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AN EVALUATION OF THE COST EFFECTIVENESS OF TRANSPORTING AIR ELIGIBLE CARGO BY AIR VERSUS SURFACE MODES OF TRANSPORTATION

Forrest H. Bennett, Jr., et al

Air Force Institute of Technology
Wright-Patterson Air Force Base, Ohio

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13. ABSTRACT

Transportation priority 1 and 2 air eligible cargo is being moved from the AFLC Air Materiel Areas to CONUS on-line LOGAIR stations by surface modes. An arbitrary limit of one LOGAIR flight per station per day imposed a ceiling on the daily capability of the LOGAIR system. The increased pipeline intransit time resulting from use of the surface modes forces a set level of inventory investment. The procurement of additional LOGAIR capability reduces the overall transportation priority 1 and 2 cargo pipeline intransit time and therefore reduces the inventory investment. The thesis proposes a method to offset the increased costs of procuring additional airlift through a reduction in inventory investment.

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AN EVALUATION OF THE COST EFFECTIVENESS OF TRANSPORTING AIR ELIGIBLE CARGO BY AIR VERSUS SURFACE MODES OF TRANSPORTATION

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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September 1972

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Approved for public release;
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and approved in an oral examination, has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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CHAPTER I

INTRODUCTION

Problem Statement

The shipment of air eligible cargo by surface modes of transportation is believed to be uneconomical. The total cost of packaging, documentation, loss and damage, and increased inventory investment associated with surface transportation shipments is greater than the total cost for air transportation shipments. The continued shipment of air eligible cargo by surface transportation is perpetuated by schedule limitations of the present contract logistical airlift (LOGAIR) system of one aircraft per base per day and the lack of coordinated cost analysis over the total distribution budget requirements. Specifically, the total U.S. Air Force distribution budget requirements are being viewed in parts rather than as an integrated plan which would allocate transportation resources efficiently against each movement demand. A critical coordinated analysis would result in a more effective and economical transportation system.

Background

The triad of strategy, tactics and logistics are inseparable elements of our defense posture. Yet, while effective logistics is indispensable to successful strategy and tactics, it is often relegated to a secondary role in defense mission planning and execution. Thus the logistical support of the Department of Defense prior to and including the Korean War was almost completely tied to surface transportation. The Air Force discovered during the Korean War that it needed a more responsive logistics system capable of delivering critical cargo in days rather than in weeks or months. The high cost of turbojet equipment, such as engines and electronic components, prohibited their stockpiling as in previous eras. It rapidly became apparent that a dependable airlift system was required to resolve these problems. The Air Force, particularly the Air Materiel Command (AMC), had a keen interest in the air logistics concept. AMC had the difficult task of supplying the combat aircraft of the Strategic Air Command and the Air Defense Command to keep these vital forces combat ready. In addition, the Air Materiel Command supplied a considerable amount of other critical, high-value, supply items to the Military Air Transport Service.

In January, 1952, Hq AMC introduced a study, "Logistics for 1956," forecasting the logistics needs of the Air Force, stating that air transportation could significantly affect dollar savings by reducing inventories since fewer items should be needed than those required to fill the existing slow supply channels. (29:7) In order to implement this plan, AMC needed a pool of transport aircraft. The command first proposed withdrawing a number of aircraft from the other major air commands to form the logistical airlift fleet. However, neither the Department of Defense nor the other major air commands, who did not want to lose their aircraft, would support the idea. When military airframes could not be made available for this project, AMC turned to civil aviation to provide the airlift service needed for their logistical system. Starting under the project name SKYWAY the system eventually expanded into the logistical airlift system as we know it today. (29:23)

The LOGAIR system, along with many other Department of Defense functions, has felt the tightening of available funds. Thus the effective utilization of Air Force resources has become an increasingly important area of concern. The post-Vietnam conflict era will undoubtedly be a time of further reductions in Department of Defense budgets even in the face of the continued employment of costly weapons systems inventories. The current annual cost of the LOGAIR system is $35 million.

The Air Force transportation budget is based upon inputs from two separate and distinct sources. The LOGAIR budget is developed from requirements submitted by user stations through their major air commands to Air Force Logistics Command (AFLC). AFLC, as the responsible agency for the operation of the logistical airlift system within the continental United States (CONUS), translates the total Air Force LOGAIR requirement into a budget request and forwards it to Hq USAF. (25)

On the other hand, the surface transportation budget follows a different route. It is submitted by each unit to its major air command for review and consolidation and then forwarded directly to Hq USAF. There appears to be no agency, at major air command, Hq USAF, or DoD reviewing the economical allocation of requirements between the two transportation modes. On the contrary, since airlift service is the most "seemingly costly" mode it is constantly considered for reduction by budget review agencies in favor of the "seemingly less costly" surface mode.

It is directed by regulation that traffic management be performed at the lowest level. It is here, where all transportation requirements originate, that the decision can best be made to select the mode of transportation which will meet the required delivery date with the least expenditure of funds. The traffic manager may elect to use truck, rail, bus, or commercial air, all of which must be funded from his own budget. He may instead elect to use mail, weapons system pouch, government owned conveyance, or government leased or contracted conveyance, all of which are provided at no cost to him.

He obviously always selects the free resource as long as it meets his delivery date requirements. He uses mail for all small shipments excepting special handling materials. Weapons systems pouch (WSP) is used for small classified shipments requiring expedited delivery. Military vehicles or aircraft are normally used only under extremely urgent conditions. The final free resource available to the traffic manager is LOGAIR. Here he is restricted by Air Force Manual 76-1 which limits cargo on LOGAIR aircraft to transportation priority (TP) 999 and 1 through 4. However, TP 3 and 4 may be moved on a space available basis only after approval by Hq AFLC. (32:1-2)

With the exception of flights between the AMAs, AFLC has felt constrained to schedule only one feeder flight per day for the user bases. Without regard to cargo requirements for any feeder flight, daily air movement is governed by the size of the aircraft assigned to that route. The AMA Air Terminal manager faced with a backlog of cargo and limited airlift capability will generally ship the excess by truck. This then results in excess cost and intransit time when viewed as a whole.

Colonel William F. Smith, III, Director of Transportation, Hq Air Force Logistics Command, was contacted to discuss the feasibility of conducting research in this area and to determine the extent of data available for analysis. He expr ed a keen interest in the study and offered the resources of his direct. During initial interviews with

Colonel Smith's staff it was discovered that a substantial data bank was available. However, little or no research has been conducted to analyze this data with regard to an expansion of the present logistical airlift capability system. Most of the research in this area has been directed toward building justification for retention of the present airlift capability.

The original direction of this study was to analyze alleged budget restrictions placed on LOGAIR system funding. The tight budget gives the impression that Hq USAF or DoD is arbitrarily placing a ceiling on logistical airlift spending. DoD has on numerous occasions attempted to reduce LOGAIR contracts. This premise was disproved when the Hq AFLC staff stated that they usually get the total airlift budget requested. (6) The Hq AFLC transportation budget monitor stated that any increase to the total AFLC transportation budget would require substantial justification although there was no limitation on the transfer of surface transportation funds to the airlift category. (7) This then led to the conclusion that all air eligible cargo requirements are not included in the airlift requirements reported at or below AFLC level. That is to say, that customarily planners are reluctant to exceed last year's budget in forecasting new transportation budget needs. The procedure appeared to avoid the prediction of total transportation needs in terms of economy of operations. Therefore, the final direction settled upon was to evaluate the cost advantages of permitting all air eligible cargo to move via the logistical airlift system.

A review of the literature in the area of movement of air eligible cargo led first to a thesis, "The LOGAIR Story," by Upson. This paper proved to be an excellent reference for background material on the evolution of logistical airlift within the Air Force. Upson's extensive research into the causal relations between significant changes in AFLC logistical airlift and critical decisions and events, provides a keen insight into the structure and policies of today's LOGAIR system.

Another reference which provided a further historical basis for this study was the thesis, "Methods for Determining Air Eligible Cargo," by Borin and Buchanan. Their analysis of air cargo eligibility factors provided the departure point for development of cost formulas. Although this study centered around generation of cargo for the C-5 aircraft, the rationale applied equally as well to LOGAIR.

A key reference is the Logistical Management Institute Study, "Criteria for Airlift Eligibility of DoD Cargo," Task 70-19, May 1971. This study was directed by DoD in March, 1970, to examine all categories of peacetime DoD cargo which might be eligible for transportation airlift. DoD felt that the present airlift eligibility criteria would not allow the generation of enough extra-CONUS cargo to effectively utilize the C-5 airlift fleet of the Military Airlift Command in the post 1975 period. Study considerations included, but were not limited to: (1) Readiness of peacetime forces as affected by availability of critical supply items, (2) Potential cost savings from shorter pipeline and reduced stock level requirements, (3) Most efficient use of military airlift capacity and extent of use of commercial airlift, (4) Peacetime requirements for mobility support forces, (5) DoD transportation costs, (6) Retrograde versus outbound traffic and (7) Impact on Military Sealift Transportation Service (MSTS). (37:15) Although this study was directed primarily at extra-CONUS cargo the methodology and analysis techniques provided a sound basis for our study.

Another key reference was the Research Analysis Corporation report, "Selection of Items for Air Shipment on an Economic Basis." This study published in January, 1971, developed formulas for use in determining whether Army cargo should be shipped by air or surface. These formulas could be applied to intra-CONUS as well as intercontinental shipments. This study provided current data on air versus surface transportation costs as well as formulas for determining stock levels and negotiating rates. (10:87)

The thesis, "Department of Defense CONUS Logistics Airlift: A Comparative Analysis of Two Alternative Methods of Operation," by Niese and Winfield, provided an excellent description and breakout of the contract costs of the airframes utilized by the current LOGAIR contractors. Reinforcement data in this area is also readily available within the Directorate of Transportation, Hq AFLC.

Scope

It was necessary to define the scope of the thesis and insure that the subject area could be treated accordingly within the time constraints of the logistics graduate program. This study dealt only with that cargo moving within the borders of the continental United States. Although a portion of this cargo may be ultimately destined for an extra-CONUS location, this limitation was imposed to insure that the only mode of transportation available to the cargo shipper was that originating and terminating within the CONUS. Since the Military Airlift Command is prohibited from moving cargo within the CONUS this criteria eliminated their involvement from this study.

An additional limitation was the exclusion of non-USAF cargo. A small percentage of the cargo moved on LOGAIR belongs to other governmental agencies and in particular the Navy. The Navy operates a logistical airlift system called "Quick Trans" which interchanges with LOGAIR. The purpose of this study was to analyze the movement patterns of Air Force cargo only.

Several detailed studies have been conducted concerning cargo eligibility. The purpose of these studies was to critically examine the present eligibility criteria for airlift of cargo in an attempt to make more cargo available to the airlift system. Some of these reports will attract more attention as the Military Airlift Command participation in the Vietnam effort scales down. Revision of the present airlift eligibility criteria appears the most feasible method of assuring economical payloads for the peacetime C-5 fleet. (37:iii) However, because of the depth and breadth of the air cargo eligibility subject area, it was decided to conduct our research, accepting the present airlift eligibility criteria as fixed.

The final consideration concerns the number and location of the present LOGAIR system users. The study recommendations were based on the premise that all points now served by LOGAIR will remain. In order to control data collection, only cargo destined for on-line LOGAIR stations was measured.

Objectives

1. To identify any air eligible cargo which was moved by other than the AFLC logistical airlift system.

2. To determine the cost effectiveness of shipping all air eligible cargo via the AFLC logistical airlift system.

Hypothesis

The hypothesis tested was that the shipment of air eligible cargo by surface modes of transportation is not as cost effective as the use of the AFLC logistical airlift system.

CHAPTER II

THE PRESENT SYSTEM

Introduction

One of the key elements of a successful logistical system is the efficient movement of materiel from origin to destination within a required time frame. Transportation performs this vital function in order to assure the strategic location and relocation of defense materiels. The Air Force logistician must select from the transport resources available to him, at any given point in time, the conveyance which best assures support of strategic, tactical, and logistical goals.

Almost without exception, every item of material entering the defense transportation system is the result of a supply requisition. This requisition represents some military consumer's demand levied against the supply system. The consumer's urgency of need for the item is also part of the requisition. The supply system translates the urgency of need into a supply priority, fills the requisition, and in turn delivers the item to a transportation agency for shipment planning, preparation, and movement. The transportation agency translates the supply priority into a transportation priority. Using the transportation priority and descriptive information of the item to be shipped, the traffic manager selects the most appropriate transportation mode to insure arrival of the item at the designated destination within the specified time limits. Regardless of size, weight, or quantity, the sequence of steps just described must be followed.

The transportation agency, in selecting the mode of transport, chooses from either commercially owned or leased conveyances of military owned or leased conveyances. In order to build a strong civil transport system, the government has actively discouraged, and in most cases prohibited, the movement of materiel within the United States on government owned conveyances in competition with civilian commercial carriers. Thus, the Department of Defense, almost entirely, buys its intra-CONUS transportation services from private enterprise.

Those shipments which impose very short delivery times on the supplier require special attention and care to preclude unnecessary delay. These shipments will be moved on an expedited mode, most commonly airlift. The AFLC logistical airlift system (LOGAIR) was established to meet this need within the U. S. Air Force.

LOGAIR provides daily support for Air Force first-line weapons systems to bases within the CONUS, as well as to all major Aerial Ports of Embarkation (APOE), from all of the Air Materiel Areas. LOGAIR is a logistical airlift system which links all users with their prime and secondary AMAs. This is not only a free resource to the user, but it assures that his shipment will remain within the control of the defense transportation system from origin to destination.

The LOGAIR Budget

The Air Force Logistics Command is responsible for planning, coordinating, and directing the operation of the LOGAIR system. In this role, it must develop the annual Air Force CONUS logistical airlift requirements, route structures, and route schedules. To assist AFLC in developing these airlift requirements, each user station is required yearly to submit its own annual LOGAIR cargo needs. This annual forecast is forwarded to the parent major air command for review, validation, consolidation with other requirements from the command, and transmittal on to AFLC. The authors have observed that the user requirements are based upon the previous year's performance alone, very often without adjustment for forthcoming changes in mission. At the same time the review at the parent major air command tends to be superficial in nature.

The Air Force Logistics Command translates the user forecasts into route requirements, numbers of aircraft, and finally into an airlift plan. The airlift plan, covering the requirements for the entire LOG-AIR system, is then submitted to Hq USAF for approval. Lengthy justification is required as previously stated for any increases over and above the previous year's submission.

By way of contrast, the financial plan for surface transportation begins its development at each transportation agency throughout the Air Force. Normally, it is computed by the same individuals who prepare the LOGAIR requirements. The surface plan is forwarded to the parent major air command where it is consolidated with the surface requirements from the other bases within the command and then submitted directly to Hq USAF. It is at this point that the primary difference between the LOGAIR and surface requirements appears. The LOGAIR requirements are consolidated at Hq AFLC, the single point of responsibility for the LOGAIR system, for all commands and submitted to Hq USAF as a single package. The surface requirements are submitted to Hq USAF separately by each major air command. There is no single point of responsibility for the review and evaluation of the entire surface requirement.

Transportation requirements submitted by Hq AFLC include both the entire LOGAIR requirement and the surface requirement for AFLC funded shipments. A representation of the air and surface requirements submissions are shown in figure 1. The approved financial plan received at Hq AFLC from Hq USAF includes both the LOGAIR and AFLC funded surface shipments. This dollar value can be divided between air and surface as AFLC sees fit.

Hq USAF receives the total transportation requirements from each major air command. Again, normal justification is required for

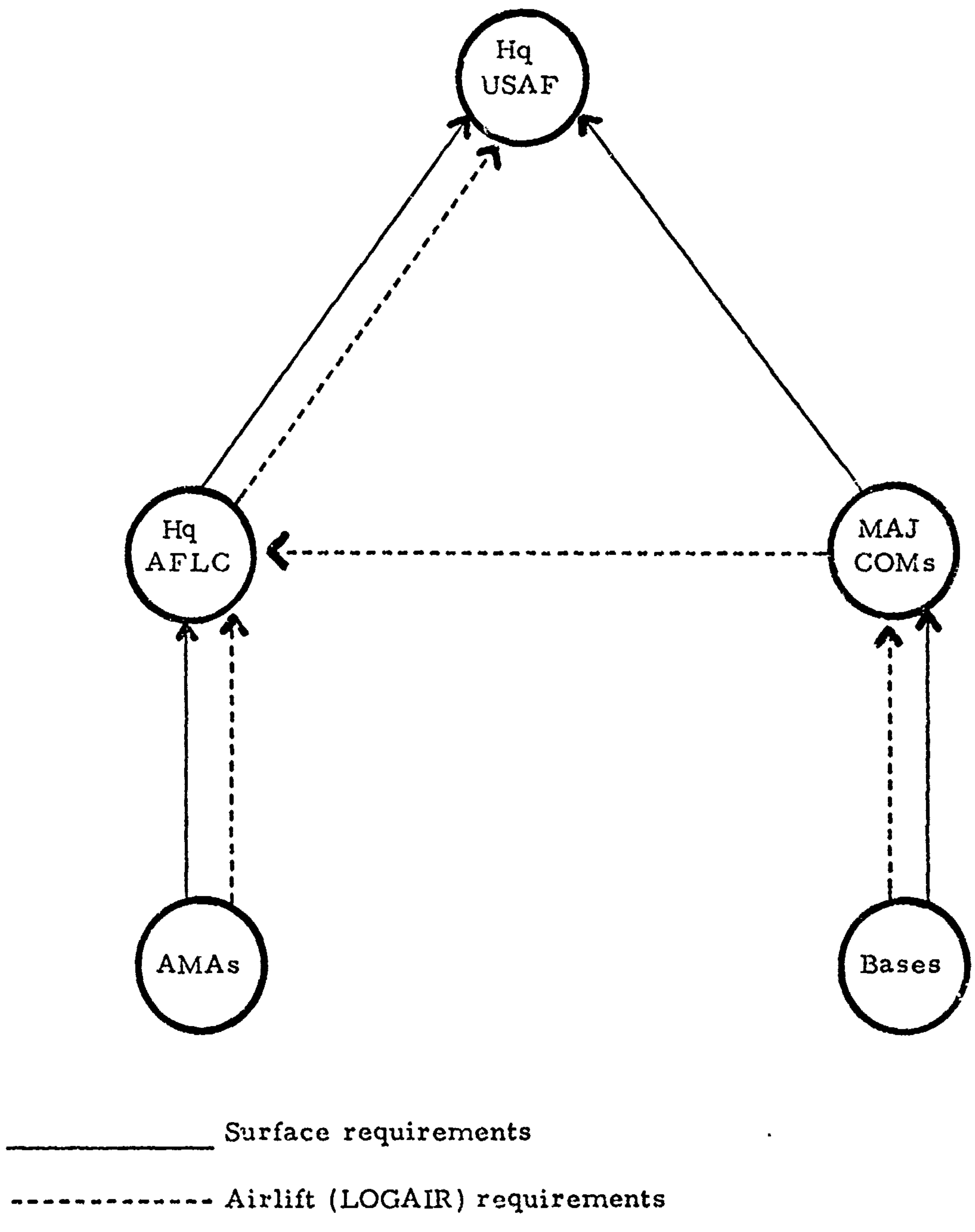

Fig. 1.--Submission of Transportation Requirements for Final Approval at Hq USAF

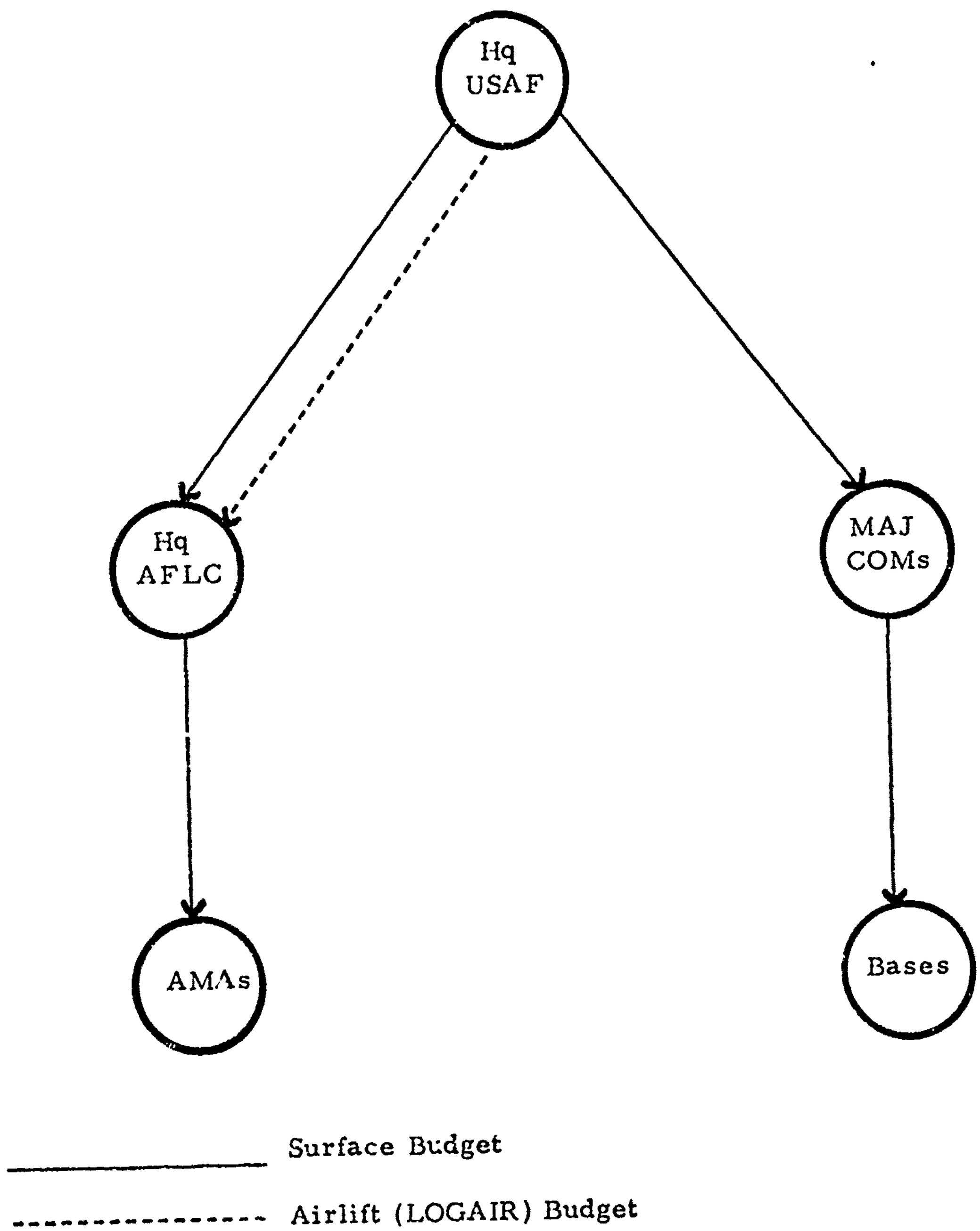

Fig. 2.--Distribution of Approved
Transportation Budgets

each element. As with the major air command, Hq USAF requires lengthy justification for any increases over and above last year's budget. There is no review made, however, questioning the division of requirements between surface and air modes.

LOGAIR Routes

Upon receipt of an approved airlift program, AFLC adjusts its proposed routings to remain with the approved funding. At the present time there are eighteen scheduled LOGAIR flights serving 61 on-line stations and approximately 560 off-line locations. An on-line station is one that receives direct LOGAIR service and is responsible for loading and off loading the aircraft. Off-line locations must deliver their cargo to and pick up cargo from an on-line station in order to utilize LOGAIR service. In addition to several Air Force bases, off-line stations include other services, reserve and ANG units, contractors, and other governmental agencies. Any shipper utilizing LOGAIR, other than an Air Force shipper must reimburse AFLC for the cost of the shipment.

AFLC prepares tentative routings based upon stated user requirements and policy direction from the Department of Defense and Hq USAF. These include annual tonnages by destination. Using these criteria, AFLC can determine the direction each route must run and the size of the airlift capability which must be applied to each route.

Each LOGAIR station receives one flight per day in accordance with current Department of Defense policy. These flights, called feeder flights, originate and terminate from one of six primary terminal locations. Other flights, called transcon flights, interconnect each of the terminal locations. The primary terminals are located at Wright-Patterson AFB, Ohio, and each of the Air Materiel Areas. In addition to their function as cargo generation points, the AMAs serve as holding areas for cargo changing from one flight to another. The primary terminal points are not limited in the number of flights transiting their station and therefore may handle ten to twelve flights in one day.

The type of aircraft selected for each type of route is carefully considered by the AFLC LOGAIR contract monitors in order to achieve maximum cargo movement at the least cost per ton-mile. All feeder flights, with one exception, are serviced by the L-188 Electra which is particularly adapted to short leg, multiple stop routes.

The transcon routes are serviced by three different types of turbojet aircraft. These aircraft must accommodate three types of cargo routes: (1) long range high cargo density, (2) long range medium cargo density, and (3) short range medium cargo density. The long range high density routes are those which run from one or more APOEs on the east coast, through the AMAs, and to one or more APOEs on the west coast, and return. These high volume routes are serviced by L-100-30 turboprop aircraft carrying a payload of 46,000 pounds. The long range medium density loads are handled by the DC-9 jet aircraft which has a 34,000 pound payload. The DC-9 is utilized on one feeder flight, however, for the most part it is ideally suited for its role in shuttling cargo between the AMAs. In addition to its utilization as a feeder flight aircraft, the L-188 turboprop carries cargo on short range routes between AMAs. These inter-AMA routes normally include stops at user stations which cannot be economically integrated into a feeder flight network.

Cargo Flow

Inasmuch as this study traces the movement of transportation priority 1 and 2 cargo from the AMAs to the on-line LOGAIR stations it is necessary at this point to discuss cargo generation and shipment planning of cargo offered to the AMA traffic manager for movement. The AMAs are referred to as the cargo generation points of the LOGAIR system. This is somewhat misleading since a portion of the cargo departing from each of the AMAs does arrive there from other origins for onward movement. No matter where the origin of the cargo, the traffic manager must exercise the same judgment in selecting the most economical transportation mode which meets the time constraints of the shipper. The shipment planning procedure for mode selection is not too difficult and can be boiled down to a few simple questions: (1) What is the required delivery date to the destination? (2) What mode is available which will meet the delivery date requirements? and (3) Is the cargo compatible to that mode of transport? Even with the straightforward mode selection process exceptions have occurred.

Diversion of Cargo to Surface Transportation

Most of the time the shipment planner will elect to ship air eligible cargo having a transportation priority 1 or 2 via LOGAIR. However, two primary considerations will cause him to divert to another mode. The first is that the destination is located in close proximity to the origin, i.e. McClellan and Travis, McClellan and Castle, Tinker and Altus, etc. In these cases the intransit time is normally reduced by utilizing a surface mode.

The second condition is the limitation of the capability of the LOGAIR system itself. Other than budgetary limitations, there is no restriction on the number of flights between AMAs. However, as previously stated, the Department of Defense has directed that no more than one flight per day will be made in and out of any user station. The only exception is at Grand Forks to facilitate the exchange of high value missile guidance and control units between Flight 25 and Flight 47. The Department of Defense restriction therefore limits the daily outbound airlift capability of each AMA terminal manager to the allowable cabin load of the feeder route aircraft.

With the daily outbound capability relatively fixed, the terminal manager focuses his attention primarily on the backlog of his terminal awaiting airlift.

Normally the shipment planner is not aware of the day to day capability of the logistical airlift system and therefore routes all air eligible cargo, not rejected by the distance criteria, into the LOGAIR system. The input into each AMA terminal is controlled by an airlift clearance authority who screens all cargo offered for airlift to insure all air eligibility requirements are met.

A further responsibility of the airlift clearance authority is to regulate the flow of cargo into the air terminal at a rate in consonance with the outbound capability of the LOGAIR system. The logic being that surface transportation will deliver the materiel to destination in less time than the combination of air terminal hold time and airlift intransit time. The lack of LOGAIR capability is then shown to be a major factor in the shipment of transportation priority 1 and 2 cargo by surface modes.

Another important cause of diversion of air eligible to surface modes is the fluctuation of the air terminal backlog. The air clearance authority uses the current air terminal backlog inventory to determine the amount of new cargo he should allow to enter the air terminal. The air clearance authority is aware of the daily outbound capability of the LOGAIR system at his particular location and can calculate an estimated backlog position at the end of each day's operation. However, the amount of intransit cargo which will arrive each day is not controllable by the air clearance authority.

The air clearance authority usually grants shippers a two to three day time frame in which to deliver their cargo to the air terminal. Thus, the total air terminal backlog can easily fluctuate over or under the target level. The effectiveness of an air terminal manager is a function of his ability to move cargo within established time frames. Therefore, in cases of high air terminal backlog, the terminal manager is compelled to divert a portion to surface modes to avoid an unfavorable low cargo turn-over rate.

The contract monitor at AFLC is aware of these conditions but is extremely limited in capability to resolve them. His airlift budget contains a small amount of funding, over and above the contract costs, with which he can purchase additional flights from the contractors. A portion of this money is used for the movement of excess backlog at the AMAs, however the amount is negligible.

Surface Transportation

At this point a discussion of the nature of the surface modes must be injected. When the term "surface mode" is used in this paper, the authors are generally referring to less-than-truckload motor freight. However, the term also includes less-than-carload rail movement as well. The amount of rail movement tends to be very small in relation to truck shipment.

Shipment of cargo by surface modes is characterized by selection of the appropriate carrier serving the desired destination, preparation of the Government Bill of Lading, and notification of the carrier of the availability of the cargo. Surface modes are not too unlike the LOGAIR system in that certain destinations can be reached by direct service from the origin. Other destinations must be reached by transfer from one unit of conveyance to another through one or more terminals or transfer points.

The primary difference between surface modes and LOGAIR lies in the intransit time required for each and the degree of control exercised over the shipment. It should be expected that almost all destinations are reached in less time by air than by surface. Likewise, the Air Force will tend to exercise better control over its own cargo than would someone else. As previously mentioned Air Force terminal managers tend to be penalized for delay of cargo while civilian carriers do not feel this same pressure.

Summary

The key to an effective logistical system is the efficient movement of materiel to strategic locations. The traffic manager plays an important role in providing transportation which will insure that materiel is moved within the required time frame at the most economical cost. The traffic manager must select from all available resources the mode of transport which best accomplishes this objective. In spite of the expedited transportation requirements, not enough LOGAIR capability exists to move all air eligible transportation priority 1 and 2 cargo. This insufficiency of LOGAIR capability results primarily from funds limitation and Department of Defense policy on frequency of flights, as was stated earlier. Therefore a portion of the priority shipments must be routed on surface modes. Surface modes tend to provide slower delivery times and offer less control over the shipment.

CHAPTER III

PROPOSED SYSTEM

Introduction

The high cost of aerospace systems today has forced dramatic re-evaluation of logistical support procedures. No longer can the inventory manager afford a comfortable stock level which attempts to achieve a 0% NORS rate. Instead, he is required to achieve the most effective distribution of his assets among the most urgent of his total requirements.

AFLC recognized that this task was extremely difficult and therefore began development of the Advanced Logistic System (ALS), thus transferring the complex accounting and decision making processes to a computer. The ALS system will strategically locate spares at points easily accessible to several potentially high consumers. As demands occur at these and other locations, spares are moved from the most accessible point to satisfy the requirement. The basic factor which can promote success or spell failure for ALS is the degree of response realized from the logistical transportation system. (19) The criteria upon which most tactical commanders will judge the success of

ALS is length of time required to deliver a spare which they cannot stock or do not have in stock.

Inventory and Reduced Intransit Time

The inventory manager, in striving to achieve a balance between minimum NORS rates and minimum inventory cost, must place the most emphasis on the high value items under his control. Stated another way, the inventory manager is just as concerned with cost of inventory, as with quantity of inventory. The inventory manager is also concerned with the delivery time from the AMA to the consumer.

The level of inventory maintained in a supply system and the delivery time available from the depot to the consumer are directly related with each other. For example, whenever an increase is made in transportation delivery time, an increase is required in the total investment in inventory. As will be shown in Chapter V, a small change in transportation delivery time results in a large change in inventory costs. Because of the close relationship between transit time and inventory levels, it would suggest that eligibility of cargo for movement on premium transportation modes should somehow be related to value of the cargo.

Cargo Eligibility

Cargo eligibility criteria for airlift of cargo is based almost entirely on required delivery time. A more realistic approach is shown in figure 3 where shipments requiring delivery within less than a specified number of days and/or valued at more than a specified cost, would qualify for movement by air. Exceptions would occur for outsized and other cargo with peculiar transportation requirements.

Using this air cargo eligibility criteria the traffic manager would require two key pieces of information in order to make this decision. The first would be the required delivery date, automatically provided to him by the supply requisition priority translated into a transportation priority. The second would be a coding which would designate all items whose value exceeds a specified amount. This information would automatically tell the traffic manager that the item should be moved by air unless size or weight dictate otherwise.

The final cost analysis of cargo shipment by air versus surface modes entails examination of other costs as well. They include the cost of documentation, cost of packaging, cost of damage and loss, and the linehaul cost. All of these factors will be evaluated in greater detail in Chapter V.

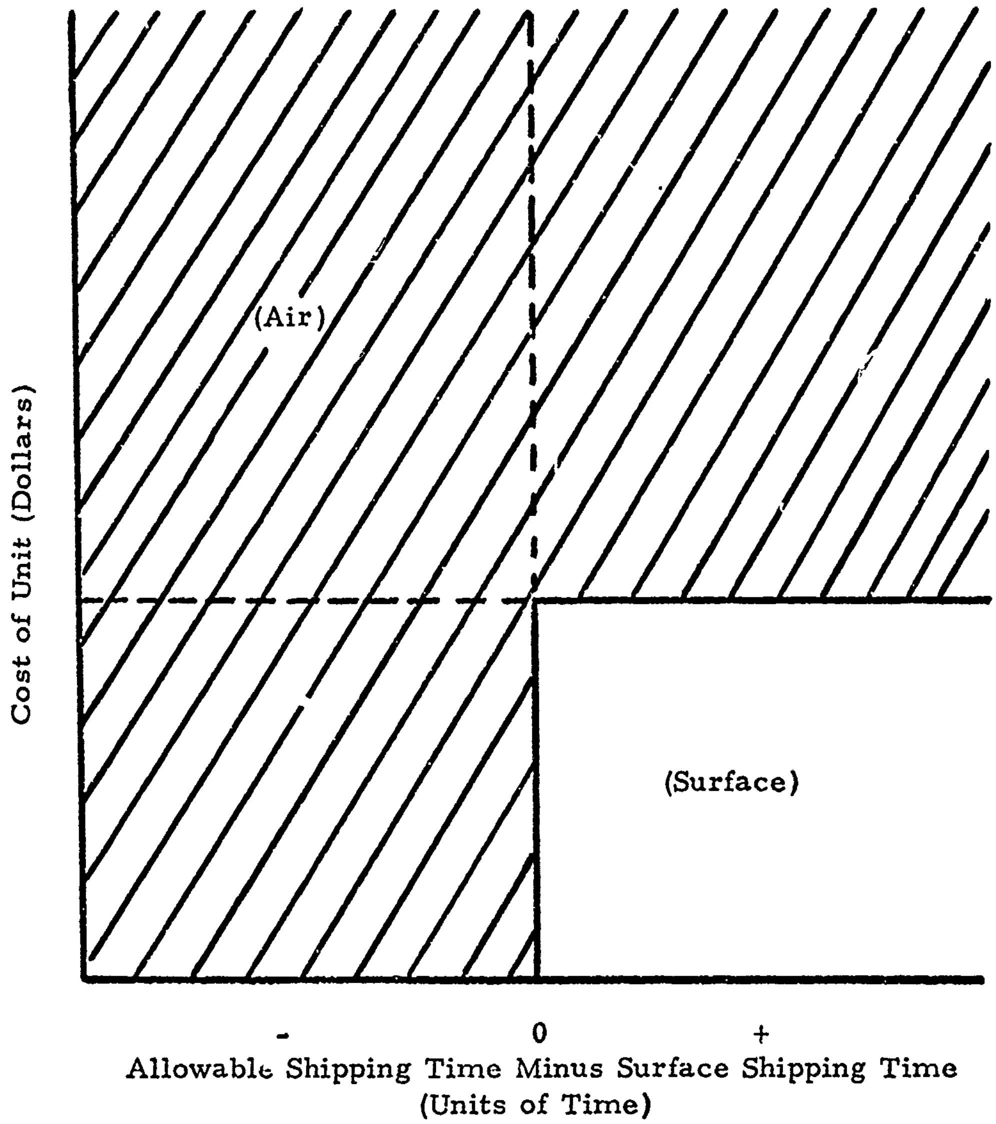

Fig. 3.--Proposed Airlift Eligibility Criteria

NOTE: The above figure illustrates a decision chart that could be used by a shipment planner to select either an air or surface mode of transport. In order to use the chart the shipment planner would first refer to the horizontal axis for Allowable Shipping Time Minus Surface Shipping Time (Units of Time). He should subtract the standard surface shipping time from the allowable shipping time. If the result is positive, the tentative decision lies to the right of the "0" point. If negative, the tentative decision lies to the left of the "0" point. A negative result indicates that the surface mode will fail to satisfy the requirement. If the result was positive, the shipment planner moves to the vertical axis for Cost of Unit (Dollars) and determines if the item unit costs falls above or below the cost level C_1. If it falls below the final decision is to ship via a surface mode. In all other cases LOGAIR should be utilized to move the shipment.

The Proposed System

The traffic manager should select that mode of transportation which insures delivery within the established time frame and at the lowest overall cost. The purpose of this paper was to evaluate the total cost of shipment of air eligible cargo by air versus the total cost by surface modes. The authors feel that the results of this study (as brought out in Chapter V and VI) show that air shipment of priority 1 and 2 cargo is generally more economical than the same shipment by surface. Hence, it is their proposal that the LOGAIR system be expanded to include all air eligible (transportation priority 1 and 2) cargo.

The increase in cargo movement within the LOGAIR system would take two forms. The first would be an overall increase in daily tonnages spread rather uniformly across the entire system. This increase would simply be resolved by an incremental increase in airlift capability across the system either through larger aircraft or increased numbers of aircraft. The second would be the periodic highs of cargo generation occurring both across the system and at individual stations within the system. This airlift requirement must be approached by the periodic purchase of additional airlift or "extra sections" to meet the fluctuating demands. See figure 4.

AFLC Management of Second Destination Transportation

AFLC is charged with funding responsibility for all Air Force shipments from their AMAs to any location within the world. Each agency within AFLC has attempted to optimalize its function as much as possible within its own sphere of influence. For example, the Transportation Directorate, Hq AFLC, in putting together its budget has sought to organize and distribute budget needs on the basis of past experience. Likewise, inventory management has attempted to decrease capital investment through reduced stock levels. Yet these two programs have been sub-optimalized when viewed in toto. Chapter V shows that a relatively small investment in faster transportation services yields large returns in reduced stock levels. This inventory savings should be used to finance the increase in airlift procurement.

In order to efficiently manage the total cargo movement, the AFLC transportation function must possess greater budgetary flexibility. First the basic surface and air budgets must accurately reflect the total cost to move all air eligible cargo by air and the remainder by surface.

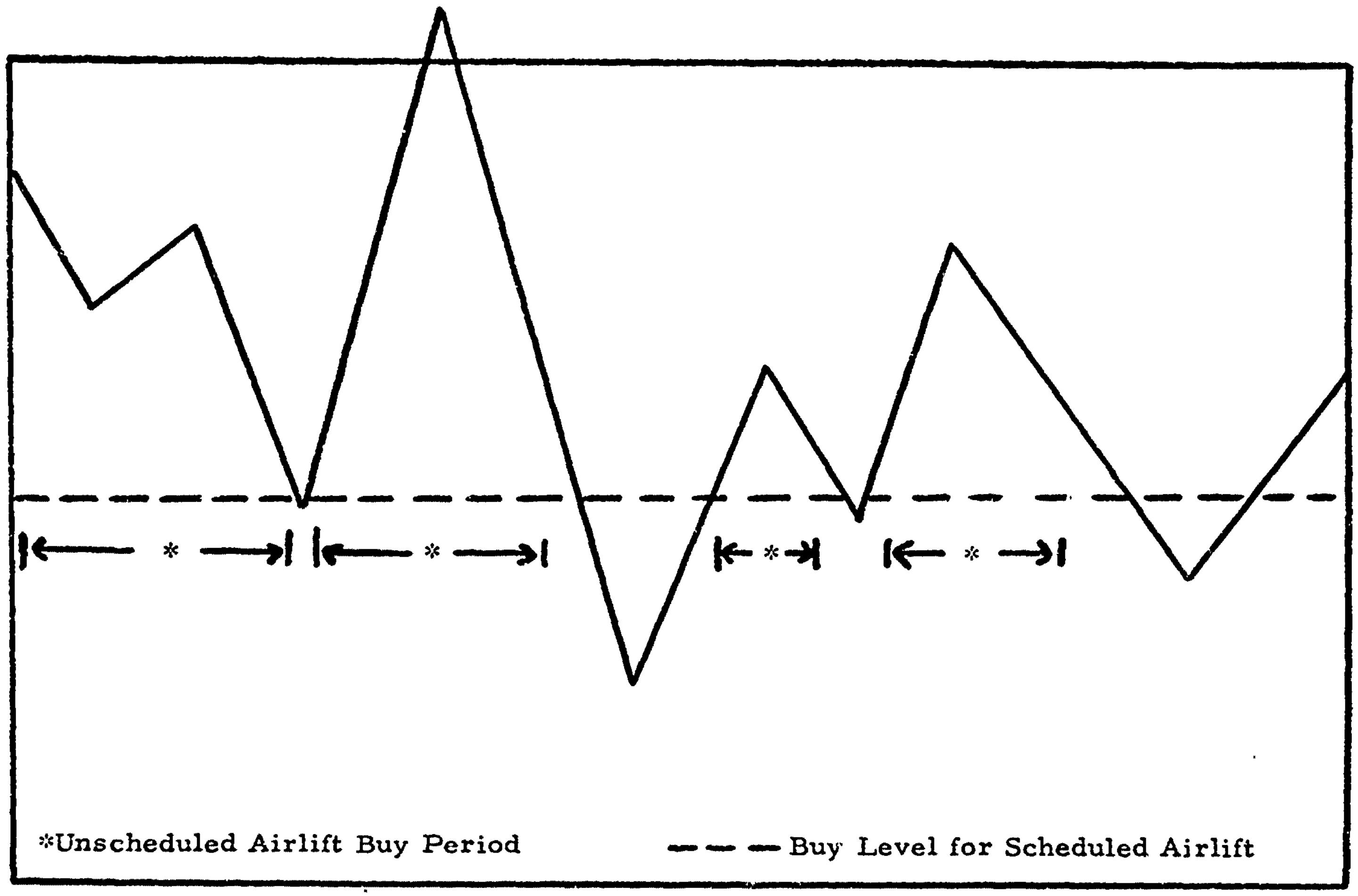

Fig. 4.--Portrayal of Annual Cargo Generation

Second, the air budget must contain two categories of funds. One will be a lump sum to fund the annual LOGAIR contracts for the scheduled movement of a set amount of cargo. This portion will be no different than the present procedure, other than the amount will be slightly larger to accomm date the increased amount of cargo to be airlifted. The other category is a lump sum of uncommitted funds which will be used to purchase additional flights from the contractors during periods of increased cargo generation.

Additional airlift will need to be purchased to augment routes generating slightly more than the daily capability, but not justifying an additional daily flight. It is anticipated that periodically the air clearance authority will be contacted by a shipper to move a quantity of air eligible cargo large enough to significantly impact the air terminal backlog. Prior to accepting the cargo for airlift, the air clearance authority will contact the Hq AFLC LOGAIR monitor for approval. This approval would be contingent upon availability of funds for additional flights.

Summary

Airlift is an important asset to the inventory manager in providing greater flexibility in the deployment of his assets. The success of the forthcoming Advanced Logistical System is dependent upon reliable, expeditious airlift. A strong relationship can be shown between the level of the spares inventory and the intransit time from supplier to consumer. Hence, a valid case is made for revision of the air eligibility criteria to include provisions for the value of the cargo. Additional LOGAIR capability can be provided by simply contracting for larger aircraft or an increased number of flights. In order to manage effectively the proposed LOGAIR system, AFLC will require funding for both scheduled and unscheduled airlift. The net result of the proposed system will be a smoother and faster flow of cargo.

CHAPTER IV

METHODOLOGY IN ANALYZING THE PRESENT SYSTEM

Nature and Sources of Data

In the previous chapter a proposal has been made in general terms to modify existing procedures in the LOGAIR system. This proposal has been made with the objective of reducing the total cost of transportation. This chapter outlines the methodology involved. Chapter V contains the detailed cost analysis of this proposal.

The data used to test the hypothesis came from several sources. The information on the quantity of air eligible cargo diverted to surface modes of transportation and the destination of the diverted cargo was extracted from the RCS: Log J-51, Transportation Summary Report, provided by Hq AFLC. The surface linehaul costs for both motor and rail shipments were extracted from the RCS: DD-I&L (Q) 493, MTMTS Progress Report, provided by Hq Military Traffic Management and Terminal Service (MTMTS). The cost that would have been incurred had the air eligible cargo actually moved on LOGAIR was provided by Hq AFLC. These costs represent the apparent or obvious costs of transportation. However, to reflect accurately the true cost of cargo shipment, it was necessary to develop the total cost for each mode of transportation. This included other costs which relate directly to the mode of shipment selected but which are normally charged to overhead. Documentation costs, packaging costs, damage and loss costs, air terminal handling costs, and inventory investment costs are examples. The prime sources for this information were air cargo eligibility studies conducted by various Department of Defense and civilian agencies.

The policies and procedures pertaining to identification of air cargo, mode selection, and operation of the LOGAIR system were obtained from Department of Defense and Air Force instructions and regulations. The entire effort was supplemented and integrated by personal and telephone interviews with staff personnel at Hq USAF, Hq MTMTS, and Hq AFLC.

Data Collection Techniques

The first major task of this study addressed the problem of verifying that air eligible cargo was being diverted from the logistical airlift system to surface modes of transportation and if so, of finding out how much cargo was being diverted. The amount of diverted cargo indicated the extent to which the LOGAIR system was failing to accommodate the actual cargo requirement. Data showing the ultimate mode and destination of the diverted cargo was extracted from the monthly

Transportation Summary Report, RCS: J-51, and is shown in Appendix A and summarized in Tables 1 and 2. This report, submitted by the AMAs to Hq AFLC, lists the tons of cargo handled at each air terminal. It also includes the weight of the cargo which the air terminal manager diverted from air to surface modes of transportation during the month.

Data was next required to compare the cost of the surface mode utilized versus the cost to the Air Force if the cargo had remained in the LOGAIR system. The cost factor for movement by LOGAIR was based on the ton mile cost of the fiscal year 1972 contract. The cost for fiscal year 1972 was $.142 per ton mile for L-100 aircraft, $.144 per ton mile for DC-9 aircraft, and $.163 per ton mile for L-188 aircraft. This information was obtained from the Hq AFLC FY73 LOGAIR Program briefing given to Hq USAF in March, 1972 from Hq Military Traffic Management and Terminal Service. The linehaul costs for the surface modes were obtained by reference to previous shipments. The primary surface mode utilized was truck. The average less-than-truckload-lot rate was found to be $.11 per ton mile for FY71 and $.124 per ton mile for FY72.

The primary advantage of contract air mode transportation lies in its advantage of faster response or shortened intransit time. A trade-off against the air time advantage is its inherent disadvantage of greater direct linehaul costs. The cost of documentation, cost of packaging, cost of damage and loss, and cost of intransit inventory

TABLE 1

TONS OF AIR ELIGIBLE CARGO DIVERTED TO SURFACE MODES OF TRANSPORTATION DURING THE PERIOD JULY 1, 1970 THROUGH JUNE 30, 1971

Depot	Tons Diverted	% of Total Air Eligible Cargo Handled
McClellan	1270.7	12%
Hill	1334.7	5%
Oklahoma City	5504.9	23%
Kelly	4530.9	19%
Warner Robins	1828.4	7%
Total	14,469.6	12%

TABLE 2

TONS OF AIR ELIGIBLE CARGO DIVERTED TO SURFACE MODES OF TRANSPORTATION DURING THE PERIOD JULY 1, 1971 THROUGH JUNE 30, 1972

Depot	Tons Diverted	% of Total Air Eligible Cargo Handled
McClellan	2348.9	17%
Hill	1399.0	6%
Oklahoma City	5582.4	25%
Kelly	3309.8	15%
Warner Robins	1333.9	6%
Total	13,974.0	13%

reflect those factors which tend to offset the higher air rates. The costs of each of these categories were developed through correlation of data from studies conducted for the Army and the Air Force on air cargo eligibility.

Data and Analysis

The validity of the hypothesis was tested by comparing the empirical data collected during the course of the research. Each category of cost was summarized for the surface and air modes for comparison of the most effective method of s' ipping air eligible cargo.

The surface transportation costs are the result of direct compu· tation involving the cost per weight carried and distance transported. With the linehaul costs so structured, transportation cost is the product of weight, in tons, times distance, in miles, times cost, in ton miles. The data dealt with movement from each AFLC depot to CONUS LOGAIR destinations.

The cost of shipment on LOGAIR was formulated from fiscal year 1972 LOGAIR system per ton mile costs and the weight of the diverted cargo. The air cost then became the weight, in tons, times the ton mile cost. At this point in the calculations the linehaul costs for LOGAIR exceeded the linehaul costs for the surface modes. The formulas used for calculating the linehaul costs are as follows:

L_A = The linehaul cost of shipment by air

L_S = The linehaul cost of shipment by surface

W = The weight of the shipment in tons

D = The distance of the shipment in miles

R = The average cost per ton mile for the mode used

$$L_A = W \times D \times R$$

$$L_S = W \times D \times R$$

The differential cost of packaging results from the quantity of labor and materials used to protect the cargo during shipment. Such factors as Air Force packaging specifications, fragility, sensitivity to spoilage, and intransit handling dictate the end cost of packaging and preservation. The previous studies mentioned on pages 7 and 8, established a seventy per cent increase in packaging costs for surface shipment over air shipment. The recent studies show only a thirty per cent increase in surface costs for packaging. This improvement can be attributed to advances in packaging technology and the increase in usage of containers for protection of shipments.

The actual cargo intransit time for air eligible cargo shipped by surface modes was obtained from an AFLC one-time report prepared by McClellan AFB. This report had been extracted from the RCS: 12-LOG-S366, Shipment Off Shelf Summary by AMA report which evaluates the shipping time differential between surface and air modes. The S366 report is a monthly summary of all off the shelf shipments from each AMA to all bases. Data is subdivided into mode, priority, and intransit time. This information was correlated against similar data published in recent air cargo eligibility studies to determine the accuracy of the study data. A 1970 Research Analysis Corporation paper established three day average savings in use of the air mode over surface modes. (10:109) The McClellan report showed as an average a savings of 4.9 days by using air over surface. (48)

Although the government is a self-insurer, loss and damage does represent a real expense. Research Analysis Corporation indicated the \$.10 per \$100.00 commodity value should be allowed for loss and damage when shipping by air. The cost of loss and damage for overload surface transportation is set at \$1.00 per \$100.00 in commodity value. As previously mentioned, commodity value was established at \$1.50 per pound. (1:76) Formulas for damage and loss were as follows:

W = The weight of the shipment in tons

D_A = The value of damage and loss per air shipment

D_S = The value of damage and loss per surface shipment

$$D_A = 0.001 \times 1.50 \times 2000 \times W$$

$$D_S = 0.01 \times 1.50 \times 2000 \times W$$

The documentation cost differential is based on the complexity in documenting surface shipments versus air shipments. The Government Bill of Lading, prepared on all surface shipments, involves considerable time in preparation, distribution, and handling. These costs were found to be from \$7.50 to \$27.00 per surface shipment. The documentation for shipment by air involves only a Transportation Control Movement Document and a manifest and costs approximately \$1.00 per shipment.

Air terminal handling costs, which are normally a part of the surface linehaul cost, are an additional expense in the LOGAIR system. Included in this cost is the expense of loading, offloading, and handling of cargo.

The following formula provided the method for determining whether the air mode or the surface mode should be utilized for a particular shipment.

Total Cost = Linehaul Cost + Documentation Cost + Damage and Loss Cost + Packaging Cost + Inventory Cost + Air Terminal Handling Cost (for Air).

The total costs for each mode were computed and compared for the most economical method.

CHAPTER V

COST ANALYSIS

Introduction

The economic analysis of a large scale operation seeks to identify the point of maximum return for any given resource input. (3:319) To achieve true optimality it is necessary to examine all costs directly related to the operation under study. It is the opinion of the authors that, far too often, within the overall logistics environment, individual managers tend to evaluate costs only within their own narrow responsibility. This study attempts to capture and compare the total costs of shipping air eligible cargo via LOGAIR and by surface modes of transportation.

The Components of Total Cost

When one compares the costs of alternative modes of transportation, he must consider the ancillary costs along with the linehaul costs of each mode. As pointed out earlier, the components of total cost that have been previously described and that are evaluated in this chapter are:

1. The actual linehaul cost of shipment.
2. Packaging costs.
3. Documentation costs.
4. Damage and loss costs.
5. Air terminal handling costs.
6. Inventory and intransit pipeline costs.

The linehaul cost is the tariff rate for movement of a shipment from point to point by a specific mode of transport. Linehaul costs are applied either at the truckload or less-than-truckload rate. In our analysis most of the cargo moved was costed at the less-than-truckload rate. All large shipments, however, were costed at the lower truckload rate. The same procedure was followed for rail shipments. In collecting both truck and rail movement data, any shipment which appeared outsized to the logistical airlift capability was eliminated from the study. A conscious attempt was made during this study to resolve questionable areas in favor of the surface modes of transportation.

As shown in Chapter IV linehaul cost is computed by multiplying the distance from the origin of the destination, in miles, times the weight of the shipment, in tons, to get the ton-mile quantity and then multiplying this quantity times the ton-mile cost for the mode being used. This is the obvious cost of a shipment. The linehaul cost for air transportation is normally greater than that for surface transportation for a given distance. The linehaul costs used in this study are explained in a subsequent section of this chapter.

The cost of packing and crating is another significant factor that must be considered. The two important factors of packing for shipment are (1) The shipment must be protected from the hazards of the voyage. Included are such things as climate, rough handling by carriers, and theft. (2) The total weight of the shipment can be increased significantly by the amount of packing required. This increase in weight due to packing has a direct bearing on the linehaul cost since the linehaul cost is based on the gross weight of the shipment. (12:450)

Although a thorough search of packaging costs was conducted, no reliable figure for the average cost of this service could be obtained. Various sources listed packaging costs for surface shipments ranging from \$1.00 to \$25.00 per 100 pounds and for air shipments from \$.75 to \$17.50 per 100 pounds. (10:180) (1:70)

The cost of documentation is the only cost being considered that does not vary in direct proportion to the weight of the shipment and the distance traversed. The cost for documentation of a shipment by LOGAIR is believed to be less than the cost of documentation for a surface shipment.

Since the government is a self-insurer, the cost of damaged and lost goods represents an expense. For air shipments the damage and loss value is computed as \$.10 to \$.20 per \$100 in commodity value of the goods being shipped. For surface shipments the value of the lost and damaged goods is estimated as varying between \$1 and \$1.75 per

$100 in commodity value. (1:72)

The intransit, or pipeline, inventory consists of the cargo in any stage of transportation from the time it leaves the source of supply to the time it arrives at its destination. This study is focusing in on material leaving an AMA and destined for another LOGAIR station. Material destined for off-line bases was not included in this study. It is this pipeline inventory cost, the hidden cost of transportation, and the increase in inventory level required, that provided the significant dollar savings in air transportation as compared to surface transportation.

Data Collection from the J-51 Report

The RCS: LOG-J-51, Transportation Summary Report was the prime source of data for the quantity and destination of the cargo diverted from the LOGAIR system to surface modes of transportation. The J-51 is printed monthly from data collected at each of the five AMAs. This report summarizes all the shipments generated at the particular AMA and lists them according to their destination stock record account. For a given destination it separates the shipments first by transportation priority and then by mode of transportation used. For each mode of transportation, within a given transportation priority, it then lists the total number of pieces shipped during the month, the total weight of all shipments, the cube of all the shipments, and finally the number of requisitions satisfied by those shipments. For example, for the month of December, 1970, from Warner Robins Air Materiel Area to Wright-Patterson Air Force Base one entry read:

FB2300 1 N 132 3739 337 203

The translation is that to stock record account FB2300, Wright-Patterson AFB, there were transportation priority 1 shipments that were mode N shipments, LOGAIR. These shipments consisted of 132 pieces of cargo weighing 3739 pounds and taking up 337 cubic feet of space. These shipments satisfied 203 customer requisitions.

The shipments included in this study were those transportation priority 1 and 2 shipments that were transported by either motor or rail, and for which the destination was an on-line LOGAIR station. Shipments excluded from this study that fit into the above criteria included those between:

1. McClellan AFB to Travis AFB
2. McClellan AFB to Castle AFB
3. McClellan AFB to Vandenberg AFB
4. Tinker AFB to Altus AFB
5. Tinker AFB to Carswell AFB

The reason for the above deletions was that these shipments are only a short distance by surface modes of transportation but require several hundreds of miles of transportation by LOGAIR due to the circle routes flown by LOGAIR.

For fiscal year 1971, the collection of data consisted of summarizing the Transportation priority 1 and 2 shipments from each AMA to each LOGAIR on-line station moved by motor or by rail. The collection of this raw data for fiscal year 1971, required four man-weeks of the authors' time. The same data was collected for fiscal year 1972 with an expenditure of three man-weeks of the authors' time. Once the raw data was summarized by depot by month another summary by depot by year was made. The data by fiscal year is included in Appendix A. For the sake of brevity the total shown includes the quantity for both motor and rail shipments.

The compiling of this data, although a very tedious task, was vital to the computation of the linehaul cost of surface transportation and the estimation of the linehaul costs had the cargo been shipped by LOGAIR. It was expected that the linehaul costs for surface would be significantly lower than that for air and would be a strong argument in favor of using surface versus air transportation. As will be shown in a later section the difference in linehaul costs was not as great as expected.

Computation of Truck/Rail Linehaul Cost

As previously mentioned the quantity of transportation priority 1 and 2 shipments, and the weight of those shipments, that were transported by surface modes of transportation from the AMAs to other on-line LOGAIR stations was extracted from the J-51 report. In the next step, AFM 177-135, Official Table of Distances, was consulted to obtain the point-to-point surface mileage from each AMA to each on-line LOGAIR station. This reference is normally used to compute reimbursement to commercial carriers for transportation services rendered to the Department of Defense. The official mileage, obtained from the manual, multipled by the annual tonnage computed from the J-51 provides the annual ton-miles of cargo moved on each route.

The costs per ton-mile for truckload, less-than-truckload, carload, and less-than-carload shipments were extracted from the MTMTS Progress Report, RCS DD-I&L(Q) 493. These costs are listed in the following table:

TABLE 3

LINEHAUL RATES

	Truck-Carload	Less-than Truck/ Carload
Motor FY-1971	$.046	$.11
Motor FY-1972	.055	.124
Rail FY-1971	.034	.098
Rail FY-1972	.035	.168

These costs multiplied by the appropriate ton-mile quantities for the surface shipments resulted in the annual cost for the surface movement of the air eligible cargo diverted from the LOGAIR system. This data is summarized in Tables 4 and 5. The total linehaul cost of the diverted cargo was $1,802,802 for FY71 and $2,335,791 for FY72.

TABLE 4

THE LINEHAUL COST OF THE CARGO DIVERTED FROM AIR TO SURFACE TRANSPORTATION FROM EACH OF THE AMAs DURING THE FISCAL YEAR 1971

	Motor	Rail	
Warner-Robins	$162,081	$19,164	
Sacramento	226,547	9,331	
Hill	146,241	23,518	
Tinker	629,845	8,495	
Kelly	519,247	58,333	
Motor Subtotal			$1,683,961
Rail Subtotal			118,841
Surface Total			$1,802,802

TABLE 5

THE LINEHAUL COST OF THE CARGO DIVERTED FROM AIR TO SURFACE TRANSPORTATION FROM EACH OF THE AMAs DURING THE FISCAL YEAR 1972

	Motor	Rail	
Warner-Robins	$225,512	$ 16,824	
Sacramento	485,383	128,843	
Hill	175,643	51,511	
Tinker	714,532	9,374	
Kelly	500,069	28,099	
Motor Subtotal			$2,101,139
Rail Subtotal			234,652
Surface Total			$2,335,797

Computation of Air Linehaul Cost

The quantities of transportation priorities 1 and 2 diverted cargo calculated for the previous section were used in this section also. First they were arranged and totaled by LOGAIR route. Then the point-to-point air mileages were obtained from the LOGAIR Trip Summary which is used by AFLC to reimburse the air carriers under the LOGAIR contract. The quantities were then multiplied by the mileage to obtain the additional ton-miles per LOGAIR route. The cost of airlift was provided by Hq AFLC for the type of aircraft used on a particular route. The costs were based on the actual cost per ton mile for cargo moved by type of aircraft. They are listed in Table 6. The ton-miles of cargo multiplied by the ton-mile cost provided the total cost by LOGAIR route. By adding all of the costs for the route segments together a total cost for the movement of the diverted cargo by air was obtained. The sum of these costs is in Table 7. The total cost of moving the cargo by air was $3,066,409 for FY71 and $3,188,239 for FY72.

Packaging Costs

All of the sources consulted stated that packing for surface movement is more costly than packing for air shipment. However most of these sources were not recent and the increase in packaging technology has dramatically reduced the differential between the external protection requirement for surface and air shipments. Numerous

TABLE 6

TON-MILE COSTS FOR TRANSPORTING CARGO ON EACH OF THE AIRCRAFT USED FOR LOGAIR ROUTES

	FY-1971	FY-1972
L-100	$.142	$.142
DC-9	.144	.144
L-188	.163	.163

TABLE 7

THE INCREASE IN LOGAIR LINEHAUL COSTS FROM EACH AMA IF THE DIVERTED CARGO HAD GONE BY LOGAIR

	FY-1971	FY-19
Warner-Robins	$256,345	$394,087
Sacramento	391,889	865,345
Hill	275,585	256,292
Tinker	1,012,437	962,301
Kelly	1,130,153	710,214
Totals	$3,066,409	$3,188,239

publications based the surface packaging costs upon sealift requirements which demand a greater degree of protection than is required for surface shipments within the CONUS. This alone raised sufficient doubt as to the validity of the figures obtained for the purposes of this study. A second, and more important, consideration, is that the protection requirements for CONUS shipments of priority cargo are almost identical for surface and air shipments. For the two reasons mentioned the authors believe that there is no real difference in the costs of packaging the diverted cargo and the costs of packaging the cargo that actually moved by LOGAIR. Therefore, no packaging costs are used in the final determination of the most economical mode of transportation.

Computation of the Documentation Costs

Of all of the previous studies consulted only two attempted to place a cost on the documentation for air and surface shipments. (1:71) (5:66) Similarly to packaging costs, the sources consulted agreed that it was considerably more expensive to document a surface shipment than to document an air shipment. For a shipment by air the only documentation required is the Transportation Movement Control Document and the air manifest. One copy of each of these documents is forwarded with the shipment and the remainder are filed at the origin air terminal. For shipment by surface, a Government Bill of Lading (GBL) is prepared and a fund citation added thereto. Copies of the

GBL are forwarded to MTMTS for quality control action, to the carrier, and to the Army Finance Center for payment. It is these actions which add to the cost of surface documentation. The only costs referenced in other studies were $1.00 for air shipments and $7.50 to $27.00 for surface shipments. (1:71) Informal telephone conversations with Hq USAF and Hq MTMTS led the authors to believe that neither cost could be accurately determined. For this reason, even though it would have added to the proof of the hypothesis, the authors decided to ignore the differential in documentation costs.

Computation of Damage and Loss Costs

The loss of destruction of material in the pipeline is an actual expense to the government. The usual way of expressing the amount of loss is as a percentage of the commodity value of the total quantity of goods shipped. Since all of the computations used in this study have dealt with the weight of goods shipped it was necessary to find a conversion factor to obtain the value of the items shipped. The only figure available was that general cargo is valued at $1.50 per pound. (1:76)

To compute the value of the diverted cargo the authors multiplied the tons of diverted cargo by 2000 to get the pounds of cargo diverted. This quantity, 28,939,200 for FY71 and 27,948,000 for FY72, was then multiplied by $1.50, the value of cargo per pound, to obtain $43,408,800 for FY71 and $41,922,000 for FY72 as the value of the diverted cargo.

The loss rate for air shipments is $.10 per $100.00 in commodity value and that for surface shipments the figure is $1.00 per $100.00 in commodity value. Changing these figures to 1% for surface and .1% for air shipments and multiplying each percent by the value of the diverted cargo resulted in $434,088 for FY71 and $19,220 for FY72 as the damage and loss costs for surface and $43,409 for FY71 and $41,922 for FY72 for damage and loss for air shipments.

Computation of Air Terminal Handling Costs

Terminal handling costs are those costs associated with the loading, off-loading, and handling of cargo. These costs are normally included in the linehaul charges of the particular transportation mode. However, in the LOGAIR system the contractor provides only actual airlift service and the Air Force performs the ground handling functions. Inasmuch as this study proposes movement of a quantity of cargo over and above the normal LOGAIR program, an air terminal handling charge must be added to the LOGAIR cost. The Army study cites a MAC charge of $29.50 per ton for terminal handling. This figure is in agreement with the Logistics Management Study, hence was used for the computation. (10:117) (37:3-18) This cc . would total to $426,853 for FY71 and $412,233 for FY72.

Inventory

An investment in inventory is required to insure prompt issue of supply items at the times a demand is placed against the system. A significant portion of this inventory is required to compensate for the time required to ship the item from the AMA to the ultimate consumer. This portion is highly sensitive to small fluctuations in intransit delivery time. An item that is primarily shipped by surface requires a higher inventory level than one which is primarily shipped by air. The item manager is always faced with maintaining an effective level of support with a reduced number of assets. The item manager should attempt to increase the use of airlift support in order to alleviate this situation.

A study is currently underway by AFLC to measure the order and shipping time of items with an Expendability Recoverability Repairability code (ERRC) of XD and XF. (47) This study covers shipments to 30 CONUS bases and shows the impact of order and shipping time on this segment of the inventory investment. The results of this project are shown in figure 5 and table 8. For compatibility with the data base used in this study, the authors scaled the data in figure 5 and table 8 as they would be for 54 bases, or the number of bases with LOGAIR terminals. These data are shown in figure 6 and table 9. It was shown in Chapter IV, tables 1 and 2, that the diverted cargo represents 12 and 13 percent of the total air eligible cargo. Table 10 shows the value of a decrease in intransit time for 12 and 13 percent of the total cargo shipped. Since the McClellan intransit time report discussed in

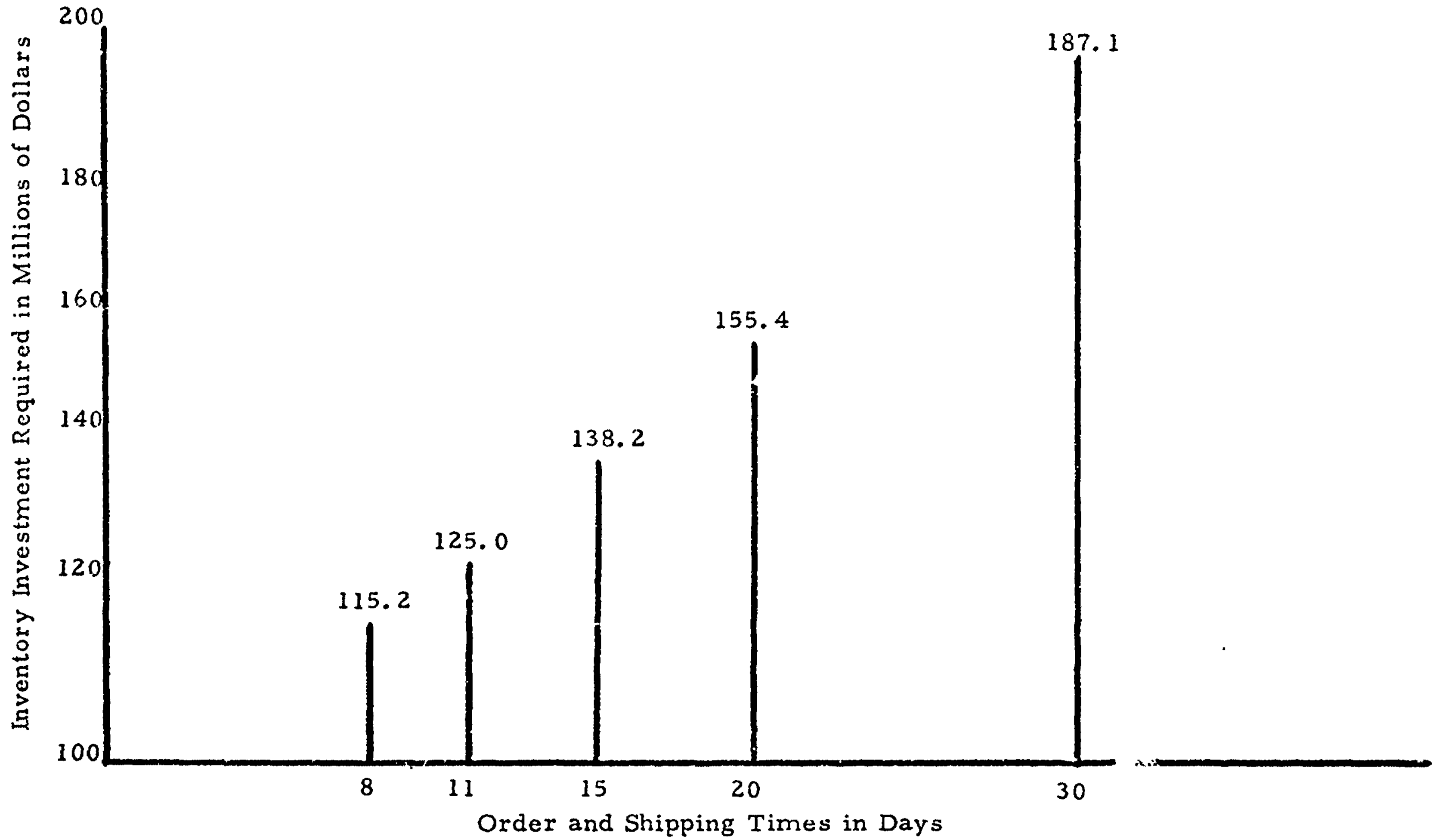

Fig. 5.--The Cost of the Inventory Investment of XD and XF Items for 21 CONUS Bases for Varying Order and Shipping Times

TABLE 8

THE DOLLAR DECREASE IN INVENTORY INVESTMENT FOR 21 BASES FOR A DECREASE OF ONE DAY IN ORDER AND SHIPPING TIME

Order and Shipping Time Between (Days)	Value of One Day Reduction in Order and Shipping Time (Dollars)
8-11	$3,229,996
11-15	3,308,902
15-20	3,431,849
20-30	3,170,887

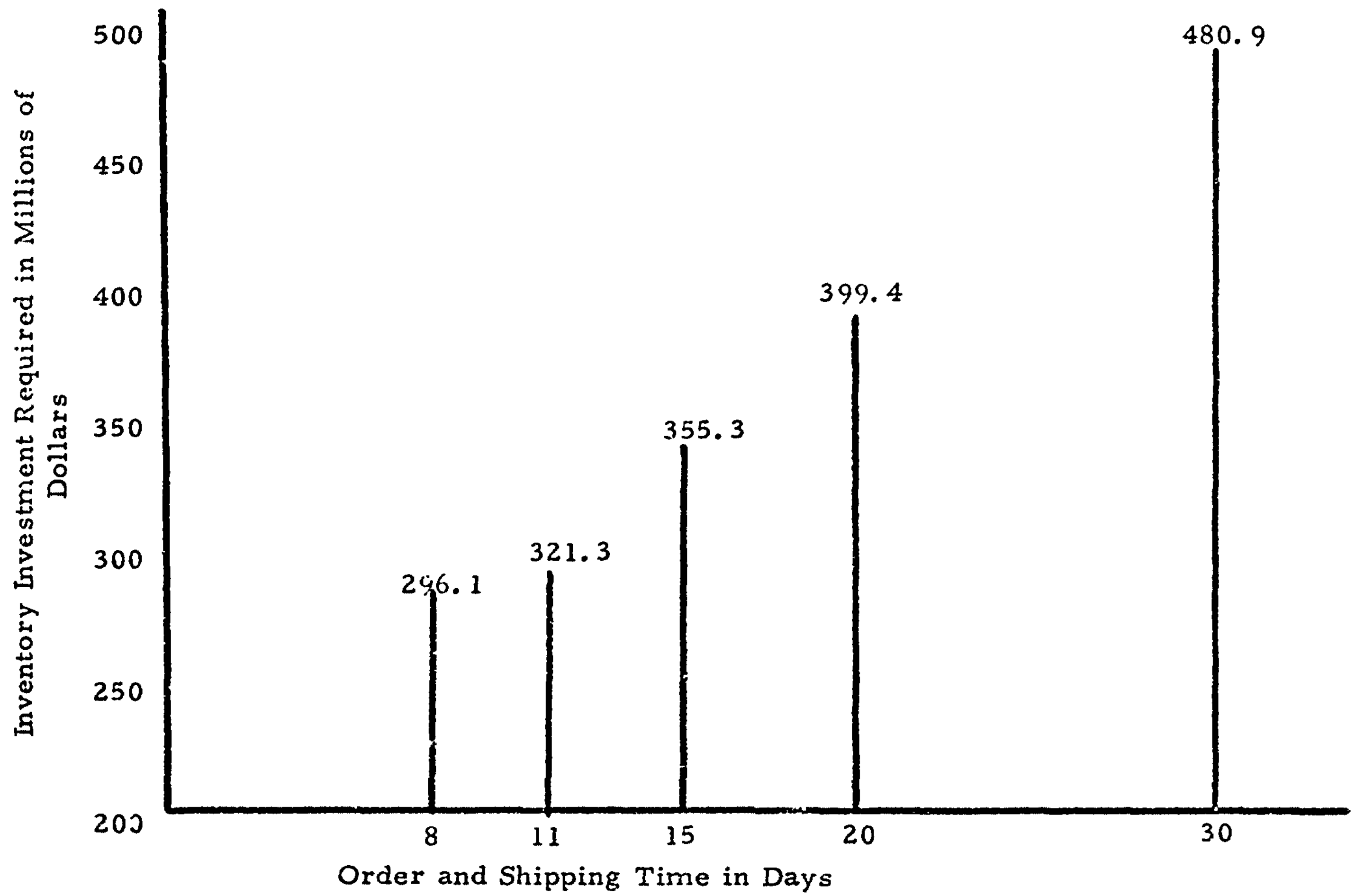

Fig. 6.--The Cost of the Inventory Investment of XD and XF Items for 54 CONUS Bases for Varying Order and Shipping Time

TABLE 9

THE DOLLAR DECREASE IN INVENTORY INVESTMENT FOR 54 BASES FOR A DECREASE OF ONE DAY IN ORDER AND SHIPPING TIME

Order and Shipping Time Between (Days)	Value of One Day Reduction in Order and Shipping Time (Dollars)
8-11	$8,386,756
11-15	8,503,879
15-20	8,819,852
20-30	8,149,179

TABLE 10

THE DOLLAR DECREASE IN INVENTORY INVESTMENT FOR 54 BASES FOR A DECREASE OF ONE DAY IN ORDER AND SHIPPING TIME APPLIED TO 12 AND 13 PERCENT OF THEIR XD AND XV INVENTORY

Order and Shipping Time Between (Days)	Value of One Day Reduction in Order and Shipping Time (Dollars)	
	12% of Inventory	13% of Inventory
8-11	$1,006,411	$1,090,278
11-15	1,020,465	1,105,504
15-20	1,058,382	1,146,581
20-30	977,902	1,159,393

Chapter IV reflects an average reduction in shipping time of 4.9 days, when air is used instead of surface transportation, the potential dollar savings to be achieved in inventory investment by having all eligible cargo transported by LOGAIR is approximately 4.9 million dollars.

Comparison of Air and Surface Costs

All of the component costs for surface and air transportation considered in this study have now been explained. Table 11 summarizes the component costs computed in this study with the exception of the inventory investment costs. With the exclusion of inventory costs, surface transportation of the diverted cargo was less expensive than air transportation of the same cargo by $1,299,781 for FY71 and $887,383 for FY72.

Table 12 compares the difference between air and surface costs including an inventory savings that can be achieved by reducing the shipping time from 1 to 5 days. During FY71 a reduction of slightly more than 1 day was required for air transportation to be more cost effective than surface transportation. During FY72, with the increase in surface linehaul rates, reduction of less than one day will make air transportation more economical than surface transportation.

Summary

In order to optimize the cost of inventory distribution it is necessary to examine the total cost of maintaining and shipping that

TABLE 11

COMPONENT COSTS OF SURFACE AND AIR TRANSPORTATION FOR FISCAL YEARS 1971 AND 1972

	FY-1971		FY-1972	
	Surface	Air	Surface	Air
Linehaul	$1,802,802	$3,066,409	$2,335,791	$3,188,239
Damage & Loss	434,088	43,409	419,220	41,922
Air Terminal Handling	----	426,853	----	412,233
Inventory Investment Cost	will be considered later	will be considered later	will be considered later	will be considered later

	FY-1971	FY-1972
Total Air	$3,536,671	$3,642,394
Total Surface	2,236,890	2,755,011
Difference	$1,299,781	$ 887,383

TABLE 12

COMPUTATION OF THE SAVINGS TO BE OBTAINED BY
REDUCING THE INTRANSIT TIME FOR THE
DIVERTED CARGO THROUGH THE
UTILIZATION OF LOGAIR
FISCAL YEAR 1971

Days Reduction	Difference from Table 11	Inventory Reduction	Savings by Air
1	$1,299,781	$1,006,411	- $ 293,370
2	1,299,781	2,012,822	+ 713,041
3	1,299,781	3,019,233	+ 1,719,452
4	1,299,781	4,025,644	+ 2,725,863
5	1,299,781	5,032,055	+ 3,732,274

TABLE 13

COMPUTATION OF THE SAVINGS TO BE OBTAINED BY REDUCING THE INTRANSIT TIME FOR THE DIVERTED CARGO THROUGH THE UTILIZATION OF LOGAIR FISCAL YEAR 1972

Days Reduction	Difference from Table 11	Inventory Reduction	Savings by Air
1	$887,383	$1,090,278	+$ 202,895
2	887,383	2,180,556	+ 1,293,173
3	887,383	3,270,834	+ 2,383,451
4	887,383	4,361,112	+ 3,473,729
5	887,383	5,451,390	+ 4,564,007

inventory. The components of cost considered in study included:

(1) linehaul cost,
(2) packaging cost,
(3) documentation cost,
(4) damage and loss cost,
(5) air terminal handling cost, and
(6) inventory investment cost.

The transportation priority 1 and 2 cargo shown in the J-51 report as being shipped by surface modes was costed at both surface and air rates. Each of the other cost elements was also considered for both of the modes. All costs were totaled and compared. Air transportation was found to be more cost effective than surface transportation for movement of transportation priority 1 and 2 shipments.

CHAPTER VI

CONCLUSIONS

Summary

The recent trend of stabilized budgets in the face of increasing costs has forced the logistician to improve the economy of his operation. However, attempts to economize within functional areas has instead resulted in less economy for the entire system as compared to what could be achieved if budget considerations crossed functional lines. That is to say the transportation and supply budgets should be considered together. The objectives of this thesis were to identify any air eligible cargo which was moved by surface transportation and to determine the cost advantage of shipping this cargo via the AFLC logistical airlift system.

This study has crossed functional lines in search of the lowest overall cost for shipment of transportation priority 1 and 2 cargo. It has considered transportation and inventory budgets. All costs associated with shipment by air were compared with all costs associated with shipment by surface. It was found that a lower overall distribution cost could be realized by shipment of all air eligible cargo via the LOGAIR system.

Findings

The hypothesis tested was that the shipment of air eligible cargo by surface modes of transportation is not as economical as the use of the AFLC logistical airlift system. The following are the findings of the study:

1. During FY72 over 28,000,000 pounds of air eligible cargo was shipped from the AFLC AMAs by surface modes of transportation. This amount represented approximately 13% of the total air eligible cargo shipped.

2. The FY72 cost to ship the diverted transportation priority 1 and 2 cargo by surface was calculated to be $2,335,791 and for air $3,188,239.

3. With the inclusion of other costs such as damage and loss and air terminal handling the FY72 surface cost became $2,755,011 and the FY72 air cost $3,642,394. (A difference of $887,383)

4. The McClellan report established that an average reduction in intransit time of 4.9 days is realized in air over surface modes of transportation.

5. The AFLC Chapter 11/17 study group data shows a difference of approximately $3.2 million in total inventory value for each day's change in order and shipping time. For the 54 bases included in this thesis the difference would be approximately $1.1 million per day for the diverted cargo.

6. In total, savings would accrue for any reduction in intransit time of 1 day or more.

Final Conclusion

The findings of the thesis show that the shipment of transportation priority 1 and 2 cargo by LOGAIR is more cost advantageous than shipment by surface. In support of this conclusion the findings show that a large amount of transportation priority 1 and 2 cargo was shipped by surface transportation. Through the application of linehaul and other ancillary costs to this quantity of cargo it was determined that LOGAIR costs are slightly higher than surface transportation costs.

The McClellan report established that a 4.9 day intransit increase is experienced when surface transportation is selected over LOGAIR. At the same time the Hq AFLC Chapter 11/17 data showed that changes in order and shipping time had a direct effect on the value of the inventory. Thus, shipment by a faster transportation mode will result in inventory investment savings.

The final comparison of all costs associated with surface transportation and all costs associated with LOGAIR shows that with a 1 day reduction in intransit time an amount in excess of $200,000 can be saved by shipping air eligible cargo by LOGAIR. This savings consists of a $1,000,000 inventory savings partially offset by a $800,000 increase in air transportation cost. For each additional day of intransit time saved an amount in excess of $1,000,000 can be saved.

The authors' final recommendations are as follows:

1. That all air eligible cargo be shipped via the LOGAIR system.

2. That funds be made available to fund the procurement of additional LOGAIR capability.

3. That the LOGAIR monitor be provided the budgetary flexibility to procure additional airlift as required to meet periods of greater than normal demand.

Value of the Study

The most important lesson learned from this study was placing the transportation linehaul cost in its proper prospective. Functional managers have tended to place disproportionate amount of emphasis on the cost of premium transportation when in fact a more significant cost is that of inventory investment. This thesis has pointed out that the more "seemingly costly" mode of transportation is in fact less costly than surface transportation.

Areas for Further Study

Serious consideration should be given to examination of the effect of determining eligibility of cargo for airlift based upon value. The investigation conducted for this paper revealed that there is a valid [illegible] between reductions in inventory investment and intransit [illegible] follows, that value should be a criteria for airlift

APPENDIX A

TRANSPORTATION SUMMARY REPORT DATA

FY7[illegible]			FROM:		
TO:	Hill	Tinker	McClellan	Kelly	Robins
Hill	---	2.19	.96	3.62	.63
Tinker	.54	---	1.09	2.38	.62
McClellan	.26	.81	---	.74	.21
Kelly	.53	3.79	.33	---	.21
Robins	.62	2.08	.49	1.40	---
Wright-Patterson	.28	1.33	.41	.53	.33
Travis	.02	.53	.12	1.00	.24
McChord	.39	.26	.05	.17	.04
Charleston	.07	.31	.02	.31	.03
Dover	.02	.28	.06	1.14	.05
McGuire	.05	.48	---	.25	.10

Daily Increase by LOGAIR Route Segment to Accommodate Surface Shipped TP 1 & 2 Cargo (Tons)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
Hill	---	2.27	.63	.92	.72
Tinker	.20	---	2.89	1.70	.83
McClellan	.23	.89	---	1.68	.52
Kelly	.27	3.32	.58	---	.45
Robins	.75	2.29	1.66	1.30	---
Wright-Patterson	.12	1.38	.43	.72	.23
Travis	.08	.38	.11	.34	.21
McChord	.09	.20	.07	.11	.07
Charleston	.28	.18	.03	.11	.09
Dover	.09	.20	.06	.24	.18
McGuire	.03	.27	.001	.19	.16

Daily Increase by LOGAIR Route Segment to Accommodate Surface Shipped TP 1 and 2 Cargo (Tons)

Flight Nr.	FY71	FY72
20	.22	---
21	2.63	3.38
25	2.62	2.47
40	3.37	1.84
46	5.10	5.22
47	2.72	3.14
48	1.92	2.45
49	2.70	3.06
50	1.21	1.32
51	2.67	2.91

Daily Increase by LOGAIR Route Segment
to Accommodate Surface Shipped
TP 1 and 2 Cargo (Tons)

FY71	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(2020) Hill	---	171,313	115,043	608,551	97,360
(2030) Tinker	220,188	---	204,781	841,350	299,163
(2040) McClellan	185,107	590,402	---	537,028	147,763
(2050) Kelly	368,936	833,264	114,379	---	93,203
(2060) Robins	47,918	261,900	108,100	323,194	---
(2300) Wright-Patterson	181,145	202,782	57,630	78,184	132,434
(2554) Duluth	---	26,574	29,721	14,866	566
(2586) Tyndall	11,547	174,252	44,771	89,568	106,846
(2598) Kincheloe	---	116,836	---	29,272	2,974
(2803) Kirtland	3,115	300,092	117,708	121,345	27,678

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY71 TO:	FROM: Hill	Tinker	McClellan	Kelly	Robins
(2823) Eglin	42,609	186,360	51,305	61,889	86,198
(2829) Patrick	1,540	25,136	10,185	14,504	65,877
(2835) Hanscom	---	19,063	14,045	33,373	9,148
(3100) Richards-Gebaur	1,100	4,139	97,981	199,162	8,278
(4208) Andrews	26,140	10,186	21,598	64,130	88,673
(4418) Charleston	47,413	222,996	8,589	221,241	16,265
(4419) Altus	4,978	185,062	94,826	103,260	14,112
(4427) Travis	11,883	383,394	84,177	730,971	174,767
(4448) Norton	192,339	401,498	20,534	74,415	67,829
(4479) McChord	278,703	189,164	36,594	118,532	27,412

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY71	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4484) McGuire	33,454	346,538	---	180,357	70,575
(4497) Dover	14,080	198,896	37,338	831,296	36,682
(4515) K.I. Sawyer	12,520	122,225	104,694	21,059	5,519
(4528) Minot	36,515	231,449	77,323	76,978	3,100
(4585) Wurtsmith	1,068	149,643	69,535	42,650	282
(4600) Offutt	6,157	94,561	13,034	54,528	117
(4604) Davis-Monthan	21,087	86,854	27,255	551,307	54,571
(4608) Barksdale	7,097	222,705	15,831	127,934	5,061
(4610) Vandenburg	39,705	7,836	177,646	18,564	2,909
(4613) F.E. Warren	12,138	12	---	31,345	4,097

Annu TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY71	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4615) Plattsburg	6,256	73,132	47,380	52,080	2,288
(4616) Griffiss	2,839	225,977	72,074	50,086	10,571
(4620) Fairchild	19,352	199,963	50,167	102,608	3,008
(4623) Pease	880	24,228	23,154	64,567	16,337
(4625) Whiteman	5,910	---	1,600	4,064	1,629
(4626) Malmstrom	20,610	21,989	11,032	154,529	9,221
(4634) Blytheville	---	159,938	---	11.794	2,894
(4654) Grissom	53,127	19,816	45,568	23,807	362
(4659) Grand Forks	40,379	157,970	28,465	20,033	1,385
(4661) Dyess	2,895	138,848	---	298,055	28,468

Annual TP 1 & 2 Ca[illegible]o Shi[illegible]d by Surface Modes
by De[illegible] (Pounds)

FY71	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4665) Westover	3, 320	238, 695	400	62. 009	55, 843
(4672) Castle	142, 353	887, 395	43, 585	36, 516	---
(4678) Loring	1, 760	180, 134	81, 113	41, 383	5, 207
(4689) Carswell	6, 152	311, 784	25, 927	108, 896	13, 449
(4690) Ellsworth	21, 614	203, 138	38, 835	61, 316	4, 081
(4800) Langley	1, 925	52, 239	13, 367	99, 968	46, 332
(4801) Holloman	32, 571	90, 316	24, 308	509, 625	22, 489
(4803) Shaw	33, 550	140, 510	45, 983	76, 820	80, 092
(4805) England	8, 168	401, 477	11, 002	78, 610	4, 969
(4809) Seymour-Johnson	66, 729	234, 925	10, 894	209, 991	1, 131, 939

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY71 TO:	FROM: Hill	Tinker	McClellan	Kelly	Robins
(4814) MacDill	116,857	318,515	9,637	57,063	105,006
(4817) Forbes	48,182	8,256	16,125	74,824	37,516
(4829) Homestead	96,476	110,121	35,3[illegible]	45,476	109,423
(4852) Nellis	39,571	218,227	30,390	56,116	11,891
(4855) Cannon	13,980	267,002	38,826	82,257	25,783
(4860) Little Rock	3,553	360	4	47,533	251,181
(4861) McConnell	28,294	185,316	69,465	87,905	4,682
(4887) Luke	5,550	336,548	9,240	49,490	11,314
(4897) Mt Home	41,726	37,884	2,990	355,778	8,069

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(2020) Hill	--	228,161	78,418	258,836	230,439
(2030) Tinker	47,337	---	291,407	458,147	347,729
(2040) McClellan	163,450	648,633	---	1,220,517	372,787
(2050) Kelly	165,620	1,003,043	347,816	---	106,194
(2060) Robins	102,865	346,971	454,935	393,641	---
(2300) Wright-Patterson	34,370	118,476	11,842	42,158	17,146
(2554) Duluth	6	13,085	2,145	5,305	---
(2586) Tyndall	16,601	74,331	34,940	61,470	16,940
(2598) Kincheloe	1,042	144,565	69,346	23,624	1,747
(2803) Kirtland	16,733	172,050	74,477	41,492	11,276

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(2823) Eglin	217,458	148,230	87,718	76,680	33,724
(2829) Patrick	21,471	11,807	14,774	11,065	6,320
(2835) Hanscom	4,750	38,970	27,628	20,032	8,609
(3100) Richards-Gebaur	647	124,898	88,646	166,763	20,618
(4208) Andrews	8,710	24,397	31,017	93,746	42,351
(4418) Charleston	200,421	130,525	19,024	77,187	65,741
(4419) Altus	19,775	197,108	42,602	41,257	36,228
(4427) Travis	56,397	272,721	74,568	241,761	150,156
(4448) Norton	284,177	292,848	43,392	127,111	124,757
(4479) McChord	58,803	145,460	48,794	76,927	44,634

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4484) McGuire	20,947	190,805	756	138,642	112,766
(4497) Dover	62,582	145,965	43,471	175,246	126,769
(4515) K.I. Sawyer	2,395	281,182	31,774	65,862	7,622
(4528) Minot	76,264	118,894	63,478	69,405	5,391
(4585) Wurtsmith	8,656	164,894	43,986	38,352	4,662
(4600) Offutt	3,328	156,700	28	16,447	9,023
(4604) Davis-Monthan	33,337	211,602	16,450	124,779	123,407
(4608) Barksdale	2,009	246,858	82,726	113,610	105,670
(4610) Vandenburg	44,988	3,417	32,139	24,918	4,516
(4613) F.E. Warren	46,794	11		3,878	9,464

Annual TP 1 & 2 Cargo Shipped by Surface Modes
by Destination (Pounds)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4615) Plattsburg	10,290	39,961	12,367	29,076	6,571
(4616) Griffiss	7,508	436,223	70,164	85,775	34,685
(4620) Fairchild	17,394	254,471	1,365	66,189	43,293
(4623) Pease	4,778	43,841	113,656	82,927	14,558
(4625) Whiteman	22,407	160	33,638	9,205	566
(4626) Malmstrom	73,555	44,464	25,917	2,748	5,088
(4634) Blytheville	310	201,398	15,364	28,786	1,552
(4654) Grissom	19,050	48,113	883,880	24,166	2,454
(4659) Grand Forks	71,690	312,385	18,270	71,782	6,888
(4661) Dyess	3,468	73,312	16,284	119,021	20,646

Annual TP 1 & 2 Cargo Shipped by Surface Modes by Destination (Pounds)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4665) Westover	592	61,432	48	53,908	22,732
(4672) Castle	163,326	759,894	34,907	58,730	19,808
(4678) Loring	2,157	263,997	37,791	200,619	62,283
(4689) Carswell	3,451	89,862	11,816	120,101	1,088
(4690) Ellsworth	275,005	189,130	15,625	65,664	18,597
(4800) Langley	18,308	79,467	86,820	43,985	40,653
(4801) Holloman	32,821	28,256	---	352,389	14,114
(4803) Shaw	69,333	78,494	41,138	135,761	185,723
(4805) England	1,099	251,669	7,013	123,136	24,864
(4809) Seymour-Johnson	16,255	265,575	24,821	28,683	18,753

Annual TP 1 & 2 Cargo Shipped by Surface Modes by Destination (Pounds)

FY72	FROM:				
TO:	Hill	Tinker	McClellan	Kelly	Robins
(4814) MacDill	20,471	397,069	369,795	44,994	41,188
(4817) Forbes	2	22,944	170	18,973	27,818
(4829) Homestead	54,867	254,142	63,979	52,738	28,000
(4852) Nellis	83,728	499,511	93,384	44,917	10,112
(4855) Cann[illegible]	6,913	254,910	466,897	38,458	3,062
(4860) Little Rock	10,522	1,179	342	70,676	20,065
(4861) McConnell	24,508	302,508	45,582	23,541	6,214
(4887) Luke	49,808	82,218	34,379	250,136	29,573
(4897) Mt Home	12,424	7,010	14,165	157,708	30,162

Annual TP 1 & 2 Cargo Shipped by Surface Modes by Destination (Pounds)

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