.
TURN
BLSS 1.0    1 3.09999 0.
TRNS
BLSS POT1   0.0   5.0 1   1.0  30.    1.0
```

```
REDUCED UTILIZATION RATE FOR BASE BLSS/POS
 1 0.   0.          VERSION 4.3  MT1MT2MT3MT4MT5
   1   3   5   7  10  15  20  25  30
OPT
      1 80
      8 25 0.80
     11  5
     15
     18
DEPT
POT1                                  0.  1999.0 0.   1.   1.   1.  1      1.
BASE
BLSS     0.   0.   0.  099.00 0.   1.00030.00 0.   1.00 1.00 1.001 0.   0.00  10
ACFT
BLSS 27.    1 27.9999  0.
SRTS
BLSS 1.     1 2.09999 0.
FLHR
BLSS 3.2    1 6.09999 0.
ATTR
BLSS0.       10.   99990.
TURN
BLSS 1.0    1 3.09999 0.
TRNS
BLSS POT1  14.0  14.0 1   1.0  15.    16.0
```

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VITA

Captain Donald G. Stone was born on 27 November 1950 in Lexington, Kentucky. He attended Western Kentucky University and the University of Kentucky, where he received a Bachelor of Arts degree in December 1973. Upon graduation, he received a commission in the USAF through the Air Force ROTC program. He was called to active duty during June of 1974, entering pilot training at that time. Upon completion of pilot training and the awarding of pilot's wings in August 1975, he underwent training as a C-130 pilot. While at Dyess AFB TX, he served as an instructor pilot in the 774th Tactical Airlift Squadron. In addition, he served in the 463rd Tactical Airlift Wing as Assistant Chief, Tactics and Techniques Branch. He was selected for the Air Force Exchange Officers Program in June of 1980 and was assigned to Number 40 Squadron, Royal New Zealand Air Force, in October of 1980. While in New Zealand, he served as a C-130 instructor pilot, evaluator pilot, and as Squadron Training Officer. He entered the School of Systems and Logistics, Air Force Institute of Technology, in May 1983.

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VITA

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