A COMPARISON OF C-17 WAR READINESS SPARES KIT COMPUTATIONS USING DYNA-METRIC

THESIS

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Abstract

This study compared the performance of two representative war readiness spares kits (WRSK) for the C-17 aircraft under strategic and tactical airlift scenarios. WRSK stock levels were calculated for a sample of 24 aircraft line replaceable units using the Military Airlift Command's (MAC) computations and the Dyna-METRIC computer model. The level of support provided by MAC's kit was compared to the Dyna-METRIC kit by assessing it with Dyna-METRIC at a 15 percent not mission capable rate. The results showed MAC's computations produced a WRSK kit comparable to Dyna-METRIC's with respect to cost, stock levels, and aircraft availability for a squadron of 14 aircraft flying tactical airlift missions. Under the strategic airlift scenario with a wing of 39 aircraft, however, there was a large variation in the stock levels and cost for the WRSK and base level self-sufficiency spares between the MAC and Dyna-METRIC kits.

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I. Introduction

Background

In 1981, the Congressionally Mandated Mobility Study (CMMS) identified serious shortfalls in the Air Force's ability to meet anticipated wartime airlift demands. The CMMS established a minimum goal of 66 million ton-miles (MTM) per day to fulfill national mobility objectives. The Air Force needed an additional 20 MTM per day capacity above the 46 million ton-mile capacity projected for FY 86 to reach this level. Additionally, the report specified fifty percent of this airlift must be capable of transporting outsized Army equipment (30:4). The solution to this critical airlift shortage is based on developing the C-17 aircraft, as outlined in the 1983 US Air Force Airlift Master Plan (30:1,14). The aircraft is scheduled to begin limited production in October, 1988, and the first squadron will reach initial operational capability (IOC) by 1992 (5).

The Military Airlift Command (MAC) is the single Department of Defense (DOD) manager responsible for providing airlift. There are two basic types of airlift: strategic and tactical. Today, C-141 and C-5 aircraft fly long-range, strategic airlift missions while the C-130 provides intratheater, tactical airlift support. The C-17 will serve in a dual role, capable of performing both strategic and tactical missions. With the introduction of this aircraft into the Air Force inventory, preliminary investigations are needed to assess logistics support for the aircraft.

Provisioning of spare parts is a major element in procuring a new weapon system. According to AFR 800-36, Provisioning of Spares and Repair Parts, all new acquisition programs will develop a provisioning strategy during program initiation, and finalize it before full scale development begins (16:1). The program manager, in conjunction with the Air Force Logistics Command system program manager, determines what method to employ. The strategy may be one of the following:

> (1) use in-house provisioning methods of the responsible provisioning activity, (2) send a conference team to conduct provisioning conferences at the contractor's facility, or (3) establish a permanent Resident Integrated Logistics Support Activity (RILSA) at the contractor's facility (35:4; 10:6).

For the C-17, initial provisioning is being performed by a RILSA located at the Douglas Aircraft Company in Long Beach, CA (33).

Initial provisioning is the first step in providing support for a weapon system. It applies to spares needed through the demand development period (DDP), a period of time from the preliminary operational capability (POC) until "... requirements can be forecasted based upon actual demands or other empirical data ...", not to exceed two years (14:3). Acquisitions under the initial provisioning process are, by definition, limited in scope. However, the provisioning policies in AFR 800-36 require each acquisition program to establish an integrated spares acquisition and support plan at the beginning of full scale development (16:2).

In order to combine spares purchases, the Air Force established the Spares Acquisition Integrated with Production (SAIP) program. The program includes those spares ordered as initial provisions and spare parts needed for follow-on support, such as war reserve materiel (WRM). "The SAIP concept gives price benefits as a result of release of spares orders integrated or concurrent with the release of the contractor's orders to his or her vendors" (17:9).

Major commands assist in identifying the quantity of war reserve materials that qualify for SAIP, but SAIP procedures only apply to follow-on requisitions if the item is in production when the spares are requested (17:3). According to AFLCR 57-27, WRM requirements are determined during provisioning and "... combined with the peacetime initial spares buys whenever possible" (14:11). WRM is procured as an additive request on AFLC's recoverable items initial requirements computation worksheet (AFLC Form 614), and purchased with replenishment funds (14:11).

AFLC has primary responsibility for identifying and procuring war reserve materiel for the Air Force. WRM requirements are based on "wartime activity from D-day (the day hostilities begin) until either P-day (the day production can meet consumption) or until the end of the wartime computational scenario, whichever occurs first" (20:6). War reserve materiel falls into one of four categories; spares, equipment, war consumables, or medical materiel, depending on the type supply (19:Ch 14). Collectively, WRM are those critical items needed to insure the Air Force's combat capability.

One major aspect of the WRM program is to stock adequate levels of aircraft spare parts. The Air Force accomplishes this through its war readiness spares kits (WRSK) and base level self-sufficiency spares

(BLSS). These kits supplement normal peacetime operating stock to sustain forces during periods of increased flying activity, and during war. The contents of WRSK and BLSS are considered WRM spares; however, the spares can be either reparable or expendable assets (44:5-7).

HQ AFLC and the using major command (MAJCOM) compute WRSK and BLSS requirements for investment items such as reparable aircraft parts (20:14). Until recently, these requirements have been determined using AFLC's D029 marginal analysis computations. The computation system minimized the weighted average of aircraft not mission capable for supply (NMCS) and the number of backordered spare parts. Today, however, AFLC is transitioning to a new method of determining WRSK requirements, one where the performance objective is to meet a specified level of aircraft availability (2:26-28). This change centers around enhancing combat capability through a comprehensive weapon system management system. The improvement was made possible through the development of the Dyna-METRIC readiness assessment model.

Dyna-METRIC

The Dyna-METRIC readiness assessment model was developed by the Rand Corporation and first released to the Air Force in 1980 (8:17). Since its introduction, Dyna-METRIC has been used to assess weapon system readiness and sustainability. The latest version of the model, Dyna-METRIC 4.4, forms the core of AFLC's requirements/execution acquisition logistics module (REALM). REALM is one of four program modules that are incorporated into the Weapon System Management Information System (WSMIS). AFLC is working toward implementing

Dyna-METRIC as the Air Force standard for computing WRSK requirements. Currently, it is used for the F-15, F-16, and F-111 weapon systems (3).

The Dyna-METRIC inventory model has been applied in a variety of studies. Captains Donald Stone and Michael Wright investigated applying the model to strategic airlift for their Master of Science thesis. They demonstrated it was possible to simulate MAC's unique supply system and to reliably assess levels of reparable spare parts in the C-141 WRSK. This initial study proved the feasibility of using Dyna-METRIC as a tool for assessing strategic WRSK (44). Since that time, members of a Dynamics Research Corporation (DRC) and government working group have developed a strategic airlift model for Dyna-METRIC version 4.4. The goal is to integrate MAC's assessments for strategic aircraft into WSMIS (42:13). The DRC contractor, located at AFLC LMSC/SMW, is currently working to validate the model prior to incorporating it into the sustainability assessment module (SAM) of WSMIS.

Dyna-METRIC has also been used as an assessment tool for initial provisioning. In 1985, Captain Michael Mills investigated the feasibility of using Dyna-METRIC to calculate initial provisioning requirements. For a sample of sixty-four F-16 line replaceable units, he compared the theoretical aircraft availability sustained by the level of parts obtained using MOD-METRIC, and the number of spares recommended by a Dyna-METRIC analysis. The results were (1) Dyna-METRIC stock-levels sustained a higher theoretical aircraft availability than did MOD-METRIC, and (2) given a fixed aircraft availability, Dyna-METRIC recommended a lower cost inventory than MOD-METRIC. The study concluded Dyna-METRIC was superior to MOD-METRIC for initial spares provisioning (35).

Captain Mills' findings were later validated through research conducted by Captain Robert Yauch. Yauch compared three techniques for calculating initial spares: AFLCR 57-27 computations, MOD-METRIC, and Dyna-METRIC. He evaluated the initial provisioning of forty-one F-16 fuel system line replaceable units. The results suggested Dyna-METRIC was equal or superior to traditional methods for initial provisioning given a fixed level of investment. Additionally, Dyna-METRIC analysis recommended fewer spare parts without diminishing aircraft performance.

Justification

Procuring essential spare parts in sufficient quantities to support a weapon system is of paramount importance. This is especially true when acquiring a limited number of WRM reparable spares for the WRSK and BLSS. In FY 88, funding for aircraft replenishment spares was only 1.9 billion when the requirement stood at 3.9 billion (40). Funding levels are unlikely to increase over the next five years because of the Gramm-Rudman-Hollings Act of 1985, and similar efforts to reduce the federal deficit. Budget austerity will continue through the period of time when the C-17 aircraft is scheduled to begin production. If WRM requirements are identified early in the provisioning process, the RILSA will be able to take advantage of the SAIP program. This research offers supplemental information for HQ MAC to project C-17 WRSK requirements.

Problem Statement

In light of current decreases in DOD funding, alternative methods of calculating spares requirements must be evaluated in order to provide the most support for dollars invested. A determination was made of the differences between a WRSK developed using Rand's Dyna-METRIC readiness assessment model versus one developed using MAC's methodology.

Research Objective

The purpose of this research was to evaluate the performance of two representative WRSK kits, each created using a different method for calculating WRSK. By comparing the result obtained with MAC's command-unique methodology and those with Dyna-METRIC, decision makers can assess which method offers the best alternative for computing WRSK.

Research Questions

1. Given a representative tactical airlift scenario, is there a significant difference in aircraft availability when operating from a WRSK kit designed by Dyna-METRIC and one created using MAC's computational techniques?

2. Given a representative strategic airlift scenario, is there a significant difference in aircraft availability between a MAC WRSK and one computed using Dyna-METRIC?

Scope

The scope of this study was limited to evaluating the relative performance of two projected C-17 WRSK. The Dyna-METRIC model was used to determine inventory requirements for a strategic and a tactical WRSK. Similarly, MAC's computations were used to obtain stock levels for each kit. A Dyna-METRIC assessment was then performed on MAC's kits to measure and compare the level of support achieved in relation to the Dyna-METRIC kits. The tactical and strategic airlift missions were modeled separately because the Dyna-METRIC assessments are scenario-dependent.

Limitations

Provisioning for the C-17 had not begun at the time of this research effort, so the study was based on limited, preliminary data. In the absence of official provisioning documents, a list of candidate WRSK items was compiled based on recommendations from experts at HQ MAC. The data base contained only a small sample of reparable spare parts because the actual composition of the C-17 WRSK had not been identified. Demand rates for government furnished equipment reflected the component's performance in other weapon systems, and demand data for contractor furnished equipment, much of which had not been built and tested, was based on projected failure rates.

The flying scenarios used in the Dyna-METRIC analysis represent the basic employment concepts for strategic and tactical airlift aircraft. They were based solely on a representative flying hour program for the C-17 aircraft. The results of this study were scenario-dependent and should not be used to make inferences about specific missions for, or to judge the capabilities of, the proposed C-17 fleet.

II. Literature Review

Introduction

This chapter begins with an overview of the development of reparable inventory models. Early models used a simple Poisson distribution to simulate demands in a steady state environment. The underlying mathematical principles followed from Palm's Theorem, a well-known queuing theorem. During the 1960's, Feeney and Sherbrooke extended Palm's Theorem to evaluate the effectiveness of an (s-1,s) inventory policy under a compound Poisson distribution. The compound Poisson distribution allowed Feeney and Sherbrooke to more accurately represent variable demands on the system. The (s-1,s) inventory policy is most appropriate for high cost, low demand items because replacements are ordered whenever a demand occurs. As a result, this policy yields reduced inventory costs; an important consideration when dealing with expensive investment items such as reparable spares.

During the early 1960s, the Air Force adopted a method for calculating spare stock known as the repair cycle demand level model. In general, the model determines the quantity of stock needed to cover a base's repair and resupply pipelines. The standard base supply system depends on base-level maintenance as a continuous source of resupply for reparable spares. Once unserviceable assets become part of the repair cycle system, they are either repaired by the base or depot, or condemned and replaced.

The Rand corporation conducted research for the Air Force to develop models that more accurately represented the demand and resupply process. In 1966, Sherbrooke introduced a model called the multi-echelon technique for recoverable item control, or METRIC. METRIC modeled multiple bases, as well as incorporating two levels of repair, a base and a depot echelon, into its calculations. MOD-METRIC followed in 1973, and this version of METRIC enhanced the model by considering the indentured relationship between line replaceable units and shop replaceable units. These versions of METRIC laid the foundation for future enhancements in the model.

A major advancement came with the introduction of Dyna-METRIC in the early 1980s. Finally, a model was able to capture the dynamic nature of a wartime logistics system. Dyna-METRIC combined the capabilities of METRIC and MOD-METRIC with features that recognize indentured repair relationships down to the subSRU level, and included multiple repair echelons and multiple bases. This model could account for variations in demand levels because it was not restricted by a mathematical assumption of steady state demands. As Dyna-METRIC grew in sophistication, so did its applications.

The Air Force adopted Rand's Dyna-METRIC computer model as a standard analytical tool. Dyna-METRIC is used to perform weapon system assessments, and WRSK/BLSS requirements computations on AFLC's Weapon System Management Information System. Assessments for MAC's fleet of strategic aircraft were not feasible using Dyna-METRIC, until the strategic airlift model was developed for WSMIS. The model is currently undergoing implementation. Likewise, strategic airlift aircraft have not been incorporated into WSMIS for requirements computations. The Dynamics Research Corporation recently performed a demonstration of Dyna-METRIC's capabilities in modeling strategic airlift. They concluded MAC's WRSK computations can be duplicated with Dyna-METRIC; however, there are several methodologies under consideration by HQ MAC and HQ AFLC for modeling strategic airlift in WSMIS.

Palm's Theorem

The theoretical framework for stationary (steady state) inventory models is based on Palm's Theorem. In 1938, Palm developed a queuing theorem which proved that

> ... for the steady state, the number of units in the system at a random point in time has a Poisson distribution with mean RT [assuming] ... demands arrive according to a Poisson process with rate R and service times have an arbitrary distribution with mean T which is independent of the demand process [8:14].

Feeney and Sherbrooke later applied Palm's basic principles to inventory control by determining the number of units in a resupply pipeline. They demonstrated how backordering creates an infinite queuing channel under an (s-1,s) inventory policy. According to this policy, a demand is accepted regardless of the amount of stock on-hand, making input to the queue equal to the demand distribution (25:3). For this case, Palm's Theorem applies and the probability of x number of units in the resupply channel are given by the Poisson distribution:

$$h(x) = (\lambda T)^x e^{-\lambda T}/x! \qquad 0 \leq x < \infty \tag{1}$$

where: h(x) is the probability that x units are in resupply, lambda is a Poisson demand rate, and the resupply distribution has a mean T (25:3).

In the same study, Feeney and Sherbrooke extended Palm's Theorem to characterize demands under a compound Poisson distribution. With a compound distribution, demands occur in batches but the time interval between demands is identical for both the simple and compound Poisson distributions. Feeney and Sherbrooke generalized "... the assumption of Poisson demand to distributions with a larger variance" because demand data for reparable aircraft parts typically had variances that exceeded the mean (25:6). They offered several reasons for the variability of demand: infant mortality, or a high incidence of failure after initial installation; premature replacements for preventive maintenance, and the occurrence of damage during installation (25:6).

(s-1,s) Inventory Policy

The (s-1,s) inventory policy is optimal for managing high cost, low demand items according to Feeney and Sherbrooke. The policy's success depends on maintaining a fixed level of spare stock, s, to protect against stockouts. Under an (s-1,s) inventory policy, stock levels are continuously monitored and replacements are ordered when the level drops to s-1, the point at which a demand occurs. Thus, the spare stock level equals the total amount of stock on-hand and on-order, minus the number of backorders (25:1). A backorder is created when no stock is available for issue; a condition the (s-1,s) inventory policy is designed to prevent. Managing inventory levels to prevent a stockout becomes critical when dealing with a limited number of assets such as reparable spares. The Air Force developed its repair cycle demand level model to make effective use of these resources.

Repair Cycle Demand Level Model

The repair cycle demand level (RCDL) inventory model is used to determine stock levels for recoverable items. The RCDL operates according to an (s-1,s) inventory policy, with one exception: the reorder quantity is restricted to one item per demand. Reparable spares are issued on a direct exchange basis; an unserviceable part must be turned-in when a replacement is ordered from base supply. The quantity of stock maintained at each base depends on its intermediate level maintenance capability and the base-level repair cycle system.

The repair cycle system serves as a primary source for spare parts. An unserviceable part is normally repaired and returned to base supply as a serviceable asset, and it becomes available for reissue. If the item cannot be repaired, it is condemned or classified as "not reparable this station (NRTS)" and sent to the depot for repair. In either case, a replacement part is requisitioned from a depot to replenish the base's stock. The quantity of reparable spares in inventory must be sufficient to cover the base-level repair cycle times, and the depot-to-base resupply pipeline in order to prevent a stockout. The quantity stocked, S, is determined by the formula:

$$S = RCQ + O\&STQ + NCQ + SLQ + K \tag{2}$$

where: RCQ = repair cycle quantity
O&STQ = order and ship time quantity
NCQ = NRTS/condemned quantity
SLQ = safety level quantity
K = constant, 0.5 if unit price is greater than $750, or 0.9 if unit price is $750 or less (26:189)

During the early 1960's, Feeney and Sherbrooke published a series of Rand Memoranda concerning research on inventory policies. Their first study examined the effectiveness of a (s-1,s) inventory policy under a compound Poisson distribution. They showed Palm's Theorem holds true if demands on a inventory (or repair) system arrive according to a compound poisson distribution. A compound Poisson distribution provides a more accurate representation of fluctuating demands because the variance is allowed to exceed the mean of the distribution (26:192). As discussed earlier, a high variability in demand is realistic when modeling a repair process for aircraft spare parts (25:6). Feeney and Sherbrooke developed the Rand base stockage policy from this research. It was the first attempt at a "systems approach" toward establishing base stock levels for reparable spares. The policy accounted for two-echelons of repair, a base and a depot level, as seen in the Air Force's repair cycle demand level model (24:2). Feeney and Sherbrooke laid the groundwork for modeling stationary, multi-echelon inventory systems with their systems approach.

Evolution of METRIC Models

METRIC. In 1966, Sherbrooke expanded the base stockage model into a multi-echelon, multi-base system. The model was known as the multi-echelon technique for recoverable item control or METRIC. METRIC incorporated a centralized depot repair facility into the base model for managing reparable spares. The primary purpose of the model was to "... optimize system performance for specified levels of system investment" (43:123). To achieve this objective, the algorithm minimized the total number of backordered spares at each base, across an entire weapon system. The model's results yielded an optimal mix of base and depot-level stock requirements, given a budget constraint or a limitation on the weapon system's performance. In addition, the model could be used to optimally redistribute assets among a depot and its bases when the quantity of each item was limited. Finally, METRIC gave managers the capability to assess the cost and performance of various depot-base allocation policies regarding reparable spare parts (43:123).

METRIC had limitations in the way it modeled repair capability and interactions within the logistics system. For example, the model did not show backorders at the depot-level; it only projected how backorders affected base-level inventory. There was no lateral resupply between bases to satisfy the demand for a part. The depot was considered to have an unlimited repair capability with no waiting times or batch processing for repair. In addition, condemnation rates were not a parameter in the model, which means 100 percent of the items sent to the depot were repaired.

Mathematical models, such as METRIC, are based on general mathematical assumptions. The two primary assumptions used in METRIC were: (1) *the distribution of demand was stationary* over the period of time in question, and (2) demands for resupply could be represented by a compound Poisson distribution.

> ... if customers follow a Poisson process with mean λ per time period, and each customer can place a number of demands that are independently and identically distributed ... so that the compound Poisson demand process has variance to mean ratio q, then the probability of x demands in the time period has the negative binomial distribution
>
> $$p(x|\lambda) = [(k + x-1)!/(x-1)!x!]\ (q-1)^{x}/q^{(k+x)} \qquad (3)$$
>
> $$(x = 0, 1, 2, \ldots, q>1, k>0)$$
>
> where $\lambda = k(\ln q)$ [43:128].

MOD-METRIC. The evolutionary development of inventory models continued when Muckstadt introduced MOD-METRIC in 1973. As stated previously, the objective of METRIC was to minimize the total number of backorders across all bases for a particular set of recoverable items, given a budget constraint. MOD-METRIC, on the other hand, attempted to minimize backorders for each end item when the money allocated for an item and its components was constrained. To accomplish this, MOD-METRIC explicitly modeled the indentured relationship between LRUs and SRUs in calculating stock level for reparable spares (36:472-475).

METRIC and MOD-METRIC offered improved techniques for inventory management, but both were limited by an underlying assumption of steady-state demands. Steady-state, or stationary, demands are adequate for modeling peacetime flying programs because the level of activity is fairly stable. Under wartime conditions, however, the consumption of spare parts is expected to fluctuate dramatically and stationary demand rates may not accurately predict the requirement for aircraft parts.

In 1980, Muckstadt investigated the validity of applying a steady state assumption to a dynamic environment. He found a "significant misallocation of stock and miscalculation of the performance ... from the repair and supply systems" resulted when the levels of flying activity were varied (37:v). Muckstadt concluded dynamic models are more appropriate for predicting demands "in periods of dynamic change, such as initial provisioning and the early operational life of a weapon system and, more important, during wartime" (37:v). METRIC and MOD-METRIC could not capture the dynamic nature of a wartime logistics system, which led to the development of Dyna-METRIC.

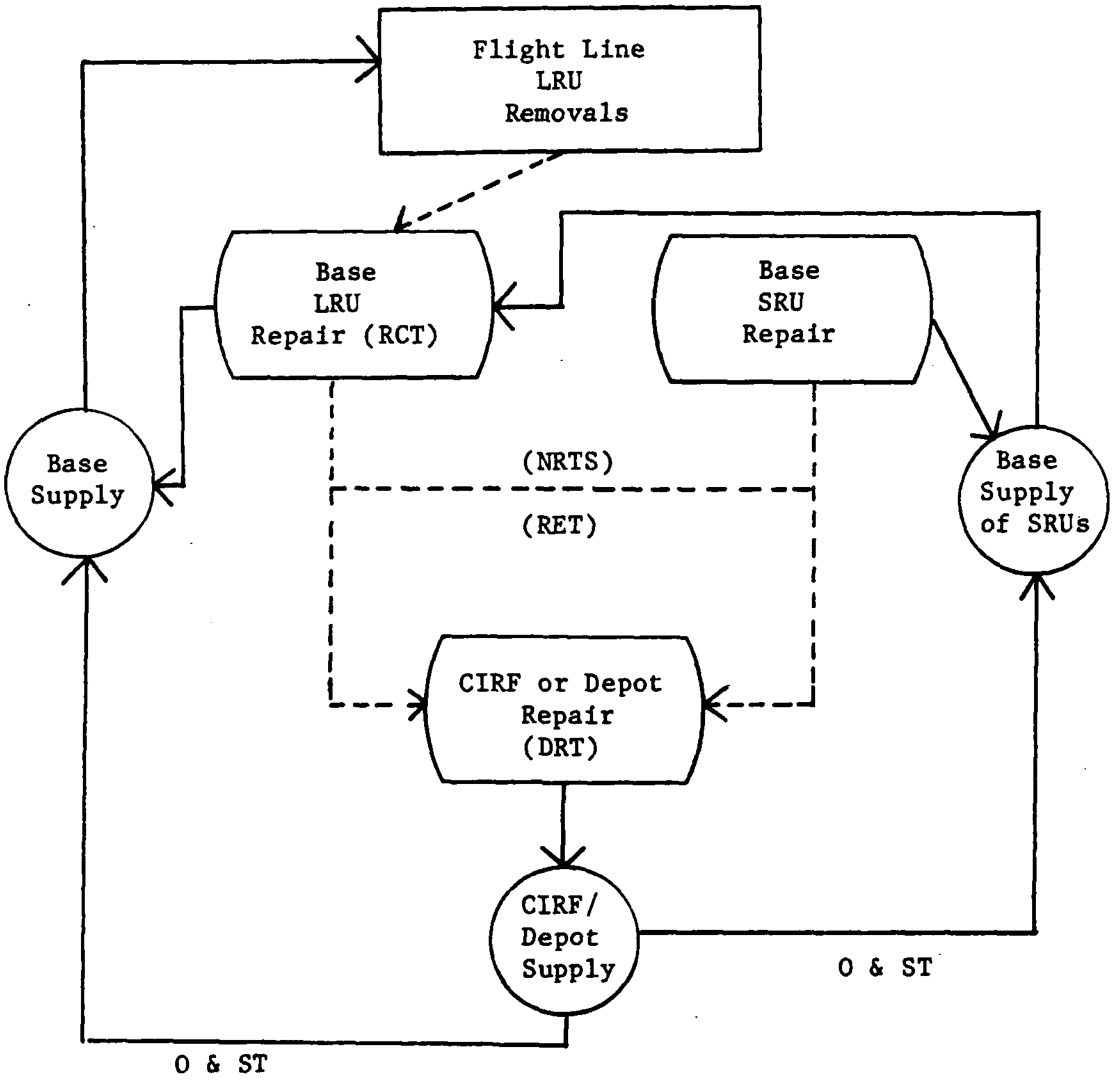
Dyna-METRIC. Dyna-METRIC took the multi-echelon, indentured-component repair features of Sherbrooke's METRIC model and added the capability to model time-dependent events (29:5). Dyna-METRIC is able to predict the effects of a wartime scenario because it explicitly models dynamic change. The impact of events, such as surges in sortie rates and transportation delays, were minimized in earlier models because variations in a system could not be replicated under a steady-state model. The probability distributions used to simulate component failure rates under previous METRIC models did not depict failures as time-dependent events because they limited their application (29:3-7).

Dyna-METRIC has undergone numerous iterations since version 2.1 was released in 1980 (8:17). The initial uses of Dyna-METRIC were for AFLC to study F-4 and F-16 readiness and to perform F-100 engine evaluations. Tactical Air Command also used Dyna-METRIC to test various support concepts for F-15 squadrons (29:iv). The model was intended to provide "(1) operational performance measures, (2) effects of wartime dynamics, (3) effects of repair capacity and priority repair, (4) problem detection and diagnosis, and (5) assessments or requirements" for a single theater (38:3). Logisticians needed information to improve support for wartime requirements, and this need has continued to increase.

Dyna-METRIC's capabilities have been enhanced over the years but the model's basic concepts remain unchanged. Dyna-METRIC treats each aircraft as a collection of spare parts, so aircraft availability becomes a function of the amount of stock on-hand, or in the repair/resupply pipeline. As components fail, they are removed from the aircraft and sent to a repair facility. The user specifies a level of repair (field, CIRF, or depot) for each LRU and determines the maintenance capability at each location. The repair pipeline for a component consists of repair times, condemnation and NRTS rates, and order and ship times. Dyna-METRIC enables the user to test the effects of a full or no cannibalization policy, as well as the impact of a limited repair capability (31:4-8). The interaction between various aspects of Dyna-METRIC's logistics system are depicted in Figure 1.

The most recent release of Dyna-METRIC is version 4.4, and its capabilities are extensive. According to Isaacson, et al, "... no previous version of the model has been able to conduct worldwide assessments of how the logistics functions and echelon system interact to enhance or constrain wartime capability" (31:1). Dyna-METRIC now captures the interaction between three echelons of repair: base to CIRF, CIRF to depot, and depot to theater level. Additionally, a full spectrum of maintenance options can be modeled because Dyna-METRIC recognizes indentured relationships between line replaceable units, shop replaceable units (SRU), and sub-SRUs (31:v). The specific assumptions and limitations of version 4.4 are discussed in Chapter 3.

Why is Dyna-METRIC so important? The Dyna-METRIC computer model gives logisticians a way to project realistic wartime requirements. It measures "the ability of available WRSK/BLSS assets to support planned wartime flying programs" (4:1). AFLC performs theater-level assessments of weapon systems to determine how well current operation plans (OPLANs) can be supported. AFLC also generates weekly, unit-level production runs for operational flying units via the worldwide military command and control system (WWMCCS) computer system. Production runs are assessments performed using the "WMP-5 for flying profiles, D029 for WRSK/BLSS component data and CSMS [combat supplies management system]



Key: DRT - Depot repair time
NRTS - Not repairable this station
O&ST - Order and shipping time
RCT - Repair cycle time
RET - Retrograde shipping time
--- - Flow of unserviceable parts
—— - Flow of serviceable parts

Figure 1. Representation of Dyna-METRIC's Logistics System

(Adapted from 31:6)

for on-hand stock for most AF weapon systems" (4:1). The assessments are used to rate the support provided by stock available in the WRSK and BLSS for Status of Resources and Training System (SORTS) reporting.

Status of Resources and Training System.

The Status of Resources and Training System is an automated reporting system that provides unit readiness information to the National Military Command Center (NMCC), which supports the National Command Authority during emergencies. However, SORTS is "... primarily an internal management tool for use by the Services, CINCs, and Joint Chiefs of Staff (JCS)" (18:10). It is an indicator of how well a unit's resources and training will enable it to perform its wartime mission. A unit's overall status (C-level) is determined by the unit commander, based on numerous subjective and objective measurements (18:20)[1]. For aircraft units, there are four objective areas rated for SORTS reporting: personnel, equipment and supplies on hand, equipment condition, and training (18:Ch 4). For tactical airlift aircraft, the production runs generated by WSMIS/SAM assess WRSK and BLSS stock levels in terms of use rate and aircraft availability. Since strategic airlift aircraft are not currently assessed in WSMIS, the effectiveness of their WRSK and BLSS stockage is measured in terms of fill levels, the percentage of items available in the kits (18:38). MAC and AFLC are working to incorporate strategic airlift aircraft into WSMIS because

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[1] Only those measurement areas pertinent to SORTS reporting are mentioned here. For a complete description of the objective and subjective factors that apply to a unit's C-level, refer to Chapter 3 of AFR 55-15.

SORTS reporting has become an integral part of the Air Force's command and control system.

Dyna-METRIC Microcomputer Analysis System

Dyna-METRIC has become a standard assessment tool for the Air Force. The latest development in Dyna-METRIC is a "mini" version known as DMAS, the Dyna-METRIC Microcomputer Analysis System. DMAS gives base-level personnel the capability to perform unit assessments. This is crucial when local conditions warrant adjusting the WSMIS/SAM baseline for SORTS reporting. Now commanders possess the means to quantitatively evaluate their unit's readiness based on new or updated information. DMAS' capabilities are limited to modeling aircraft at a single location, but the scenario can include CIRFs and depots (1). The primary application of Dyna-METRIC, however, is in conjunction with AFLC's Weapon System Management Information System.

Weapon System Management Information System

The Air Force Logistics Command developed the Weapon System Management System (WSMIS) to give system program managers (SPM) more effective control and efficient use of their resources. WSMIS is an Air Force-wide, computer-based logistics management assessment tool that has two primary functions. First, the system is used to measure the combat capability of weapon systems in terms of readiness and sustainability. Secondly, it is used to determine wartime requirements for aircraft engines, and recoverable items in the WRSK and BLSS.

WSMIS consists of four program modules: the sustainability assessment module (SAM), the readiness assessment module (RAM), the requirements/execution availability logistics module (REALM), and the get-well assessment module (GWAM). The first three modules provide a quantitative tool for analyzing the level of support provided by logistics resources. The fourth module, GWAM, outputs reports of limiting factors identified by RAM and SAM. The features of each program module are described separately in the paragraphs below.

Sustainability Assessment Module. The sustainability assessment module measures combat capability in terms of logistics resources. Specifically, the program predicts the availability of mission capable aircraft, and projects the number of aircraft sorties/flying hours that can be flown given a wartime tasking. SAM also identifies factors that limit a unit's ability to achieve a specified level of readiness or a specific sortie objective.

SAM has several objectives. First, the program is used to determine how well individual war plans can be supported given authorized and on-hand levels of spare engines, recoverable spares, and consumable materials. Next, SAM identifies critical shortfalls or limiting factors for a given scenario. Shortages in these areas would constrain combat capability. SAM is designed as tool to aid decision-makers in evaluating various wartime scenarios, both at the unit and theater levels. Additionally, the commander can use SAM to measure a flying unit's capability and to assign a combat status (C-level) (47:2-7). An assessment is based on the number of aircraft able to fly the unit's wartime tasking. Dyna-METRIC predicts the number of aircraft that will be available as a function of spare parts and the repair/resupply pipeline. Currently, AFLC performs assessments on helicopters, tactical fighter, tactical airlift aircraft, and strategic bombers and tankers using WSMIS (39; 49).

Readiness Assessment Module. The readiness assessment module is a common database containing readiness information on weapon systems, selected equipment, recoverable spares, and other items (47:4-3). The program tracks the status of a weapon system by comparing available levels of critical resources to the inventory needed to satisfy mission requirements. Currently, RAM includes items such as as engines and recoverable spares, but is being expanded to incorporate support equipment and consumable materials into its program. RAM identifies those resources which constrain weapon system readiness. For example, spare parts shortages are reported as the number of MICAP incidents per hour by national stock number (47:4-14). Once such limiting factors are known, the GWAM module is used for developing get-well plans. Readiness of a weapon system can be assessed at the mission design series, major command, or unit level. This information allows the user to redistribute assets where needed (47:2-6).

Get-Well Assessment Module. The get-well assessment module provides information on resources shortages that adversely affect combat capability. The module accepts data on problem parts generated by RAM and SAM. One feature of GWAM, the problem item identification module, summarizes and categorizes various critical and potentially critical items (47:4-10). The system allows the user to devise a plan for resolving shortfalls or minimizing the impact of critical limiting factors. With GWAM, managers can develop and evaluate get-well strategies (47:2-8).

Requirements/Execution Acquisition Logistics Module. The requirements/execution acquisition logistic module computes recoverable spares requirements for WRSK, BLSS, WRM engines, and base-level equipment. REALM enhances AFLC's purchasing power for WRM spares by identifying the combination of recoverable spares that yields the most combat capability within a given budget. Future improvements to REALM will automate the WRSK/BLSS review process (47:2-9).

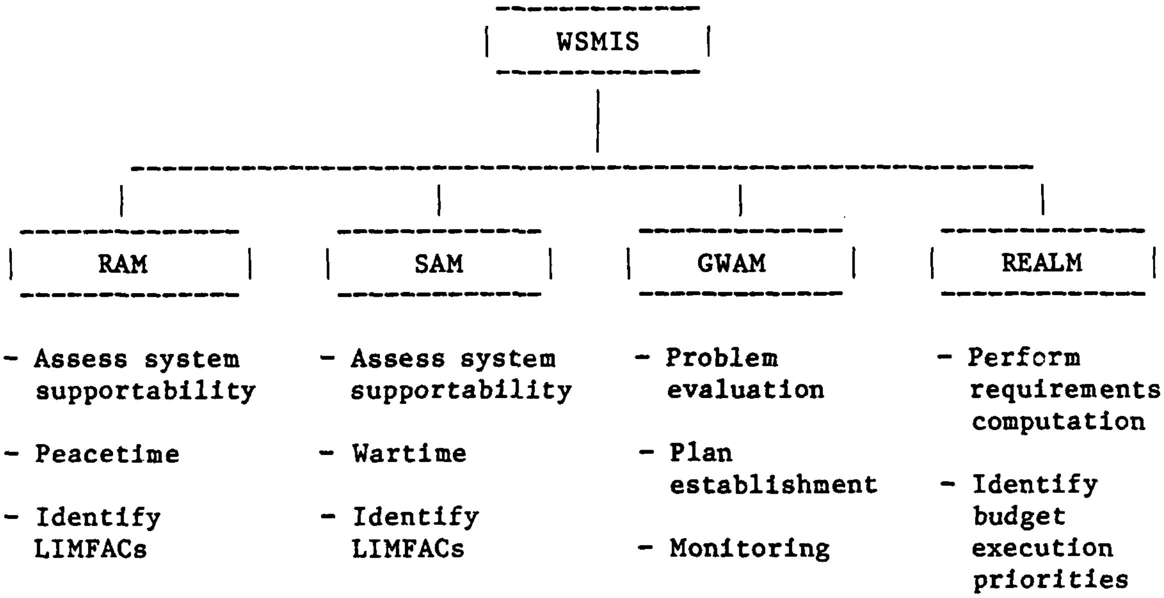

Figure 2. Overview of WSMIS Objectives

(Reprinted from 47:2-5)

Strategic Airlift Model

Dyna-METRIC was originally designed for Tactical Air Command to measure the performance of its fighter units. The model predicted the number of sorties achieved and the expected level of NMCS aircraft, based on the availability of spare parts in the WRSK. Consequently, fighter aircraft were the first weapon systems incorporated into SAM and automated in the SORTS reporting system. SAM's applications gradually expanded to include assessments of tactical airlift aircraft and helicopters in the late 1985, early 1986 timeframe (39). These weapon systems could be modeled using Dyna-METRIC because they operate from a single location. Modeling strategic airlift, however, posed several challenges.

The Dynamics Research Corporation developed a strategic airlift model (STRAM) for strategic aircraft to be incorporated into WSMIS/SAM. The purpose of the model was to provide HQ MAC with reliable assessments for SORTS reporting. STRAM created a Dyna-METRIC scenario compatible with the strategic airlift mission. The project began in 1985 as a joint effort between personnel from AFLC LMSC/SMW, AFLC LOC/AT, AFLC/XRS, HQ MAC/LGS, and DRC. The unique nature of the strategic airlift mission and the limitations of Dyna-METRIC made the project a formidable task that required over two years to complete (42:13).

Strategic airlift is difficult to replicate because of its dynamic nature. MAC aircraft continuously relocate as they travel through the overseas channel system. In other words, strategic aircraft do not operate from, nor return to, the same location each day. The movement of aircraft is scheduled and tracked through the MAC flow generator, or FLOGEN system. A strategic version of Dyna-METRIC had to account for aircraft transiting numerous locations and also interface with FLOGEN outputs for its scenario data. During initial development, the scenario inputs were computed manually by HQ MAC and then included in the model

(42:14). An automated interface, the strategic airlift scenario interface, is still under development at HQ AFLC/XPSA (39).

Other significant adjustments were needed to adapt Dyna-METRIC for strategic airlift. The measures of capability had to be tailored to MAC's mission. Performance of the strategic airlift fleet is measured in terms of use or utilization rates (UTE), flying hours achieved, and ton-mile capacity; not by sortie generation as with tactical fighter units. Additionally, the LRU information required for Dyna-METRIC analysis was not available in AFLC data bases (42:14). There is limited interface between AFLC's D029 WRSK/BLSS computation system and the programs used by HQ MAC. MAC has command-unique programs (Q40 and Q52) for computing WRSK and BLSS requirements and they are described further in Chapter 3. Input data for the Dyna-METRIC model was compiled by HQ MAC and provided to AFLC's Logistics Management Systems Center (LMSC). The strategic airlift model reached initial operating capability in July 1988, and its implementation is currently awaiting formal acceptance by HQ MAC (39). The final phase of integrating strategic airlift aircraft into WSMIS is to perform WRSK/BLSS computations in REALM.

Strategic Airlift Demonstration

In 1987, HQ MAC requested HQ AFLC to investigate methodologies for computing strategic WRSK and BLSS in WSMIS/REALM. HQ AFLC/MMM commissioned Dynamics Research Corporation to demonstrate the capabilities of Dyna-METRIC version 4.4 to model strategic airlift. The purpose of the study was to compare different approaches for computing WRM requirements for strategic airlift aircraft in REALM. The goal was to identify the best techniques for modeling strategic airlift using Dyna-METRIC 4.4 in WSMIS/REALM (41; 49).

The initial study was completed in the spring of 1988. Several technical obstacles had to be overcome before the strategic aircraft could be modeled in Dyna-METRIC. The first step was to obtain current component data from MAC's Q40 and Q52 programs and convert it into Dyna-METRIC input format. The available BLSS data was found to be incomplete, so the study was limited to evaluating WRSK. DRC established a baseline by duplicating MAC's WRSK computations and performing an assessment using those quantities. With this method, Method 1, they discovered MAC's kit achieved a direct support objective (DSO) of 2.4 percent, which represents the percentage of aircraft grounded after 30 days due to a lack of spare parts. Method 1 and Method 2 produced identical results at the baseline DSO.

DRC computed requirements using four methods (scenarios) for modeling strategic airlift and then compared several criteria for stock purchased under each methodology. They used the baseline DSO, a target NMCS rate of 2.4 percent, to assess their requirements computations. In general, the scenarios were as follows[2]:

(1) Method 1 - Duplicated MAC's WRSK computations based on the total fleet of aircraft

(2) Method 2 - All aircraft and WRSK increments/segments were assigned to one location

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[2] Refer to Chapter 3 for a complete discussion of MAC's WRSK computations and segmentation.

(3) Method 3 - Aircraft were assigned (by percentage) to unique segments across all increments
- TA segment/80 aircraft
- TB segment/40 aircraft
- AA segment/12 aircraft
- Sum the segments for total WRSK quantity

(4) Method 4 - Aircraft were assigned (by percentage) to unique segments within one increment
- TA segment/13 aircraft per increment
- TB segment/ 7 aircraft per increment
- AA segment/ 2 aircraft per increment
- For total WRSK quantity, sum all segments and increments

The flying program was based on 47 percent of the total number of flying hours for one year, and demand rates for the components were taken from forward supply system data. The study was originally conducted using the 2.4 percent DSO, but it was repeated using a 17 percent NMCS rate. This is the standard DSO applied to non-tactical aircraft (41; 45).

Another major consideration arose over how to allocate stock across the numerous increments and segments in Method 4's scenario. DRC experimented with two allocation schemes to identify the best technique for dividing stock among the WRSK segments. The stock levels for each scenario were adjusted according to the following schemes and assessed using Method 4 because its scenario is the most demanding. In allocation scheme 1, the stock levels obtained with each method were divided by six, and truncated. Any remaining stock was allocated to each increment consecutively, and stock for the entire segment (Methods 1 and 2) was further divided among individual segments by applying the segment's percentage of the total segment.

For allocation scheme 2, the segment percentage was applied to the stock (Methods 1 and 2 only), and the results for each item were divided by six, and rounded. The results demonstrated how dramatically the allocation scheme can affect the support provided by WRSK because of variations in stock levels. Determining how stock levels should be allocated is a crucial issue to resolve before WRSK requirements computations are automated under WSMIS/REALM (41).

Reporting detailed results of the entire strategic airlift demonstration are too lengthy for the purpose of this overview, so they have been summarized. DRC examined the kit cost, the percent of flying hours achieved, the units of stock purchased, and the percent NMCS aircraft on day 30 for each of the scenarios described previously. The results for both studies were relatively similar. In general, Method 3 proved to be a compromise between Methods 2 and 4. At a 17 percent NMCS rate, the costs were $93.2, $105.8, and $179.5 million for the Method 2, 3, and 4 kits, respectively. At the 2 percent NMCS rate, the kits cost $112.5, $165.5, and $273.6 million, respectively.

Method 4 produced the most expensive kit, achieved the highest percentage of cumulative flying hours, and met the target NMCS rate. Results for the Method 2 and Method 3 kits were not as consistent. At a 17 percent NMCS rate, the Method 2 kit was less expensive than the Method 3 kit, but it failed to provide better support in terms of attaining a lower NMCS rate or achieving a greater number of flying hours. At the 2 percent NMCS rate, the results were inconclusive as to which method, Method 2 or Method 3, produced a superior kit.

From this study, DRC concluded MAC's WRSK computations can be be closely duplicated in Dyna-METRIC. They found MAC's scenario, Method 2, to be the most cost effective approach; however, other methods (Method 4 in particular) provided better support. Method 4 is the most accurate representation of how MAC actually deploys its WRSK, but MAC computes its WRSK requirements on a fleet-wide basis, similar to Method 2. The stock allocation scheme is an important consideration in automating requirements calculations because it affects the quantity of stock at each location. Finally, the DSO is a significant factor in WSMIS/REALM because it establishes the target level of support for Dyna-METRIC's calculations (41).

The purpose of DRC's study was to demonstrate the feasibility of modeling strategic airlift in REALM. The decision as to which scenario and allocations schemes to choose remains at the discretion of HQ MAC and HQ AFLC (49).

Summary

This chapter presented a brief introduction to inventory theory and the history of reparable inventory models. The models evolved from Palm's queuing theorem, which predicts the steady state probability of the number of components in a resupply pipeline. Feeney and Sherbrooke extended Palm's Theorem to show the distribution of the system's output remains Poisson even when demands on the system follow a compound Poisson distribution. Their research provided the mathematical foundation for more complex inventory models.

During the period from 1960 through 1980, researchers at the Rand corporation developed several reparable inventory models. The group produced a series of METRIC models: METRIC, MOD-METRIC, and Dyna-METRIC. Each model built upon, expanded, and enhanced the capabilities of its predecessor. Dyna-METRIC offered the capability to model an entire logistic system under dynamic, wartime conditions. A world-wide network for managing weapon systems was created around the Dyna-METRIC computer model.

AFLC's Weapon System Management Information System is a valuable logistics tool. WSMIS has four program modules with separate functions, but the system's operation centers around SAM and REALM. SAM simulates a wartime environment and assesses a weapon system's (or an operational unit's) performance based on the amount of stock available in WRSK and BLSS. WRM requirements for WRSK, BLSS, and spare aircraft engines are computed in REALM. Portions of WSMIS are still under development, and not all Air Force weapon systems have been incorporated into WSMIS.

The Military Airlift Command and Air Force Logistics Command are working to integrate MAC's strategic airlift fleet into WSMIS. At present, an airlift model has been developed to perform production runs (assessments) in WSMIS for SORTS reporting. WRSK and BLSS requirements are not being computed in WSMIS, but research is currently underway to determine the best approach to modeling strategic airlift in REALM.

The next chapter covers the research design of this study. The Military Airlift Command's strategic airlift mission places unique requirements on its supply system. MAC's supply concepts are explained in detail in the introductory material because they impact the experimental approach. The remainder of the chapter focuses on how the Dyna-METRIC scenarios were constructed and describes how the research was accomplished.

III. Research Methodology

Overview

The chapter opens with a description of the Military Airlift Command supply support system. Many aspects of the support structure are unique to MAC and are crucial to understanding the research methodology. In general, wartime spares requirements for strategic aircraft are augmented by base level self-sufficiency spares at home station and by war readiness spares kits at enroute locations. Tactical airlift aircraft deploy as an independent unit supported by WRSK. The war readiness spares kit designs are discussed in detail to highlight the differences between the strategic and tactical airlift missions. In addition, MAC employs command-unique methods for computing WRSK and BLSS requirements. Following the overview of MAC's supply system, the research design is described.

The purpose of this research was to compare two war readiness spares kits for the C-17, each calculated using a different technique. The experimental design required two Dyna-METRIC scenarios, one for strategic airlift and the other for tactical airlift. Stock levels for the strategic and tactical WRSK were determined using MAC's formulas and Dyna-METRIC's requirements program. Finally, the kits' performance was tested by performing a Dyna-METRIC assessment and comparing the cost of each.

MAC Methodology

The strategic airlift mission places unique demands on MAC's supply system. MAC positions spare parts at 12 major enroute locations throughout the world to maintain aircraft away from home station. These forward supply locations (FSLs) are part of the forward supply system (FSS), a resupply network designed to support the daily offshore activity of C-141 and C-5 aircraft transiting overseas stations. For an in-depth explanation of the FSS, refer to Stone and Wright (44). WRSK can be used to expand the existing enroute system, or to augment selected FSS locations during a wartime mobilization (34).

HQ AFLC computes WRM spares requirements for all weapon systems except MAC's strategic airlift fleet. MAC determines its own requirements because the D029 WRSK/BLSS requirements computation system cannot accommodate the large number of strategic aircraft. The D029 system uses a direct support objective (aircraft availability target) for establishing WRSK, and a conventional computation with fixed safety levels of stock for BLSS. WRSK and BLSS are designed to support wartime activity from D-day until resupply is established (15:7). This normally covers a period of 30 days, under current AFLC guidance, because investment (recoverable) spares are approved and funded accordingly. However, when computing wartime requirements, continuous resupply is not assumed until after D+30 in the continental United States, and D+45 for overseas locations according to AFR 400-24 (20:Ch 2, para 2-2, (15, 16)).

Strategic WRSK. MAC's strategic WRSK is based on a single kit concept, where one kit is calculated for the entire fleet of aircraft. The kit is owned by HQ MAC, but divided into increments that can be positioned at separate wings. For example, there are a total of six C-141 kit increments positioned across the country at various wings, and they are controlled by a parent numbered air force. The individual increments are further subdivided into deployable packages, so a single increment actually consists of seven segments. Each segment is designed to support a fixed number of aircraft landings as shown in Table 1 (21).

HQ MAC computes its WRSK requirements using a command-unique method known as the MAC Q40 program. The calculations, shown in Table 2, are based on an historical account of demands placed on the forward supply system. Off-shore demand rates are used to establish a baseline, known as the peacetime daily demand rate (DDR). The DDR is the total number of demands (by stock number) divided by the number of days over which the data has been collected. The peacetime daily demand rate is then multiplied by a wartime planning factor, the program factor adjustment (PFA). This yields the wartime daily demand rate (WDDR) needed to calculate a wartime stockage objective (WSO). The quantity of items in the WRSK reflects the wartime stockage objective plus a wartime safety level (21).

Strategic BLSS. Base level self-sufficiency spares (BLSS) kits are designed for units that will operate from home station during a conflict. BLSS is the amount of spares needed to augment peacetime operating stock during the first 30 days of a war. Since the unit does not deploy, BLSS kits are built around a remove, repair, and replace (RRR) concept designed to takes advantage of the unit's maintenance repair capability. MAC computes strategic BLSS requirements using the MAC Q52 program. The calculations are based on historical, on-shore demands placed on the standard base supply system at each wing (21).

Tactical WRSK. Unlike the single kit concept for strategic aircraft, WRSK for a tactical airlift squadron belongs to and deploys with the unit. The tactical WRSK is divided into 3 segments; a primary support kit (PSK) and two smaller enroute support kits (ESK). Each WRSK is designed to achieve a direct support objective for a specific number of flying hours, as directed in the WMP-5 (33; 21:Ch 2, para 2-2, (17)). Segmentation of the C-130 kit is shown in Table 1.

Dyna-METRIC

Dyna-METRIC is the standard computer model incorporated into AFLC's Weapon System Management Information System. WSMIS helps logisticians plan for war by estimating combat capability through analytical modeling. The Dyna-METRIC readiness assessment model has three basic capabilities: to assess the performance of logistic systems, to compute spares requirements, and to provide diagnostics for its assessments.

Dyna-METRIC predicts whether the logistics system can meet a direct support objective (aircraft availability target) for a particular flying scenario, within a given level of confidence. In the assessment mode, the model projects the number of aircraft available on a given day of the scenario, and the number of sorties/flying hours achieved. In Dyna-METRIC, an aircraft becomes not fully mission capable because of a lack of spare parts. The repair pipeline determines how quickly a replacement becomes available if there is no cannibalization of parts between aircraft. In the requirements mode, Dyna-METRIC computes the quantity of stock needed to sustain a minimum number of aircraft in fully mission capable status.

TABLE I

WRSK Segmentation

C-141 Segmentation

Segment	Number of Landings
AA	75
AB	75
AC	75
TA	375
TB	175
TC	175
TD	175

C-130 Segmentation

AA	PSK
AB	ESK
AC	ESK

TABLE II

WRSK Computation Method

Peacetime Daily Demand Rate (DDR) $= \frac{\text{total FSL demands}}{\text{days of demand}}$

Program Factor Adjustment (PFA) $= \frac{\text{wartime UTE rate}}{\text{peacetime UTE rate}}$

Wartime Daily Demand Rate (WDDR) = DDR x PFA

Wartime Stockage Objective (WSO) = WDDR x (# days of support)

Wartime Safety Level (WSL) $= \sqrt{\text{WSO} \times 3}$

WRSK Quantity = WSO + WSL + 0.5

This research project used Dyna-METRIC as the tool for assessing the capability of WRSK for the C-17 aircraft. Tactical and strategic airlift scenarios were developed for Dyna-METRIC as described later in the chapter. Although Dyna-METRIC cannot directly model the MAC enroute system, the program was made to emulate strategic airlift by building the scenario "around" WRSK segments as shown by Stone and Wright (44:45-55). Dyna-METRIC 4.4 was accessed through HQ AFLC's CREATE computer system.

Model Assumptions and Limitations

Dyna-METRIC, like all models, is based on mathematical assumptions that allow the model to approximate the dynamic nature of actual events.

1. Dyna-METRIC may overestimate or underestimate performance of the logistics system when repair is unconstrained. If repair capability is not constrained in the model, several assumptions are necessary. First, demands are considered proportional to flying hours or sorties. Secondly, demands on the repair system arrive according to either a Poisson or a negative binomial probability distribution, and the mean and variance of that distribution are known. Finally, the probability distributions for repair and transportation times are also known, and they are independent of previous demands. (31:10).

2. Lateral resupply cannot be modeled explicitly because it violates Dyna-METRIC's mathematical assumptions; namely independent demand, repair, and resupply distributions. Workarounds exist for scenarios where a cirf is not used in the analysis (31:11).

3. Aircraft are assumed to be identical because cannibalization options (full or partial) affect the availability of spare parts, and consequently, the number of FMC aircraft and sorties/flying hours achieved. Dissimilar aircraft must be modeled separately (31:11).

4. The computations for constrained repair "only approximate probable logistics system performance" (31:12). Dyna-METRIC uses expected (deterministic) values to compute pipeline distributions and then treats the distributions as if they were independent. Under conditions of constrained repair, neither the arrival of parts, nor the

repair times are independent because the parts require additional queuing (31:12).

5. Dyna-METRIC can accommodate an order for multiple quantities of a single item, but its mathematics is only precise for an order quantity of one. For economic order quantity (EOQ) items the calculations are approximate because supply pipeline variability increases along with the order quantity (31:12).

6. Dyna-METRIC adds the expected value for backorders and awaiting parts to the appropriate pipelines rather than computing a joint probability for these quantities (31:12).

7. Achieving sorties/flying hours depends on more than the availability of FMC aircraft. Limitations on flightline resources, such as personnel and support equipment, cannot be modeled explicitly (31:13).

8. Dyna-METRIC's accuracy and precision is limited by the way computers perform mathematical operations on extremely small probabilities. Normally this is only a problem when the demand rate is high and the resupply time is long (31:13).

Experimental Design

This study looked at two techniques for calculating spares requirements. The purpose of this research was three-fold: First, identify the quantity of spares needed for the C-17 WRSK using each method; second, determine how well each kit performs in terms of sustaining a flying program; and, third, compare the relative costs of WRSK calculated with each method.

The first C-17 WRSK was developed using Dyna-METRIC's requirements mode to determine an optimal mix of LRUs in the WRSK given a representative flying scenario. A WRSK was calculated for a hypothetical C-17 wing of strategic airlift aircraft and a companion WRSK was calculated for a squadron of tactical airlift aircraft. Because the strategic single kit concept includes WRM for both WRSK and

BLSS, the BLSS computations were included for those reparable spares contained in both WRSK and BLSS (22).

The second C-17 WRSK was developed for both strategic and tactical airlift aircraft using MAC's command-unique calculations (Appendix C). Again, the strategic calculations include both WRSK and BLSS. The calculations were accomplished using a LOTUS 1-2-3 spreadsheet provided by HQ MAC/LGSWR (Appendix E). These WRSK were then assessed using Dyna-METRIC. The kit's performance was evaluated by holding the direct support objective (DSO) constant. With Dyna-METRIC, WRSK performance is measured in terms of aircraft availability; specifically, how many aircraft become not mission capable for supply (NMCS).

The NMCS rate obtained using MAC's WRSK, and the cost of that WRSK, was then compared to the NMCS rate and cost of the WRSK computed in Dyna-METRIC's requirement mode. Dyna-METRIC was run again using the NMCS rate of the MAC WRSK as a target, and costs were again compared.

Strategic Airlift Scenario

A representative scenario, suitable for the purposes of this study, was developed with assistance from Maj Miller of HQ MAC/LGSWR. A basic flying hour program was constructed based on a hypothetical wing of 39 aircraft. This is similar, but not identical to, proposed C-17 wings described in Section VII (U) of the C-17 System Operational Concept (12:17). A basing scheme was devised for the strategic mission by "working around" the C-141 kit's structure. The C-141 kit was chosen as a model because the C-17 WRSK will be implemented using HQ MAC's single kit concept.

The scenario was built through a four-step process. First, the flying hour program was calculated using a surge utilization rate (UTE) of 15.6 hours/day for the first 10 days, and a wartime sustained UTE of 13.9 hours/day for a period of 35 days thereafter:

[(Surge UTE x # Days) + (Sustained UTE x # Days)] x 39 PAA =
Total flying hours (3)

Next, the flying hours were divided between WRSK and BLSS based on MAC's standard assumption of allocating 47 percent of its flying hours to off-shore activity (WRSK), and 53 percent of its flying hours to on-shore (BLSS) flying:

Total flying hours x .47 = WRSK flying hours
Total flying hours x .53 = BLSS flying hours (4)

The WRSK increment was then divided into its component segments, with each segment representing a different location. WRSK segments are designed to support a specified number of landings, with some supporting more landings than others. To simplify the model, it was assumed that landings would be evenly distributed across flying hours. WRSK flying hours were apportioned to each segment after determining the percentage of landings per segment to the total number of landings supported by the WRSK increment. These percentages were applied to WRSK flying hours to determine the number of flying hours per segment:

Landings per segment / Total # increment landings = % per segment
% per segment x WRSK flying hours = WRSK hours per segment (5)

Finally, the number of aircraft were assigned to each segment by dividing the number of WRSK hours per segment by the combined UTE factors. The number of aircraft was rounded to the nearest whole number:

$$\frac{\text{WRSK hrs per segment}}{[(\text{Surge UTE} \times \#\ \text{Days}) + (\text{Sustained UTE} \times \#\ \text{Days})]} = \text{PAA per segment} \tag{6}$$

Table 3 contains the strategic basing parameters obtained from these calculations.

Tactical Airlift Scenario

The tactical airlift scenario is based on a single squadron (14 PAA) of aircraft flying a constant UTE of 8.0 flying hours per day for 45 days. This is consistent with current plans to establish two tactical C-17 squadrons, with a support period of 45 days for the WRSK (12:17; 23).

Tactical units deploy to a single location and operate from WRSK designed to sustain a remove and replace (RR) maintenance concept. Under this concept there is no intermediate maintenance capability at the deployment site.

Scenario Assumptions and Limitations

1. Results are based on the assumption that BLSS repair facilities are unconstrained. In other words, the repair facilities have an unlimited capacity for handling any amount of work. "Such an assumption is quite adequate in many situations, especially when *repair cycle times* are used in place of repair times in the LRU/SRU/SSRU records" (31:46).

TABLE III

Strategic Basing Scheme

Base	WRSK Segment Landings	Percent of Total Landings	Flying Hours	Aircraft Assigned
BLSS	N/A	N/A	13,281	21
TA	375	33.33	3,925	6
TB	175	15.55	1,832	3
TC	175	15.55	1,832	3
TD	175	15.55	1,832	3
AA	75	6.66	785	1
AB	75	6.66	785	1
AC	75	6.66	785	1
Total	1125		25,057[1]	39

[1] The total number of flying hours does not add up to 25,057.5 hours due to rounding.

TABLE IV

Dyna-METRIC Input Parameters

	Surge UTE	Sustained UTE	Max UTE	PAA
Strategic	15.6	13.9	16.3	39
Tactical	8.0	8.0	16.3	14

2. The strategic airlift scenario is deliberately simplistic and does not take advantage of many of the capabilities offered by Dyna-METRIC. An elaborate model was not needed to accomplish the objectives of this study. After the C-17 aircraft is fielded and actual demand data becomes available, Dyna-METRIC can be used to assess specific weapon system capabilities. The following data was not included in this study:

   - Off-shore demand rates
   - Administrative delay time for BLSS repair
   - Transportation/ order and ship times
   - Aircraft attrition
   - Depot support for the BLSS
   - NRTS rates
   - Retrograde shipments

3. The lack of certain essential information forced several assumptions concerning C-17 LRU data. A minimum essential subsystem list (MESL) is not yet available, so it was difficult to determine which components will be designated as mission essential. The basic system list identifies the minimum systems required to be operational for an aircraft to fly at least one mission (11:2-4). For this reason, the minimum QPA for each LRU was assumed to be identical to the QPA. Additionally, all cannibalizations were assumed to be feasible, instantaneous, and 100 percent successful.

LRU Data Base

HQ MAC/LGSW assisted in compiling a list of representative line replaceable units (LRUs) for analysis. Actual spares for the C-17 WRSK have not been identified, but the components included in this data base are likely candidates for the kit (23).

The components can be divided into two categories: government furnished equipment (GFE) and contractor furnished equipment (CFE). Demand rates for the GFE indicate a component's performance on an existing weapon system, and may not be an accurate measure of its performance when installed on the C-17. Similarly, the CFE failure rates are based on engineering predictions of the component's mean time between failure and may not hold true.

Provisioning for the C-17 had not begun at the time of this study, so the LRU data base is small. It is composed of 14 engine and avionics LRUs, plus ten long-lead procurement items. The sample contains the best information available as of 30 June 1988. Refer to Appendix D for a complete list of the data and their sources.

Engine Components. The engine under development for the C-17 is the F117-TW-100 engine, Pratt and Whitney's military version of the PW-2037 commercial jet engine. The cost figures and failure rates (MTBD) are based on a commercial application of the PW-2037 engine (48). Only partial information is available on the level of repair for each component, so the percent base repair statistics and the repair cycle times used in the Dyna-METRIC model BLSS computation are taken from C-141 engine data. Also, MTBD is used in place of MTBF as shown in the WRSK/BLSS computational formulas given in Appendix C. MTBD is used as the baseline for determining initial maintenance factors because "attempts to forecast initial spare operational requirements against the engineered reliability value (MTBF), consistently results in underpredicting initial requirements" (13:13).

Avionics Components. The avionics components are GFE items presently in-use on various weapon systems (6). Failure rates for these LRUs were obtained from the Comprehensive LSA Automated Support System (CLASS) data base at the RILSA (32). The cost information was retrieved from the HQ AFLC D043 computerized data base (28).

Long-Lead Items. Ten long-lead procurement items are included in the data base, which are among the first components to be provisioned. Information for these parts came from preliminary LSA-036 reports, individual summary sheets that specify provisioning requirements for each item (7). The reports are normally generated from H-records contained in the logistic support analysis (LSA) data base, but this preliminary data was obtained from HQ MAC/LGSW. Demand data is reported as a maintenance replacement rate I (MRRI) on the LSA-036 summaries. The MRRI or maintenance factor expresses the number of failures per 100 hours. Refer to Appendix B for a definition of MRRI. The data is based on engineering estimates, but the information is not completely reliable. At this point in time, the reported MRRI values are being reevaluated and are subject to change.

Validation and Verification

Dyna-METRIC has been externally validated by the Tactical Air Command. The first validation of Dyna-METRIC (version 3.04) took place at Nellis AFB, NV, during a TAC Leading Edge exercise (44:67). In July 1987, TAC validated Dyna-METRIC version 4.4 for the F-15 aircraft in a Coronet Warrior exercise at Langley AFB, VA. The initial results of this test indicated Dyna-METRIC overestimated the expected number of NMCS aircraft, given the demand rates contained in AFLC's D029 data base. However, when the actual demand rates for the exercise were loaded into Dyna-METRIC, the model produced reliable results. Dyna-METRIC predicted 16 aircraft would be reported as FMC. By the end of the exercise, however, 17 aircraft were actually FMC (4:20). TAC also conducted a Coronet Warrior II exercise to validate Dyna-METRIC for the

F-16. The results of this exercise have not yet been tabulated or released (33). Currently, Dyna-METRIC 4.4 has not been verified or validated for MAC, but the process is underway.

Volant Cape

The Military Airlift Command performed a C-130 WRSK flyout during its Volant Cape exercise held in August-September 1988. The purpose of the exercise was to validate the 3NCCA aviation unit type code (UTC) by determining whether the current WRSK can support the designed operational capability UTE for 30 days. The exercise involved 16 C-130E aircraft operating from a simulated bare base environment. Data gathered during the exercise will also be used to validate Dyna-METRIC as a tool for tactical airlift WRSK assessments and requirements computations (27:1). Dyna-METRIC's acceptance has been slow in MAC because of the lack of empirical data needed to validate WSMIS calculations in SAM and REALM. Volant Cape was similar to the TAC Coronet Warrior exercises used to validate Dyna-METRIC for the F-15 and F-16 WRSK.

IV. Results and Analysis

Overview

This research was designed to compare the cost and performance of two C-17 WRSK, one developed in Dyna-METRIC's requirements mode, and the other calculated using MAC's computational techniques. In order to compare level of support provided by each kit, the stock levels obtained with MAC's calculations were evaluated using Dyna-METRIC in the assessment mode. The kits were assessed under tactical and strategic airlift scenarios because the C-17 will perform missions in both capacities. The scenarios were based on employment and supply concepts for the C-141 and the C-130; however, they are representative of the C-17's dual role.

The results were reported separately for the tactical and strategic airlift scenarios. The original experimental design was modified to include a second strategic airlift scenario that combined all WRSK assets at one location; uneven multiples of stock could not be allocated across several locations. Requirements computations were performed to determine the total cost and the combination of LRUs stocked in each WRSK. In the assessment mode, Dyna-METRIC predicted the number of aircraft expected to be available on any specific day of the scenario, given a target NMCS rate and a limited quantity of WRSK. The performance of the MAC and Dyna-METRIC kits were compared for total cost and the number of expected aircraft available at the end of a 45 day period.

Results for Research Question 1

Requirements for the WRSK were calculated using two separate methods, then compared for cost and kit performance. Dyna-METRIC measured kit performance by calculating an expected aircraft NMC rate given a specific flying program. The tactical airlift scenario consisted of 14 aircraft flying a sustained UTE of 8.0 hours per day. The WRSK was designed to support RR maintenance at a single operating location for 45 days.

MAC's formula for WRSK is based strictly on a flying hour program with a fixed, additive level of safety stock. WRSK requirements calculated using MAC's method cost $6,146,895, while Dyna-METRIC produced a slightly more expensive kit at $6,221,081. Results from the Dyna-METRIC output and the spreadsheet are combined in Appendix E so the recommended quantities and costs for individual LRUs can be compared easily. The MAC kit contained at least one of each item, in contrast to the Dyna-METRIC kit which did not include 9 of the 24 LRUs. There was one notable difference between the kits; the level of stock for item 5841-01-221-8638, the radar altimeter receiver/transmitter, varied considerably. The MAC kit contained only 10, and the Dyna-METRIC kit recommended a quantity of 19.

The performance of both kits was comparable at a 15 percent NMCS rate. As expected, no more than 2 aircraft were grounded on day 10, 20, 30 or 45, the days selected for detailed analysis. Dyna-METRIC purchased enough stock to meet this support objective throughout the scenario. A Dyna-METRIC assessment was then performed using stock levels calculated on the MAC spreadsheet. The analysis showed MAC's kit exceeded the target NMCS rate toward the end of the support period. The model projected 2.48 aircraft would be grounded on day 45 of the scenario, so the actual level of aircraft availability did not reach the goal of 12 FMC aircraft. Overall, the MAC kit performed at a level comparable to the Dyna-METRIC kit, at a slightly lower cost.

Results for Research Question 2

The original experimental design, as outlined in Chapter 3, was modified to include a second strategic airlift scenario. The first strategic scenario consisted of one BLSS location and seven WRSK locations. This design replicated the structure of the C-141 kit and fully tasked an entire WRSK increment. The concept provided an accurate representation of the kit; however, the scenario proved to be ineffective for a Dyna-METRIC assessment. Allocating stock between the various segments became a problem when the recommended quantities were not divisible by seven. The capability of MAC's kit could not be assessed accurately if parts were added to or eliminated from the calculated stock levels. To resolve this inconsistency, a second scenario was added that combined WRSK assets at a single location.

Multiple WRSK Locations. For multiple operating locations, Dyna-METRIC computed a significantly less expensive WRSK than obtained with MAC's formulation. The MAC kit cost $11,299,535 compared to $9,090,699 for the Dyna-METRIC kit. The two kits differed considerably when considering the quantity of LRUs stocked. The LRUs whose stock levels varied by more than 50 percent between the two kits are reported in Table 5. The results demonstrate how Dyna-METRIC used marginal analysis to compile a cost effective combination of LRUs. By contrast, MAC's computations added a fixed level of safety stock to every item. An assessment was not performed on MAC's stock levels for the multiple WRSK scenario as discussed earlier. Refer to Appendices F and G for a complete list of the MAC and Dyna-METRIC WRSK.

Single WRSK Location. The MAC kit was identical for the single and multiple WRSK locations because its calculations are independent of a scenario. Consequently, the cost figures were $11,299,535 and $2,296,036 for the WRSK and BLSS, respectively. The Dyna-METRIC requirements computation resulted in substantially lower stock levels for WRSK and BLSS. Each kit contained only four LRU types, as shown in Table 6. The dollar value associated with the WRSK was only $497,669 and $341,917 for the BLSS.

These results were considered interesting for several reasons. First, the large number of aircraft at a single location permitted a high degree of cannibalization. Dyna-METRIC cannibalized sufficient parts to keep aircraft FMC without purchasing stock. The model's cannibalization option is carried out without regard for the number of maintenance personnel or the time required to support such actions. Furthermore, the BLSS stock quantities were justifiably lower than the WRSK quantities because Dyna-METRIC assumed an unlimited repair capability for these components, in addition to cannibalizing spare parts from the fleet of aircraft. The large variation between the Dyna-METRIC and MAC kits cannot be attributed to a single, identifiable cause.

Sensitivity Analysis

The term direct support objective, or DSO, is the acceptable number of aircraft that are not mission capable for supply (NMCS). The model attempts to meet a DSO (the target NMCS rate) specified by the user. Currently, the approved and funded level of aircraft availability is an 84 percent fully mission capable rate (20:Ch 2, para 2-2, a(5)). An ideal NMCS rate has not been identified for Dyna-METRIC analyses of strategic airlift. In Dyna-METRIC, the confidence level indicates the likelihood or probability a particular DSO will be achieved. The target NMCS rate and confidence level affect the model's performance and, consequently, composition of the WRSK. Refer to Chapter 2 for a complete discussion on efforts to validate Dyna-METRIC for strategic airlift.

Sensitivity analysis was performed by varying target NMCS rates on Dyna-METRIC assessments of MAC's kits. The NMCS rates were lowered from 15 percent to ten and five percent, respectively, with the confidence levels held constant at 80 percent. By making the DSO successively more difficult to attain, parts shortages occurred. The "potential problem parts report" is an option available in Dyna-METRIC's assessment function that identifies which LRUs cause the model to exceed the target NMCS rate. The NMCS rates tested are within the range of DSO values used by DRC contractors in their demonstration of WSMIS/REALM for strategic airlift aircraft.

Strategic Assessment.

The sensitivity testing identified only one occurrence of a parts shortage. The strategic BLSS was unable to meet spares requirements on day 10 with a target NMCS rate of five percent.

The WRSK levels were sufficient to support 18 aircraft for 45 days without any adverse affects on aircraft availability, even at a five percent NMCS. The complete results are reported in Tables 7 and 8. The potential problem parts are listed in Table 10.

Tactical Assessment. Several problem parts for the WRSK appeared when the NMCS rates were lowered. As shown in Table 9, parts shortages emerged on day 45 at a ten percent NMCS, and on days 20, 30, and 45 for a NMCS rate of five percent. The problem LRUs are given in Table 11.

Summary

The purpose of this research was to compare WRSK computed using MAC's formulas and Dyna-METRIC's requirement mode. The stock levels for each kit were assessed using Dyna-METRIC under tactical and strategic airlift scenarios. For the tactical airlift scenario, MAC's technique yielded a less expensive kit than did Dyna-METRIC, but the level of support from the MAC kit fell slightly during the last 15 days of the scenario. The strategic airlift scenario, however, produced very different findings. The WRSK and BLSS costs for the Dyna-METRIC kit were extremely low compared to the amount required for MAC's kit. This disparity can be attributed, at least in part, to the unconstrained repair capability at the BLSS location and the unlimited cannibalization at all locations. Dyna-METRIC was able to meet the DSO without purchasing additional spare parts. Specific conclusions and recommendations concerning the results are addressed in the next chapter.

TABLE V

Significant Variations in Stock Levels

LRU	MAC Quantity	Dyna-METRIC Quantity	LRU Cost
787116851000-001	5	13	1,651.00
121158008-1000-1	35	15	77,876.24
45AAAENGHYDPUMP	3	15	7,428.18
98571854703-1	2	6	67,219.00
5821-01-054-6424	2	7	811.64
5841-01-193-6401	8	17	4,271.41
42DAFC42CAL--GEN	6	15	8,526.83
23GA--STARTERASY	1	6	9,721.55
23GB--STARTERVLV	1	6	3,661.92
23HCA-F/FXMITTER	2	6	5,085.61
23HBA-OILPRXMIT	1	6	1,975.88

TABLE VI

Dyna-METRIC's Strategic Kits

LRU	WRSK Quantity	BLSS Quantity
121158008-1000-1	6	4
5841-01-221-8638	7	7
5821-01-208-1093	1	1
5821-01-062-0986	1	1

TABLE VII

Strategic BLSS

Day	Target NFMC 15%	Target NFMC 10%	Target NFMC 5%	Expected NFMC 15%	Expected NFMC 10%	Expected NFMC 5%	Problem Parts 15%	Problem Parts 10%	Problem Parts 5%
10	3	2	1	2.133	2.133	2.133	No	No	Yes
20	3	2	1	1.067	1.067	1.067	No	No	No
30	3	2	1	0.582	0.582	0.582	No	No	No
45	3	2	1	0.212	0.212	0.212	No	No	No

TABLE VIII

Strategic WRSK

Day	Target NFMC 15%	Target NFMC 10%	Target NFMC 5%	Expected NFMC 15%	Expected NFMC 10%	Expected NFMC 5%	Problem Parts 15%	Problem Parts 10%	Problem Parts 5%
10	3	2	1	0.270	0.270	0.270	No	No	No
20	3	2	1	0.270	0.270	0.270	No	No	No
30	3	2	1	0.270	0.270	0.270	No	No	No
45	3	2	1	0.270	0.270	0.270	No	No	No

TABLE IX

Tactical WRSK

	Target NFMC			Expected NFMC			Problem Parts		
	15%	10%	5%	15%	10%	5%	15%	10%	5%
Day									
10	2	1	1	0.132	0.132	0.132	No	No	No
20	2	1	1	0.691	0.691	0.691	No	No	Yes
30	2	1	1	1.292	1.292	1.292	No	No	Yes
45	2	1	1	2.480	2.480	2.480	No	Yes	Yes

TABLE X

Problem Parts List - BLSS

LRU	
121158008-1000-1 131607569312-011 071878509505-901	Day 10 at five percent NMCS

TABLE XI

Problem Parts List - WRSK

LRU	
071878509505-901 131607569312-011 5841-01-221-8638	Day 45 at ten percent NMCS
071878509505-901 45AAAENGHYDPUMP	Day 20 at five percent NMCS
071878509505-901 131607569312-011 45AAAENGHYDPUMP 42DAFC42CAL--GEN	Day 30 at five percent NMCS
071878509505-901 131607569312-011 5841-01-221-8638 42DAFC42CAL--GEN 730308508700-961 5821-01-208-1093 45AAAENGHYDPUMP 23HCA-F/FXMITTER	Day 45 at five percent NMCS

V. Conclusions and Recommendations

The purpose of this study was to make a relative comparison of two methods used for computing WRSK requirements. The LRU data base contained only a small sample of parts because the actual composition of the C-17 kit will not be identified until formal provisioning begins in October 1988. The information available at the time of this study was preliminary, and the results must be interpreted in that context. Although it is not possible to make specific recommendations concerning C-17 WRSK, some general observations can be made.

Conclusions

Research Question 1. Dyna-METRIC has proven to be a valuable tool for computing cost-effective WRSK but the total cost for Dyna-METRIC's WRSK and BLSS was unusually low in the strategic airlift scenario. The broad, generic scenario devised to represent a strategic mission for the C-17 did not take into account some key parameters in the Dyna-METRIC model. By eliminating such factors as transportation time and depot repair time, the RRR maintenance for BLSS could not be modeled completely. Consequently, the requirement for BLSS stockage was low. In addition, the full cannibalization policy greatly reduced the need for spare parts. It is difficult to quantify the impact of a full cannibalization policy on both WRSK and BLSS requirements without running a comparison assessment under a no-cannibalization policy. Until Dyna-METRIC is validated for WSMIS/REALM, caution must be used in applying requirements calculations to strategic airlift aircraft.

Research Question 2. Under a tactical airlift scenario, the WRSK stock levels calculated in Dyna-METRIC's requirements mode proved very similar to the quantities stocked under MAC's current WRSK computations. In fact, MAC's kit was shown to be less expensive than the Dyna-METRIC kit, but aircraft availability dropped slightly between day 30 and day 45 of the scenario. It is not feasible to draw a firm conclusion as to which technique is superior for calculating tactical WRSK based on the results of this study.

Recommendations

There is a need for further research in the area of C-17 WRSK to determine specific spares requirements for the aircraft. Dyna-METRIC analyses should be performed as soon as provisioning data becomes available. One technique that deserves consideration, especially for BLSS computations, is to establish a pipeline floor using MAC's computations and then apply Dyna-METRIC to compute a variable level of safety stock. MAC's methodology involves computing a fixed level of safety stock for every item in the WRSK. Their WRSK calculations do not allow for cost-performance tradeoffs as does Dyna-METRIC. Dyna-METRIC should be used to compute a more cost effective combination of spare parts for the level of safety stock in strategic WRSK and BLSS.

Appendix A: Acronyms

AFLC - Air Force Logistics Command

AFLCR - Air Force Logistics Command regulation

ALC - Air Logistics Center

BLSS - Base-level self-sufficiency spares

CFE - Contractor furnished equipment

CINC - Commander-in-Chief

CIRF - Centralized intermediate repair facility

CLASS - Comprehensive LSA Automated Support System

CSMS - Combat supplies management system

DAC - Douglas Aircraft Company

DDP - Demand development period

DOD - Department of Defense

DRC - Dynamics Research Corporation

Dyna-METRIC - Dynamic Multi-Echelon Technique for Recoverable Item Control

FLOGEN - Flow generator

FSS - Forward supply system

GFE - Government furnished equipment

GWAM - Get-well assessment module

HQ - Headquarters

IOC - Initial operational capability

LMSC - Logistics Management Systems Center

LRU - Line replaceable unit

LSA - Logistics support analysis

MAC - Military Airlift Command

MAJCOM - Major command

MDS - Mission design series

MESL - Mission essential subsystem list

METRIC - Multi-Echelon Technique for Recoverable Item Control

MRRI - Maintenance Replacement Rate I

MTBD - Mean time between demand

MTBF - Mean time between failure

MTM - Million ton-miles

NMCS - Not mission capable for supply

NRTS - Not reparable this station

OPLAN - Operations plan

PAA - Primary aircraft authorization

PFA - Program factor adjustment

POC - Preliminary operational capability

POS - Peacetime operating stock

RAM - Readiness assessment module

RCT - Repair cycle time

REALM - Requirements/execution acquisition logistics module

RILSA - Resident Integrated Logistics Support Agency

SAIP - Spares Acquisition Integrated with Production program

SAM - Sustainability assessment module

SOC - System operational concept

SORTS - Status of Resources and Training System

SRU - Shop replaceable unit

SSRU - Sub-SRU

STRAM - Strategic airlift model

TAC - Tactical Air Command

UTE - Utilization rate

WMP - War and Mobilization Plan

WRM - War reserve materiel

WRSK - War readiness spares kit

WSL - Wartime safety level

WSMIS - Weapon System Management Information System

WWMCCS - Worldwide military command and control system

Appendix B: Definitions

Base Level Self-Sufficiency Spares - "WRM spares and repair parts intended for use as base support for units which plan to operate in-place during wartime considering the available maintenance capability. BLSS represents the difference between the peacetime operating stock levels expected to be available at the unit in wartime and it's total wartime requirement for a specified period of time" (20:45).

Contractor Furnished Equipment - "Items acquired or manufactured by the contractor for use in the system or equipment under contract" (17:Para 1(c)).

Demand Development Period - "The DDP is that period of time extending from the date of POC to a point in time (not exceeding 2 years) beyond the POC date when requirements are forecast entirely based upon actual demands or other empirical data indicative of the need for spare and repair parts" (14:59).

Direct Support Objective - "An average value of aircraft expected to be not mission capable supply (NMCS) or partial mission capable supply (PMCS) at the end of the WRSK/BLSS support period" (15:2).

Government Furnished Equipment - "Items stocked or acquired by the government and later delivered to, or made available to, the contractor for integration into the system or equipment" (17:Para 1(d)).

Initial Operational Capability - "The first attainment of the capability to employ effectively a weapon system or equipment of approved specific characteristics which is manned or operated be an adequately trained, equipped, and supported military unit or force" (14:59).

Initial Provisioning - "The process of determining the range of quantity of items required to support and maintain an end item or article of materiel for an initial period of operation" (14:59).

Initial Spares - "Reparable spares and repair parts needed to support and maintain newly fielded systems or subsystems during the initial phase of service, including pipeline quantities needed as initial stockage at all levels" (17:para1(e)).

Maintenance Replacement Rate I - "The MRRI can be defined by each of the following options.

Option 1. The MRRI is the maintenance replacement rate of the item per peacetime operating program. The operating program will be provided by the requiring authority. The MRRI will consider secondary failures, idleness, operator error, preventive/planned maintenance, handling and storage.

Option 2. The peacetime replacement rate factor for the item indicating the number of expected failures, which will require removal and replacement of the support item below depot level in a given next higher assembly per equipment/ end item per year. This factor is to be based on the known/estimated end item usage" (9:491).

Marginal Analysis - "An optimization technique in which spare parts are iteratively added to a requirement in order of greatest increase of support per dollar until the desired level of support is achieved" (15:3).

Preliminary Operational Capability - "The attainment of the capability for equipment or systems to be used by operational units and to function in a manner that is preliminary to, but in support of, the achievement of an initial operational capability (IOC)" (14:60).

Primary Aircraft Authorization - "The number of aircraft in a unit supported by WRSK or BLSS" (15:3).

Quantity Per Application - "The number of units of an item which are installed on one weapon system or end item" (15:3).

Replenishment Spares - "Items acquired for logistics support of a system to resupply initial stockage, or increased stockage for reasons other than support of newly funded end items" (17:Para 1(h)).

Safety Level - "Additional level over and above the conventional quantity. The safety level provides spares for those items which experience a greater than average failure rate. Safety level is normally determined in units of the standard deviation of the conventional quantity" (15:3).

War Readiness Spare Kit - "An air transportable package of WRM spares, repair parts and related maintenance supplies required to support planned or contingency operations of a weapon or support system for a specified period of time pending resupply" (20:49).

War Reserve Materiel - "That materiel required in addition to peacetime assets, to support the planned wartime activities reflected in the United States Air Force war and mobilization plan (WMP)" (20:49).

Appendix C: C-17 WRSK/BLSS Computations

1. Tactical WRSK (per squadron)

$$\frac{(\text{UTE Rate})\ (\text{PAA})\ (\#\ \text{Days})}{\text{MTBF}} + \text{Safety Level}_w$$

$$\text{where Safety Level}_w = \sqrt{\frac{(3)\ (\text{UTE Rate})\ (\text{PAA})\ (\#\ \text{Days})}{\text{MTBF}}}$$

2. Strategic WRSK

$$(\%\ \text{offshore activity}) \left[\frac{(\text{UTE Rate})\ (\text{PAA})\ (\#\ \text{Days})}{\text{MTBF}} + \text{Safety Level}_w \right]$$

3. Strategic BLSS

$$(\%\ \text{offshore activity}) \left[\frac{(\text{UTE Rate})\ (\text{PAA})\ (\#\ \text{Days})\ (1-\text{PBR})}{\text{MTBF}} + \text{Safety Level}_b \right]$$

$$\text{where Safety Level}_b = \sqrt{\frac{(3)\ (\text{UTE Rate})\ (\text{PAA})\ (\#\ \text{Days})\ (1-\text{PBR})}{\text{MTBF}}}$$

Key:

UTE rate - utilization rate
PAA - primary aircraft authorization
PBR - percent base repair
MTBF - mean time between failure

(Reference 22)

Appendix D: LRU Source Data

LONG-LEAD ITEMS

LRU	Nomenclature	MRRI	NRTS	Base RCT	Cost	Data Base	Source	Reference
131607569312-011	Computer, Mission	0.0594	0.04	15	250,135.00	LSA-036 Summary	Engineering Estimates	Davis
07187509505-901	Display, Multi-Function	0.0569	0.06	15	228,713.00	LSA-036 Summary	Engineering Estimates	Davis
98571854704-1	Control, Indicator	0.0055	0.06	15	31,499.00	LSA-036 Summary	Engineering Estimates	Davis
787116851000-001	Control, Comm System	0.0217	0.06	15	1,651.00	LSA-036 Summary	Engineering Estimates	Davis
121158008-1000-1	Receiver-Transmitter	0.2188	0.06	15	77,876.24	LSA-036 Summary	Engineering Estimates	Davis
730308508700-961	Computer, Air Data	0.0630	0.06	15	53,733.00	LSA-036 Summary	Engineering Estimates	Davis
121158605-2000-1	Coder-Decoder	0.0473	0.06	15	132,267.00	LSA-036 Summary	Engineering Estimates	Davis
121158605-5000-1	Switch, RF	0.0117	0.08	15	22,916.00	LSA-036 Summary	Engineering Estimates	Davis
98571854703-1	Display, Mission Communication	0.0062	0.06	15	67,219.00	LSA-036 Summary	Engineering Estimates	Davis
131607569313-011	Keyboard, Mission	0.0131	0.04	15	129,891.00	LSA-036 Summary	Engineering Estimates	Davis

ENGINE COMPONENTS

LRU	Nomenclature	WUC	MTBD	NRTS	Base RCT	Cost	Data Base	Source	Reference
45AAAENGHYDPUMP	Engine Driven Hyd Pumps	45AAI	9534	0.09	8	7,428.18		PW-2037/ C-141	Warfield/ Triplett
42DAFC42CAL—GEN	90 KVA Generator	42DAF	3972	0.10	7	8,526.83	UD040-151	PW-2037/ C-141	Warfield/ Triplett
23GA—STARTERASY	Starter Assembly	23GA	46120	0.05	6	9,721.55	Listing,	PW-2037/ C-141	Warfield/ Triplett
23GB—STARTERVLV	Starter Air Shutoff Valve	23GB	69000	0.06	7	3,661.92	D029	PW-2037/ C-141	Warfield/ Triplett
23HCA-F/FXMITTER	Fuel Flow Transmitter	23HCA	22320	0.03	5	5,085.61	Worksheets	PW-2037/ C-141	Warfield/ Triplett
23HBA-OILPRXMIT	Oil Pressure Transmitter	23HBH	44630	0.05	2	1,975.88		PW-2037/ C-141	Warfield/ Triplett

AVIONICS COMPONENTS

LRU	Nomenclature	MTBD	NRTS	Base RCT	Cost	Data Base	Source	Reference
5895-01-220-9138	Transponder, I-Band Radar	2209	1.00	2	33,000.00	D043,CLASS, WSMIS	DAC Estimates	Kwon/ Miller
5821-01-054-6424	Selector, Antenna UHF-DF	19329	0.60	2	811.64	CLASS, WSMIS	KC-10, AFM 66-1	Kwon/ Miller
5841-01-221-8638	Radar Altimeter R/T	913	1.00	4	3,066.00	D043, CLASS	KC-10, AFM 66-1	Kwon/ Miller
5841-01-193-6401	Signal Data Converter, Rdr Alt	2744	0.71	7	4,271.41	D043,CLASS, WSMIS	DAC Estimates	Kwon/ Miller
5821-01-208-1093	VHF AM/FM Comm R/T	2193	0	7	7,548.87	D043,CLASS, WSMIS	C-5A	Kwon/ Miller
5821-01-012-1938	ARN 118 TACAN	3802	0.95	7	12,006.71	WSMIS	C-141	Miller
5821-01-180-2157	HF Receiver/ Transmitter (ARC-190)	11236	0.53	6	12,508.32	WSMIS	C-5B	Cameron/ Miller
5821-01-062-0986	VHF, AM/FM Comm	3289	0.74	6	1,401.83	WSMIS	F-16	Cameron/ Miller

Appendix E: C-17 WRSK/BLSS Spreadsheet[1]

WAR RESERVE MATERIEL FOR A HYPOTHETICAL C-17 STRATEGIC WING AND TACTICAL SQUADRON

		% BASE	# DAYS		TAC	STRAT UTE		#	PAA	PAA	% ON	% OFF	TAC[2]	STRAT[2]	STRAT[2]
LRU	MTBD	REPAIR	SRG	SUST	UTE	SRG	SUST	SQD	TAC	STRAT	SHORE	SHORE	WRSK	BLSS	WRSK
131607569312-011	1684	0.96	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	5.9	1.0	10.9
07187509505-901	1757	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	5.8	1.3	10.5
98571854704-1	18182	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.1	0.3	1.7
78711685-1000-001	4608	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	2.9	0.7	4.7
1211580081000-1	457	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	16.7	3.6	34.4
730308508700-961	1587	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	6.2	1.4	11.4
121158605-2000-1	2114	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	5.0	1.2	9.0
45AAAENGHYDPUMP	9534	0.91	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.7	0.6	2.7
121158605-5000-1	8547	0.92	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.9	0.6	2.9
98571854703-1	16129	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.2	0.3	1.8
131607569313-011	7634	0.96	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	2.0	0.4	3.2
5895-01-220-9138	2209	0	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	4.9	9.8	8.6
5821-01-054-6424	19329	0.40	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.1	1.3	1.6
5841-01-221-8638	913	0	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	9.5	20.9	18.5
5841-01-193-6401	2744	0.29	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	4.1	6.2	7.2
5821-01-208-1093	2193	0	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	4.9	9.8	8.7
42DAFC42CAL—GEN	3972	0.90	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	3.2	1.1	5.3
5821-01-012-1938	3802	0.05	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	3.3	6.0	5.5
23GA—STARTERASY	46120	0.95	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	0.6	0.1	0.9
23GB—STARTERVLV	69000	0.94	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	0.5	0.1	0.7
23HCA-F/FXMITTER	22320	0.97	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.0	0.2	1.4
5821-01-180-2157	11236	0.47	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	1.6	1.7	2.4
5821-01-062-0986	3289	0.26	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	3.6	5.5	6.2
23HBA-OILPRXMIT	44630	0.95	10	35	8.0	15.6	13.9	1	14	39	0.53	0.47	0.6	0.1	0.9

Key: MTBD = mean time between demand
DAYS SRG = number of days of surge UTE
DAYS SUST = number of days of sustained UTE
STRAT UTE SRG = surge strategic UTE
STRAT UTE SUST = sustained strategic UTE

Note 1: Original LOTUS 1-2-3 spreadsheet provided by HQ MAC/LGSWR was modified and reaccomplished in Perfect Calc.

Note 2: Stock levels used in Dyna-METRIC obtained by increasing individual WRSK and BLSS quantities to next largest whole number.

Appendix F: Comparison of Tactical WRSK

A COMPARISON OF TACTICAL WRSK STOCK LEVELS AND COSTS FOR DYNA-METRIC AND MAC KITS

		Dyna-METRIC		MAC Calculation	
LRU	Cost	QTY	Total Cost	QTY	Total Cost
131607569312-011	250,135	7	1,750,945	6	1,500,810
07187509505-901	228,713	8	1,829,704	6	1,372,278
98571854704-1	31,499	0	0	2	62,998
787116851000-001	1,651	5	8,255	3	4,953
121158008-1000-1	77,876	16	1,246,016	17	1,323,892
730308508700-961	53,733	8	429,864	7	376,131
121158605-2000-1	132,267	4	529,068	5	661,335
45AAAENGHYDPUMP	7,428	0	0	2	14,856
121158605-5000-1	22,916	1	22,916	2	45,832
98571854703-1	67,219	0	0	2	134,438
131607569313-011	129,891	0	0	2	259,782
5895-01-220-9138	33,000	5	165,000	5	165,000
5821-01-054-6424	812	2	1,624	2	1,624
5841-01-221-8638	3,066	19	58,254	10	30,660
5841-01-193-6401	4,271	7	29,897	5	21,355
5821-01-208-1093	7,549	8	60,392	5	37,745
42DAFC42CAL—GEN	8,527	4	34,108	4	34,108
5821-01-012-1938	12,007	4	48,028	4	48,028
23GA—STARTERASY	9,722	0	0	1	9,722
23GB—STARTERVLV	3,662	0	0	1	3,662
23HCA-F/FXMITTER	5,086	0	0	1	5,086
5821-01-180-2157	12,508	0	0	2	25,016
5821-01-062-0986	1,402	5	7,010	4	5,608
23HBA-OILPRXMIT	1,976	0	0	1	1,976
	Total WRSK Cost:		6,221,081		6,146,895

APPENDIX G: Dyna-METRIC Strategic WRSK/BLSS (Multiple WRSK Locations)

DYNA-METRIC STOCK LEVELS AND COSTS

			WRSK								Cost	Cost	Total
LRU	Cost	BLSS	TA	TB	TC	TD	AA	AB	AC	Total	BLSS	WRSK	Cost
131607569312-011	250,135	0	0	2	2	2	1	1	1	9	0	2,251,215	2,251,215
07187509505-901	228,713	0	0	2	2	2	1	1	1	9	0	2,058,417	2,058,417
98571854704-1	31,499	0	0	1	1	1	0	0	0	3	0	94,497	94,497
787116851000-001	1,651	0	1	2	2	2	2	2	2	13	0	21,463	21,463
121158008-1000-1	77,876	4	3	3	3	3	1	1	1	15	311,504	1,168,140	1,479,644
730308508700-961	53,733	0	1	2	2	2	1	1	1	10	0	537,330	537,330
121158605-2000-1	132,267	0	1	1	1	1	1	1	1	7	0	925,869	925,869
45AAAENGHYDPUMP	7,428	0	0	3	3	3	2	2	2	15	0	111,420	111,420
121158605-5000-1	22,916	0	0	1	1	1	1	1	1	6	0	137,496	137,496
98571854703-1	67,219	0	0	1	1	1	1	1	1	6	0	403,314	403,314
131607569313-011	129,891	0	0	1	1	1	0	0	0	3	0	389,673	389,673
5895-01-220-9138	33,000	0	1	1	1	1	1	1	1	7	0	231,000	231,000
5821-01-054-6424	812	0	1	1	1	1	1	1	1	7	0	5,684	5,684
5841-01-221-8638	3,066	7	5	5	5	5	3	3	3	29	21,462	88,914	110,376
5841-01-193-6401	4,271	0	2	3	3	3	2	2	2	17	0	72,607	72,607
5821-01-208-1093	7,549	1	2	3	3	3	2	2	2	17	7,549	128,333	135,882
42DAFC42CAL--GEN	8,527	0	0	3	3	3	2	2	2	15	0	127,905	127,905
5821-01-012-1938	12,007	0	1	2	2	2	1	1	1	10	0	120,070	120,070
23GA--STARTERASY	9,722	0	0	1	1	1	1	1	1	6	0	58,332	58,332
23GB--STARTERVLV	3,662	0	0	1	1	1	1	1	1	6	0	21,972	21,972
23HCA-F/FXMITTER	5,086	0	0	1	1	1	1	1	1	6	0	30,516	30,516
5821-01-180-2157	12,508	0	0	1	1	1	1	1	1	6	0	75,048	75,048
5821-01-062-0986	1,402	1	2	2	2	2	2	2	2	14	1,402	19,628	21,030
23HBA-OILPRXMIT	1,976	0	0	1	1	1	1	1	1	6	0	11,856	11,856
										Total Cost:	341,917	9,090,699	9,432,616

APPENDIX H: MAC Strategic WRSK/BLSS

MAC STOCK LEVELS AND COSTS FOR STRATEGIC WRSK/BLSS

		Quantity		Cost		
LRU	Cost	BLSS	WRSK	BLSS	WRSK	Total
131607569312-011	250,135	1	11	250,135	2,751,485	3,001,620
07187509505-901	228,713	2	11	457,426	2,515,843	2,973,269
98571854704-1	31,499	1	2	31,499	62,998	94,497
787116851000-001	1,651	1	5	1,651	8,255	9,906
121158008-1000-1	77,876	4	35	311,504	2,725,660	3,037,164
730308508700-961	53,733	2	12	107,466	644,796	752,262
121158605-2000-1	132,267	2	9	264,534	1,190,403	1,454,937
45AAAENGHYDPUMP	7,428	1	3	7,428	22,284	29,712
121158605-5000-1	22,916	1	3	22,916	68,748	91,664
98571854703-1	67,219	1	2	67,219	134,438	201,657
131607569313-011	129,891	1	4	129,891	519,564	649,455
5895-01-220-9138	33,000	10	9	330,000	297,000	627,000
5821-01-054-6424	812	2	2	1,624	1,624	3,248
5841-01-221-8638	3,066	21	19	64,386	58,254	122,640
5841-01-193-6401	4,271	7	8	29,897	34,168	64,065
5821-01-208-1093	7,549	10	9	75,490	67,941	143,431
42DAFC42CAL--GEN	8,527	2	6	17,054	51,162	68,216
5821-01-012-1938	12,007	6	6	72,042	72,042	144,084
23GA--STARTERASY	9,722	1	1	9,722	9,722	19,444
23GB--STARTERVLV	3,662	1	1	3,662	3,662	7,324
23HCA-F/FXMITTER	5,086	1	2	5,086	10,172	15,258
5821-01-180-2157	12,508	2	3	25,016	37,524	62,540
5821-01-062-0986	1,402	6	7	8,412	9,814	18,226
23HBA-OILPRXMIT	1,976	1	1	1,976	1,976	3,952
		Total Cost:		2,296,036	11,299,535	13,595,571

Appendix I: Dyna-METRIC Strategic WRSK/BLSS (Single WRSK Location)

DYNA-METRIC STOCK LEVELS AND COSTS

		Quantity		Cost		
LRU	Cost	BLSS	WRSK	BLSS	WRSK	Total
131607569312-011	250,135	0	0	0	0	0
07187509505-901	228,713	0	0	0	0	0
98571854704-1	31,499	0	0	0	0	0
787116851000-001	1,651	0	0	0	0	0
121158008-1000-1	77,876	4	6	311,504	467,256	778,760
730308508700-961	53,733	0	0	0	0	0
121158605-2000-1	132,267	0	0	0	0	0
45AAAENGHYDPUMP	7,428	0	0	0	0	0
121158605-5000-1	22,916	0	0	0	0	0
98571854703-1	67,219	0	0	0	0	0
131607569313-011	129,891	0	0	0	0	0
5895-01-220-9138	33,000	0	0	0	0	0
5821-01-054-6424	812	0	0	0	0	0
5841-01-221-8638	3,066	7	7	21,462	21,462	42,924
5841-01-193-6401	4,271	0	0	0	0	0
5821-01-208-1093	7,549	1	1	7,549	7,549	15,098
42DAFC42CAL--GEN	8,527	0	0	0	0	0
5821-01-012-1938	12,007	0	0	0	0	0
23GA--STARTERASY	9,722	0	0	0	0	0
23GB--STARTERVLV	3,662	0	0	0	0	0
23HCA-F/FXMITTER	5,086	0	0	0	0	0
5821-01-180-2157	12,508	0	0	0	0	0
5821-01-062-0986	1,402	1	1	1,402	1,402	2,804
23HBA-OILPRXMIT	1,976	0	0	0	0	0
		Total Cost:		341,917	497,669	839,586

APPENDIX J: Dyna-METRIC Input Files

```
TACTICAL REQUIREMENTS SCENARIO
11  0.    0.    0.    VERSION 4.4  MT1MT2MT3MT4MT5
  10  20  30  45
OPT
      2 15 0.80
      4 15 0.80
      5 15 0.80
      6 15 0.80
      9
     12 15 0.80
     15
     18
BASE
BAS1      99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00  0.   99.0  11
TRNS
BAS1    0.     0.  0   0.     0.     0.
ACFT
BAS1  0.    1 14.
SRTS
BAS1 0.     1 8.09999 0.
FLHR
BAS1 0.     1 1.09999 0.
ATTR
BAS1 0.    99990.
TURN
BAS116.39999   0
```

```
STRATEGIC REQUIREMENTS SCENARIO - MULTIPLE WRSK LOCATIONS
11  0.    0.    0.    VERSION 4.4  MT1MT2MT3MT4MT5
  10  20  30  45
OPT
      2 15 0.80
      4 15 0.80
      5 15 0.80
      6 15 0.80
      9
     12 15 0.80
     15
     18
BASE
BLSS      99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0  1.0  1.0  1.00 10.0  0.   11
TA        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
TB        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
TC        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
TD        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
AA        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
AB        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
AC        99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
TRNS
BLSS     0.     0.  0    0.     0.     0.
TA       0.     0.  0    0.     0.     0.
TB       0.     0.  0    0.     0.     0.
TC       0.     0.  0    0.     0.     0.
TD       0.     0.  0    0.     0.     0.
AA       0.     0.  0    0.     0.     0.
AB       0.     0.  0    0.     0.     0.
AC       0.     0.  0    0.     0.     0.
ACFT
BLSS   0.    1 21.9999  0.
TA     0.    1  6.9999  0.
TB     0.    1  3.9999  0.
TC     0.    1  3.9999  0.
TD     0.    1  3.9999  0.
AA     0.    1  1.9999  0.
AB     0.    1  1.9999  0.
AC     0.    1  1.9999  0.
SRTS
BLSS 1.0    115.6   1113.99999 0.
TA   1.0    115.6   1113.99999 0.
TB   1.0    115.6   1113.99999 0.
TC   1.0    115.6   1113.99999 0.
TD   1.0    115.6   1113.99999 0.
AA   1.0    115.6   1113.99999 0.
AB   1.0    115.6   1113.99999 0.
AC   1.0    115.6   1113.99999 0.
FLHR
BLSS 1.09999 0.
TA   1.09999 0.
TB   1.09999 0.
```

```
TC   1.09999 0.
TD   1.09999 0.
AA   1.09999 0.
AB   1.09999 0.
AC   1.09999 0.
ATTR
BLSS0.    99990.
TA  0.    99990.
TB  0.    99990.
TC  0.    99990.
TD  0.    99990.
AA  0.    99990.
AB  0.    99990.
AC  0.    99990.
TURN
BLSS16.39999    0
TA  16.39999    0
TB  16.39999    0
TC  16.39999    0
TD  16.39999    0
AA  16.39999    0
AB  16.39999    0
AC  16.39999    0
```

```
STRATEGIC REQUIREMENTS SCENARIO - SINGLE WRSK LOCATION
11  0.   0.   0.   VERSION 4.4  MT1MT2MT3MT4MT5
  10  20  30  45
OPT
      2 15 0.80
      4 15 0.80
      5 15 0.80
      6 15 0.80
      9
     12 15 0.80
     15
BASE
BLSS     99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0  1.0  1.0  1.00 10.0  0.0  11
WRSK     99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
TRNS
BLSS    0.    0. 0   0.    0.    0.
WRSK    0.    0. 0   0.    0.    0.
ACFT
BLSS  0.   1 21.9999  0.
WRSK  0.   1 18.9999  0.
SRTS
BLSS 1.0   115.6  1113.99999 0.
WRSK 1.0   115.6  1113.99999 0.
FLHR
BLSS 1.09999 0.
WRSK 1.09999 0.
ATTR
BLSS0.   99990.
WRSK0.   99990.
TURN
BLSS16.39999   0
WRSK16.39999   0
```

```
LRU FILE
131607569312-011        1 0 03 0300.000594        15.0  .04
131607569312-011                                              250135
071878509505-901        1 0 04 0400.000569        15.0  .06
071878509505-901                                              228713
98571854704-1           1 0 02 0200.000055        15.0  .06
98571854704-1                                                  31499
787116851000-001        1 0 02 0200.000217        15.0  .06
787116851000-001                                                1651
121158008-1000-1        1 0 01 0100.002188        15.0  .06
121158008-1000-1                                               77876
730308508700-961        1 0 02 0200.000630        15.0  .06
730308508700-961                                               53733
121158605-2000-1        1 0 01 0100.000473        15.0  .06
121158605-2000-1                                              132267
45AAAENGHYDPUMP         1 0 08 0800.000105        08.0  .09
45AAAENGHYDPUMP                                                 7428
121158605-5000-1        1 0 02 0200.000117        15.0  .08
121158605-5000-1                                               22916
98571854703-1           1 0 04 0400.000062        15.0  .06
98571854703-1                                                  67219
131607569313-011        1 0 02 0200.000131        15.0  .04
131607569313-011                                              129891
5895-01-220-9138        1 0 01 0100.000453        02.0 1.00
5895-01-220-9138                                               33000
5821-01-054-6424        1 0 01 0100.000052        02.0  .60
5821-01-054-6424                                                 812
5841-01-221-8638        1 0 02 0200.001095        04.0 1.00
5841-01-221-8638                                                3066
5841-01-193-6401        1 0 02 0200.000364        07.0  .71
5841-01-193-6401                                                4271
5821-01-208-1093        1 0 02 0200.000456        07.0 1.00
5821-01-208-1093                                                7549
42DAFC42CAL--GEN        1 0 04 0400.000252        07.0  .10
42DAFC42CAL--GEN                                                8527
5821-01-012-1938        1 0 02 0200.000263        07.0  .95
5821-01-012-1938                                               12007
23GA--STARTERASY        1 0 04 0400.000022        06.0  .05
23GA--STARTERASY                                                9722
23GB--STARTERVLV        1 0 04 0400.000014        07.0  .06
23GB--STARTERVLV                                                3662
23HCA-F/FXMITTER        1 0 04 0400.000045        05.0  .03
23HCA-F/FXMITTER                                                5086
5821-01-180-2157        1 0 02 0200.000089        06.0  .53
5821-01-180-2157                                               12508
5821-01-062-0986        1 0 01 0100.000304        06.0  .74
5821-01-062-0986                                                1402
23HBA-OILPRXMIT         1 0 04 0400.000022        02.0  .05
23HBA-OILPRXMIT                                                 1976
```

```
TACTICAL ASSESSMENT AT 15% NFMC
11  0.    0.    0.    VERSION 4.4  MT1MT2MT3MT4MT5
  10  20  30  45
OPT
      8 10
     11 15 0.80
BASE
BAS1      99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00  0.   99.0  11
TRNS
BAS1    0.     0.  0   0.     0.     0.
ACFT
BAS1  0.    1 14.
SRTS
BAS1 0.     1 8.09999 0.
FLHR
BAS1 0.     1 1.09999 0.
ATTR
BAS1 0.   99990.
TURN
BAS116.39999   0
LRU
131607569312-011       1 0 03 0300.000594         15.0  .04
131607569312-011                                                250135
071878509505-901       1 0 04 0400.000569         15.0  .06
071878509505-901                                                228713
98571854704-1          1 0 02 0200.000055         15.0  .06
98571854704-1                                                    31499
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121158605-5000-1                                                 22916
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5895-01-220-9138                                                 33000
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5841-01-221-8638                                                  3066
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5821-01-208-1093       1 0 02 0200.000456         07.0 1.00
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5821-01-208-1093                                                     7549
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23GA--STARTERASY                                                     9722
23GB--STARTERVLV     1 0 04 0400.000014        07.0   .06
23GB--STARTERVLV                                                     3662
23HCA-F/FXMITTER     1 0 04 0400.000045        05.0   .03
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5821-01-180-2157     1 0 02 0200.000089        06.0   .53
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5821-01-062-0986     1 0 01 0100.000304        06.0   .74
5821-01-062-0986                                                     1402
23HBA-OILPRXMIT      1 0 04 0400.000022        02.0   .05
23HBA-OILPRXMIT                                                      1976
STK
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071878509505-901 BAS1     6
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787116851000-001 BAS1     3
121158008-1000-1 BAS1    17
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42DAFC42CAL--GEN BAS1     4
23GA--STARTERASY BAS1     1
23GB--STARTERVLV BAS1     1
23HCA-F/FXMITTER BAS1     1
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STRATEGIC ASSESSMENT OF BLSS/WRSK AT 15% NFMC
11  0.   0.   0.   VERSION 4.4  MT1MT2MT3MT4MT5
  10  20  30  45
OPT
      8 10
     11 15 0.80
     15
BASE
BLSS      99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0  1.0  1.0  1.00 10.0  0.0  11
WRSK      99.0 99.0 99.00  1.0 98.0 99.00  1.0 98.0 99.0 99.0 99.00 10.0 99.0  11
TRNS
BLSS    0.    0.  0   0.    0.    0.
WRSK    0.    0.  0   0.    0.    0.
ACFT
BLSS  0.   1 21.9999  0.
WRSK  0.   1 18.9999  0.
SRTS
BLSS 1.0   115.6  1113.99999 0.
WRSK 1.0   115.6  1113.99999 0.
FLHR
BLSS 1.09999 0.
WRSK 1.09999 0.
ATTR
BLSS0.   99990.
WRSK0.   99990.
TURN
BLSS16.39999   0
WRSK16.39999   0
LRU
131607569312-011      1 0 03 0300.000594       15.0  .04
131607569312-011                                           250135
071878509505-901      1 0 04 0400.000569       15.0  .06
071878509505-901                                           228713
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98571854704-1                                               31499
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787116851000-001                                             1651
121158008-1000-1      1 0 01 0100.002188       15.0  .06
121158008-1000-1                                            77876
730308508700-961      1 0 02 0200.000630       15.0  .06
730308508700-961                                            53733
121158605-2000-1      1 0 01 0100.000473       15.0  .06
121158605-2000-1                                           132267
45AAAENGHYDPUMP       1 0 08 0800.000105       08.0  .09
45AAAENGHYDPUMP                                              7428
121158605-5000-1      1 0 02 0200.000117       15.0  .08
121158605-5000-1                                            22916
98571854703-1         1 0 04 0400.000062       15.0  .06
98571854703-1                                               67219
131607569313-011      1 0 02 0200.000131       15.0  .04
131607569313-011                                           129891
5895-01-220-9138      1 0 01 0100.000453       02.0 1.00
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5895-01-220-9138                                                      33000
5821-01-054-6424          1 0 01 0100.000052          02.0   .60
5821-01-054-6424                                                        812
5841-01-221-8638          1 0 02 0200.001095          04.0 1.00
5841-01-221-8638                                                       3066
5841-01-193-6401          1 0 02 0200.000364          07.0   .71
5841-01-193-6401                                                       4271
5821-01-208-1093          1 0 02 0200.000456          07.0 1.00
5821-01-208-1093                                                       7549
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42DAFC42CAL--GEN                                                       8527
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5821-01-012-1938                                                      12007
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23GA--STARTERASY                                                       9722
23GB--STARTERVLV          1 0 04 0400.000014          07.0   .06
23GB--STARTERVLV                                                       3662
23HCA-F/FXMITTER          1 0 04 0400.000045          05.0   .03
23HCA-F/FXMITTER                                                       5086
5821-01-180-2157          1 0 02 0200.000089          06.0   .53
5821-01-180-2157                                                      12508
5821-01-062-0986          1 0 01 0100.000304          06.0   .74
5821-01-062-0986                                                       1402
23HBA-OILPRXMIT           1 0 04 0400.000022          02.0   .05
23HBA-OILPRXMIT                                                        1976
STK
131607569312-011 BLSS     1 WRSK   11
071878509505-901 BLSS     2 WRSK   11
98571854704-1    BLSS     1 WRSK    2
787116851000-001 BLSS     1 WRSK    5
121158008-1000-1 BLSS     4 WRSK   35
730308508700-961 BLSS     2 WRSK   12
121158605-2000-1 BLSS     2 WRSK    9
45AAAENGHYDPUMP  BLSS     1 WRSK    3
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5821-01-012-1938 BLSS     6 WRSK    6
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23GB--STARTERVLV BLSS     1 WRSK    1
23HCA-F/FXMITTER BLSS     1 WRSK    2
5821-01-180-2157 BLSS     2 WRSK    3
5821-01-062-0986 BLSS     6 WRSK    7
23HBA-OILPRXMIT  BLSS     1 WRSK    1
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Captain Haney is married to [redacted]

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This ~~study~~ compared the performance of two representative war readiness spares kits (WRSK) for the C-17 aircraft under strategic and tactical airlift scenarios. WRSK stock levels were calculated for a sample of 24 aircraft line replaceable units using the Military Airlift Command's (MAC) computations and the Dyna-METRIC computer model. The level of support provided by MAC's kit was compared to the Dyna-METRIC kit by assessing it with Dyna-METRIC at a 15 percent not mission capable rate. The results showed MAC's computations produced a WRSK kit comparable to Dyna-METRIC's with respect to cost, stock levels, and aircraft availability for a squadron of 14 aircraft flying tactical airlift missions. Under the strategic airlift scenario with a wing of 39 aircraft, however, there was a large variation in the stock levels and cost for the WRSK and base level self-sufficiency spares between the MAC and Dyna-METRIC kits. Keyword [illegible]