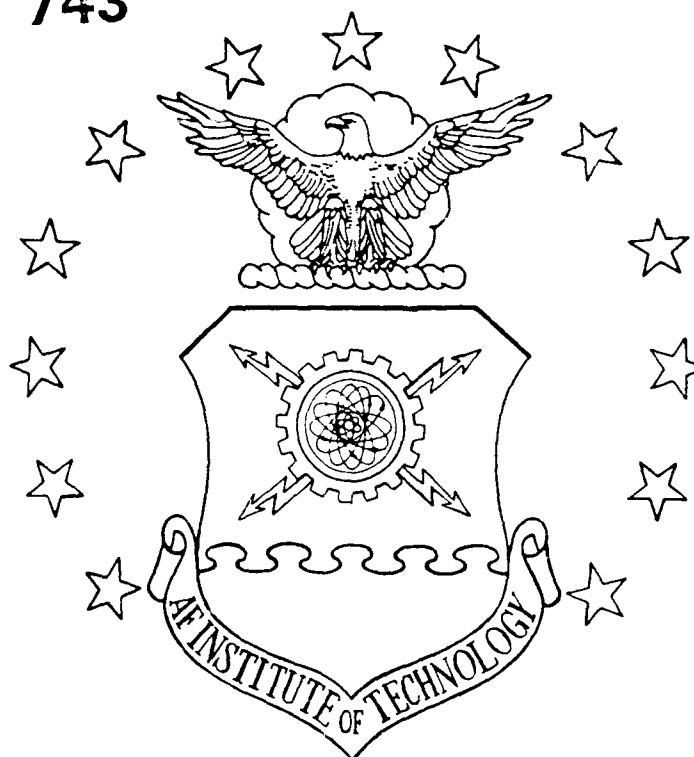


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SUPPLY SUPPORT OF AIR FORCE  
463L EQUIPMENT:  
AN ANALYSIS OF THE 463L EQUIPMENT  
SPARE PARTS PIPELINE

THESIS

Brett A. Gordon  
Captain, USAF

AFIT/GLM/LSM/89S-24

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SUPPLY SUPPORT OF AIR FORCE 463L EQUIPMENT:  
AN ANALYSIS OF THE 463L EQUIPMENT SPARE PARTS PIPELINE

THESIS

Presented to the Faculty of the School of Systems and  
Logistics of the Air Force Institute of Technology  
Air University

In Partial Fulfillment of the  
Requirements for the Degree of  
Master of Science in Logistics Management

Brett A. Gordon, B.S.  
Captain, USAF

September 1989

Approved for release; distribution unlimited

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-Brett A. Gordon

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Abstract

"Getting the right thing to the right place at the right time," is the goal of a logistics system. With the goal of the logistics system in mind, commanders and managers are now asking what makes up a logistics system and how does the system work? This thesis addresses these questions by analyzing one pipeline within the Air Force logistics system, the spare parts pipeline for 463L equipment. This paper focuses on this pipeline for two reasons: (1) parts availability for these mission assets is essential to the Air Force; and (2) individual pipelines are more manageable than the logistics system as a whole.

Through flowcharts and process descriptions this thesis describes the organizations responsible for processing MICAP spare parts requisitions for 463L Materials Handling Equipment. Pipeline management, measurement, and interactions are highlighted along with their impact on pipeline functions.

The major outcomes of the thesis research were (1) detailed flowcharts of the requisition process for 463L parts from vehicle maintenance through the depots and back to maintenance; (2) an absence of responsibility for the entire pipeline by a single manager or office; (3) key pipeline measurements and management reports provided.

limited visibility over pipeline performance, and overlooked areas that degraded customer service; and (4) the order processing system created inherent delays in the pipeline because of outdated and indirect information systems and technology. This research provides the groundwork for future pipeline and logistics studies on pipeline performance and measurement.

SUPPLY SUPPORT OF AIR FORCE 463L EQUIPMENT:  
AN ANALYSIS OF THE 463L MATERIALS HANDLING EQUIPMENT  
SPARE PARTS PIPELINE

I. Introduction

Combat power equals the combination of combat operations and combat support. Combat support is the foundation of aerospace power... (4:3-6)

This opening quotation from the Air Force Combat Support Doctrine clearly states the importance of combat support or logistics to warfighting capability. In fact, the ability of the logistics community to "Get the right thing in the right amount to the right place at the right time," is vital to achieving the principle of balance in combat support (4:3-3). Logisticians achieve this movement primarily through management of the supply pipeline. They ensure the supply pipeline provides for the effective and efficient flow of supplies and spare parts from point-of-origin to point-of-consumption (34:6). If the pipeline is managed improperly and operational commanders are unable to get accurate supply status, they are unable to effectively plan, support, and control operations (4:3-5). Thus, improper management and incomplete knowledge of the supply pipeline can diminish unit combat capability.

In order to manage and control the supply pipeline, it is essential for logisticians and commanders to understand

the structure of the pipeline. The supply pipeline is the system of interdependent organizations, processes, interactions, and information flows required to process supply requisitions from inception, when a requirement is first identified, to termination. (36:2). Each part or element of this pipeline is also a system in itself and is composed of its own subsystems (36:2). As a result, managers and commanders must consciously define, select, and understand the parts of the pipeline they control and utilize.

How should systems be defined and analyzed? It depends on the developmental level of the system. When the Air Force supply system was maturing the predominant view toward system analysis was the analytical approach (31:7). This approach took a micro-analytic view and analyzed the constituent parts of a system to gain a better understanding of the system as a whole (31:6,7; 26:17). Years ago when "organizations were not as complex as today," this analytical approach served managers well (31:7). But as organizations grew and researchers began to study the mutual interactions of system elements, other methods of analysis were developed that provided a more holistic approach to analyzing large systems.

Today, in a time of increasing complexity, a macro-analytical approach is used in systems analysis. With this

approach, organizations evaluate themselves as a whole understanding that

a whole cannot be taken apart without loss of its essential characteristics...[hence] instead of explaining a whole in terms of its parts, parts must be explained in terms of the whole. (31:vii)

This macro-systems approach does not eliminate analytical thinking, it only emphasizes that the essential interrelationships between parts must be considered as well (31:7). Now, "the systems analyst, instead of 'microanalyzing' the parts, focuses on the processes that link the parts together" (31:7). Through macroanalysis, managers note "that the input of one system is the output of another system, and that the output of a system becomes the input to another system," as illustrated in Figure 1 (31:25). This diagram indicates a change in one

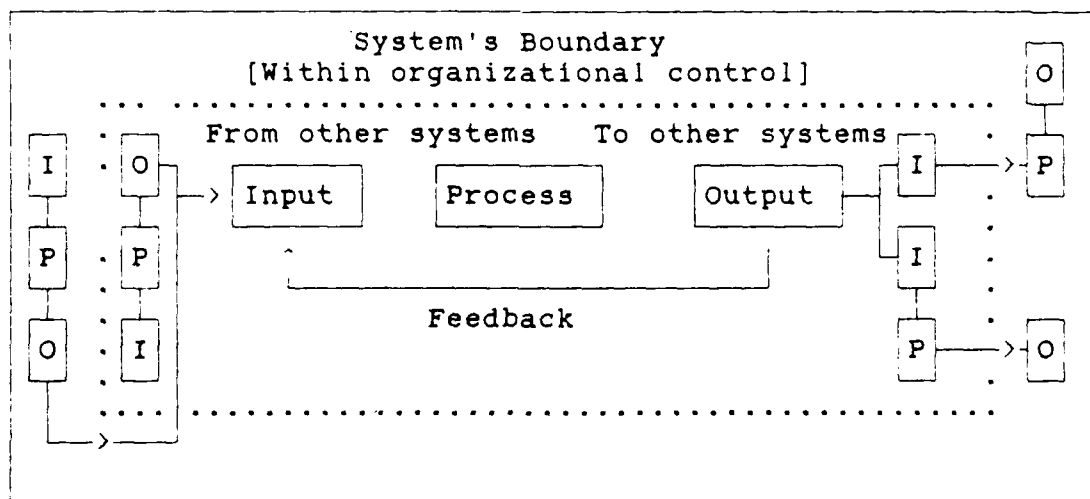


Figure 1. System Interdependence (31:25)

system or process effects all systems that follow. Macro-systems analysis recognizes system changes do not occur within a vacuum and a change in one system or process affects other systems throughout an organization (31:7,8,9).

The Air Force supply pipeline is a system and can be analyzed using the macro-systems approach. Because of the wide variety of pipeline types within the supply system, it is difficult to analyze all of the specific pipelines involved. Consequently, this thesis concentrates on a single pipeline type, the spare parts pipeline for 463L Material Handling Equipment.

#### General Issue

How well can the Air Force support and maintain its 463L equipment? Much has been observed and documented on the necessity of adequate 463L support but, what process or system has the Air Force actually developed to ensure this equipment will operate when needed?

#### Background

Today's national strategic military policy of flexible response is reliant on the ability to rapidly respond and deploy forces to conflicts around the world. Rapid deployment over long distances to conflict locations may be accomplished only through massive airlift (28:14-15). For example, a deployment of two F-15 squadrons to a base operation in the Middle East will take nearly two weeks and about one-quarter of the Military Airlift Command's (MAC) fleet of cargo aircraft (28:17). Deployment requirements of

this magnitude place tremendous strain on the airlift system, especially the cargo handling area which must operate at full capacity for the system to work (16:6).

One key element of the cargo handling system is the 463L Material Handling Equipment (MHE) used in the movement and preparation of air cargo. 463L equipment is essential to the safe, effective, and rapid up and downloading of cargo aircraft. This equipment, consisting primarily of 10K forklifts (10K F/L), 25K and 40K cargo loaders (25K and 40K-loaders), and elevated loaders, is the backbone of the surface portion of the airlift system (23:6). Lt Col Gary B. May emphasizes the criticality of 463L equipment in his research report, The Impact of Material Handling Equipment on Airlift Capabilities, as he writes

Even if MAC had the airframes necessary to eliminate the airlift capability shortfalls, the nation could not deploy or sustain combat forces on a world-wide basis because of insufficient amounts of operable materials handling equipment [463L equipment] (25:70).

Lt Col May's reference to the availability of operable MHE or 463L equipment was based on two factors: equipment procurement and positioning, and the vehicle in-commission (VIC) rates of on-hand equipment. This research effort examines the second factor and its impact on availability. Equipment procurement and positioning are dependent on the budget and needs of the Air Force, and they are beyond the scope of this thesis.

With limited on-hand 463L equipment resources, it is essential to maintain high in-commission rates to meet

deployment and mobilization needs. The necessity of maintaining this equipment frequently is documented in cases throughout the Vietnam conflict where the in-commission rates ranged from 40 to 70 percent (25:70). In fact, "Brigadier General William G. Moore, then 834th ALD commander said, 'our greatest limitation in the airlift system now is the lack of MHE'" (25:7). The lack of MHE is not necessarily driven by a shortfall of on-hand vehicles, but primarily due to a significant lack of spare parts (25:26,28; 16:7). As a result of the spare parts shortage, the MHE system which was intended to increase airlift efficiency and effectiveness actually constrained our airlift efforts (16:7).

Past, present, and future dependency on airlift dictates the Air Force support its 463L equipment to the fullest extent possible. Spare parts supply is essential to maintaining this equipment in operable condition. Thus, it is essential to understand and control the spare parts pipeline to provide the most effective means of getting the right parts to the right place at the right time to support the airlift mission.

#### Specific Issue

What organizations and processes make up the current spare parts pipeline for 463L equipment, and how do these organizations and processes affect the availability of 463L equipment?

### Research Objective

This thesis examines the spare parts supply pipeline for 463L equipment to develop the flow pattern of spare parts requirements from identification of need to receipt of the part by vehicle maintenance. The flow chart developed and processing time data collected are used to develop a network design which may be used subsequently to show the impact each part of the pipeline has on the pipeline as a whole.

### Investigative Questions

There are five major question areas examined in this thesis.

1. What offices, sections, and organizations are involved in the spare parts pipeline for 463L equipment?
2. What are the procedures followed by each section or unit of the pipeline in the processing of spare parts requisitions?
3. Who is responsible for monitoring the data collected for the unit and for the system as a whole?
4. How are processing times recorded and what reports reflect and summarize these times?
5. What are the average processing times and time distributions for each section of the pipeline? How do changes in the times and distributions impact the pipeline time as a whole?

Chapter III will describe the procedures used to gather this information and provide the results.

### Scope and Limitations

The supply pipeline analyzed in this thesis is limited to the pipeline developed to process Mission Incapable (MICAP) parts requisitions for 463L equipment. The MICAP portion of the pipeline is studied because of the impact of MICAP requisitions on airlift capability. By definition, MICAP requests are initiated when equipment is inoperable and the parts required for repair are not available through base resources. Thus, MICAP requests for 463L equipment reduce Air Force capability to conduct airlift missions and create problems such as those experienced in Viet Nam.

This research is limited further by the type and quantity of pipeline time data collected and management reports used at Military Airlift Command (MAC) bases and headquarters as well as, the Air Logistic Center (ALC) and Defense Logistics Agency (DLA) depots. The data recorded at these locations is not always as detailed as required for network analysis, as many of the processing times record only summary statistics which consolidate handling times for a number of different functions. Also, vehicle maintenance work order data is limited to work orders closed within 90 days of the date of research because of Air Force administrative regulations.

### Assumptions

The major assumption made throughout the analysis is that all organizations record time data in the same manner, i.e. start and stop times are recorded at exactly the same

stage of the process. Although this assumption is highly unlikely, the data gathered still provides useful information for developing solid time statistics and distributions for developing a network model. Another assumption is that base vehicle maintenance and supply data, although gathered from only one base, is representative of processing times at all Air Force bases. Although this is far too comprehensive to be valid, the use of Charleston AFB as a model for the base level requisitioning process does provide an example of how MICAP requisitions are initiated, particularly at bases within MAC.

#### Chapter Summary

This chapter provided an introduction to the supply pipeline and to 463L equipment. It outlined the macro-analytical approach to system analysis and the rationale for using this approach when analyzing the supply pipeline. The chapter provided a short history and explanation of the importance of 463L equipment. Also included were the objectives and research questions to be addressed in the thesis along with the scope and limitations, and assumptions of the thesis.

Chapter II provides a literature review of the order cycle. Chapter III develops the methodology used in the research. Chapter IV draws a detailed outline of the spare parts pipeline process for 463L equipment MICAP parts requisitions to provide answers to the first two investigative questions posed in Chapter I. Chapter V

data collected and responds to the last three questions. Finally, chapter VI draws on the analysis and provides topics to be further research.

## II. Literature Review

### Introduction

The logistical process does not end...when the product is turned over to the next level in the distribution channel...[the] ultimate responsibility for logistics does not end until the product in question is finally accepted by the...enterprise that will use it. Therefore, to properly direct the logistical activities, planning horizons must transcend the total distribution channel. (2:88)

What is logistics? Within the military, logistics is often referred to as "the bridge between the industrial base and the armies" (29:15). And, the JCS Pub 1 defines logistics as

the science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations which deal with: a. design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposal of material...(39:1-1)

This definition encompasses the broad range of functions required to support combat forces (39:1-1). This description is much broader in scope than its business logistics counterpart. Logistics management, as described commercially, relates more to the physical distribution and materials management aspects of the military definition than to its design, development, and maintenance aspects. The Council of Logistics Management defines logistics management as

the process of planning, implementing and controlling the efficient cost-effective flow and storage of...goods and related information from

point-of-origin to point-of-consumption for the  
purpose of conforming to customer requirements.  
(34:7)

This definition refers to the flow of goods and information, a flow resembling what the military refers to as the supply pipeline. Because of the similarity of the business definition of logistics and that of the pipeline in the military, the remainder of this literature review will use the terms supply pipeline and pipeline to refer to what the commercial literature terms logistics.

This literature review will describe the make-up of a supply pipeline, an order processing system, and an order cycle using the following relationships. Conceptually, Figure 2 shows how the supply pipeline encompasses the order processing system which, in-turn, encompasses the order cycle. With this model in mind, the review will discuss the customer service aspects of a pipeline followed by a logistics cost tradeoff model. The scope of the review

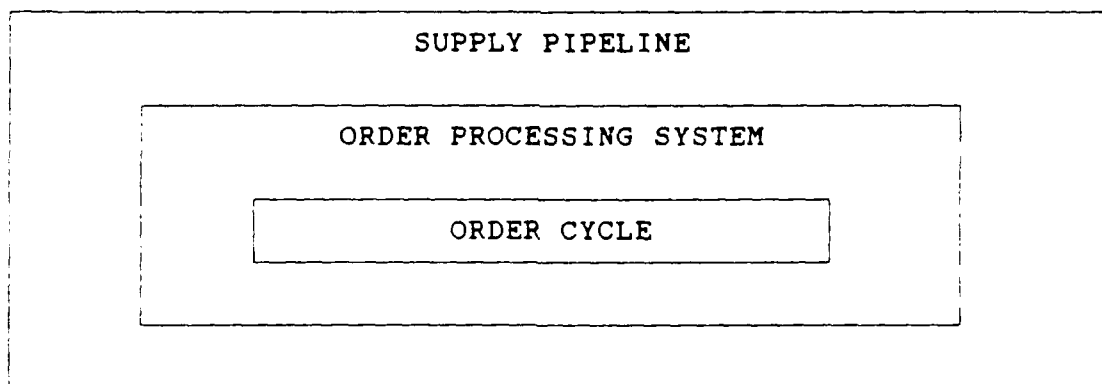


Figure 2. Relationships Within a Pipeline

then will focus on the order processing sub-system of the pipeline by describing each component of this sub-system. Finally, the literature review will describe the order cycle and how it relates to the pipeline as a whole.

### Supply Pipeline

The supply pipeline provides a system through which products and information flow between suppliers and customers. Many sub-systems or functions make-up the pipeline including: order processing, transportation, warehousing, inventory control, distribution communications, and procurement (34:7). But, as products and information move through the pipeline, the traditional boundaries between functions are transcended and each individual function becomes part of a smooth, efficient, and effective process for meeting customer requests. (10:4,25). Figure 3 provides an example of how the channel assimilates the individual functions and transcends their boundaries.

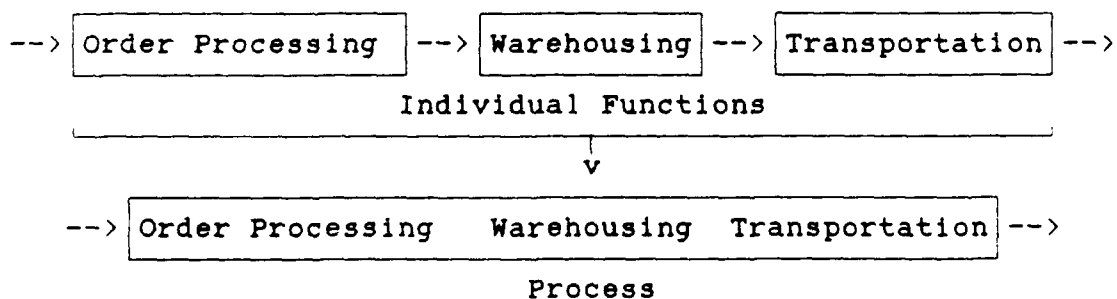


Figure 3. Pipeline Flow Process

Without a smooth flowing, integrated pipeline, a firm may never achieve its strategic goals (2:267). Therefore,

appropriate organization and control of the pipeline supports the mission of the enterprise as a whole rather than the individual goals of the sections within the company (10:25). "To be effective, a pipeline must attain [the] levels of performance in each of its component functions which together achieve the goals of the enterprise" (2:274). This strategic orientation acknowledges business is not solely concerned with the use of inputs but the creation of outputs; therefore, it is logical to think and manage in terms of outputs first and inputs second (10:25).

#### Customer Service

"The single output of any organization is customer service. Customers, not managers or products, drive the organization" (10:11). Therefore, a company's pipeline performance is measured in terms of customer service levels. Pipeline service depends on three factors: product availability, delivery capability, and information communication (34:100).

Availability refers to a supplier's ability to provide the customer with the product ordered. Availability results from a firm's stockage policy, where a greater level of inventory generates greater customer service levels because it reduces the potential for stock-outs (10:410). A stock-out means a product is not available when needed, and can result in lost sales depending on how a customer evaluates the stock-out event (32:282). In other words, a customer's reaction to a stock-out depends on his perception of product

availability which incorporates both objective and subjective components (10:18). Objective availability reflects a supplier's actual ability to fill customer orders, whereas subjective availability represents the impression of a supplier's service that a customer develops over time (10:17). "The point being that the more often a [pipeline] is perceived as being out of stock, the more likely the customer" will switch suppliers (10:17,18).

Pipeline capability constitutes the second factor used in determining a pipeline's customer service level. "Pipeline capability results from the design and dependability of the components that make up" the order processing system of the pipeline (2:274). Capability reflects the level of customer service provided by a supplier expressed in terms of the time lapse between the placement of a customer's order and its physical delivery, commonly described as order cycle time (10:5). This measure relates to both the speed and consistency of delivery times (37:39). Delivery speed refers to the length of the average or stated delivery time; whereas, delivery consistency refers to the frequency and magnitude of deviation between the average or stated delivery time and the actual time of delivery, in other words, order cycle variability (34:501,502). A good supplier not only offers prompt deliveries, but also consistent deliveries (37:39).

Communication is the third and final factor to affect a pipeline's level of customer service. Communication between

a supplier and a customer usually refers to a supplier's ability to provide timely and accurate product information and order status (34:101). Product information alludes to the information a supplier provides a customer prior to the submission of an order and can include: product specifications, prices, availability, and substitutability (34:101). Order status relates to information provided to the customer after an order has been placed. Order status normally includes order acknowledgement with an expected delivery date (EDD), timely and accurate order status updates, and order tracking information (10:76). The overall level of customer service provided by a supply pipeline depends on the pipeline's ability to provide the right product or information to the right place at the right time (34:11).

Pipeline Cost Tradeoffs. As stated earlier, a strategic business orientation acknowledges business is not solely concerned with the use of inputs but the creation of outputs, so it is logical to think and manage in terms of outputs first and inputs second (10:25). Once pipeline managers evaluate and determine the service level outputs required to satisfy and maintain the firm's customer base, management then strives to achieve an economical balance between this pipeline performance and its input costs (2:274). The key to realizing the most efficient combination of inputs is through a total cost analysis of the logistics operation. In a total cost analysis,

management strives to minimize the total cost of logistics rather than the cost of each individual logistics activity. (34:45) Included in this total cost analysis, management evaluates the organization, control, and goals of each section of the pipeline to ensure they are operating at levels optimizing the performance and cost effectiveness of the enterprise rather than optimizing their individual operations (10:25). "To be effective, a pipeline must attain levels of performance in each of its component functions which together achieve the goals of the enterprise" (2:274).

To meet the goals of the firm, it might be necessary to sub-optimize operations in some logistical functions to make the entire pipeline more effective and efficient (10:4). Figure 4 provides a cost trade-off model which illustrates the complex interactions of logistics activities which combine to provide customer service levels. The lower portion of this model illustrates why pipeline costs and activities are evaluated in terms of flows, and why total cost and output of the pipeline depend on the efficiency of the interactions among all logistics activities (10:23).

By simply following the arrows, one realizes that a change in any logistics activity will impact the output and flow of the entire system. For example, if a firm decides to reduce the number of warehouses in an attempt to reduce

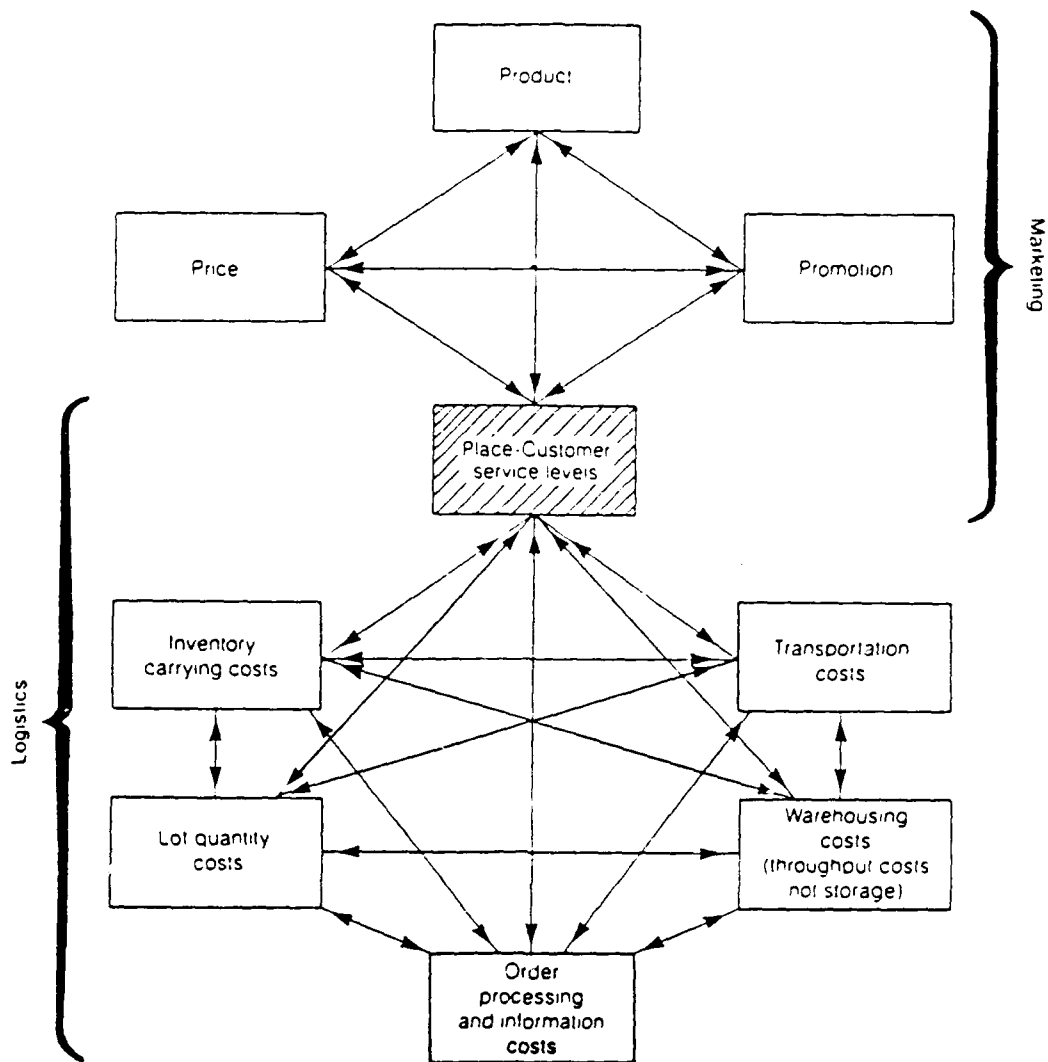


Figure 4. Cost Trade-Off Model (34:127)

inventory carrying costs, all other factors being equal, the firm will have to increase its inputs in another logistics activity, such as transportation or order processing, in order to maintain the same level of customer service experienced before the change (34:311,312).

When evaluating cost trade-offs management also must consider the costs associated with lost or foregone sales

resulting from reductions in customer service levels (34:45; 32:281,282). The costs of lost sales are particularly apparent when evaluating warehousing decisions.

"Reducing the number of warehouses to reduce warehousing costs can act as a double-edged sword...[along with reducing costs]. It reduces the ability to provide response to customers on short notice when needed and perhaps even more importantly, it reduces the customer's perception of the suppliers' ability to respond." (32:283)

In many cases, a customer reacts to this reduction in a supplier's real or perceived ability to respond by changing suppliers. Thus, the resultant loss in sales and revenues offsets at least part of the savings achieved from reduced warehousing costs (10:18). The most important thing for a pipeline manager to remember is there is a difference between the lowest cost alternative for a logistics activity and the lowest cost/most profitable alternative for the pipeline and organization as a whole (32:294).

#### Order Processing System

The raison d'etre of the distribution system of a company is to fulfil customer orders...The distribution manager should know the actual path (not necessarily the same as the official path) taken by customers' orders within his own company. Then by using this information to produce a flow chart of this path, the distribution manager is in the position to undertake a careful analysis of the flows and thus to identify "problem areas." By tackling these problem areas, the distribution manager may expect to speed up the entire order-handling process, which will reduce the overall order cycle time. The principle difficulty often encountered is that order processing may cross several different functional boundaries within a company, many of which are outside the control of the distribution manager. (10:73)

In order to evaluate the performance of an order processing system, a manager must first have a basic understanding of the system and its components. This section begins with an overview of the order processing system and its effect on the supply pipeline. Following this general description, the specific components of a typical order processing system are described.

"The order processing system is the nerve center of the logistics system" (34:499). The order processing system serves as a network for transmitting order information and transactions that link customers to suppliers (34:505). In essence, the order processing system provides the medium, within the supply pipeline, through which customer orders flow from order preparation to order delivery (2:274; 34:505).

Information flowing through the order processing system activates the physical distribution process and may precede, accompany, or follow the actual movement of material (21:32; 35:142). The speed and quality of the information flow directly impacts pipeline capability to efficiently process orders and satisfy customer demands (21:32). Information delays or inconsistencies slow pipeline processes and increase total distribution costs (34:519; 10:73). Total costs increase because any delays within the order processing system require suppliers to carry additional inventories and/or use premium transportation to maintain customer service levels (10:73). Thus, the effectiveness of

an order processing system directly impacts the cost and efficiency of the supply pipeline (21:32).

Each component of the order processing system contributes to the overall effectiveness of the supply pipeline. Thus, understanding the components of the system is essential to managing the pipeline.

A typical order processing system consists of the following components: (1) order preparation and communication, (2) order entry and order processing, (3) order picking and packing, (4) order transportation, and (5) customer receiving (34:499,502). Each component contributes to system performance.

The first component, order preparation and communication, begins when a buyer decides to place an order initiating both the customer service cycle and order processing system (15:58; 34:505). "The customer order serves as the trigger that sets the physical distribution process [pipeline] in motion" (21:32). The quality of the information submitted in a customer order impacts the cost and efficiency of the entire processing system, so it is essential customers possess the latest product data and specifications prior to submitting their orders (34:499; 15:58). More accurate orders increase the efficiency of the order processing system.

Once an order is prepared, "order transmittal should be as direct as possible," since it is the order which sets the logistics system in motion (34:505). Orders transmitted

electronically, rather than manually or via mail, minimize the risk of human error and decrease order transfer times. Electronic order transmission provides the most accurate and rapid method of getting the order to the supplier, and the more accurately and quickly a requirement reaches a supplier, the sooner the order is processed (34:503,505).

The second component, order entry and order processing, starts when the supplier receives a customer's order. It begins with various checks to determine the priority and acceptability of the order. Upon receipt, orders normally undergo the following sequence of events:

- (1) Orders are sorted according to processing requirements such as immediate orders....
- (2) Orders are vetted to ensure that all data are in computer-acceptable form.
- (3) Information on the order form is validated by interrogating the computer files. Product [and order information] accuracy is also checked.
- (4) Orders are screened against customer credit limits. Accepted orders will be passed on...[while rejected orders will be held or returned]
- (5) Valid orders are provided with a unique reference number and passed on for either on-line or batch processing. (10:75)

Once the order is entered into the system, the order processing function begins. This function is not to be confused with the order processing system. The order processing function is a component of the order processing system and constitutes the supplier's internal "activities associated with the assignment and commitment of inventories to orders" (2:132).

Order processing requires the flow of order information from one department to another, as well as from one

logistics function to another. (34:518). Order processing provides both the internal and external information required to fill orders and provide customer service. Order processing generates internal information which provides such internal business documentation as: invoices for accounting, inventory updates for inventory control, picking instructions for warehousing, and shipping instructions for transportation. External documentation generated for customer use includes: inventory availability, order acknowledgements, expected delivery dates, and back-order information. A suppliers ability to rapidly generate accurate internal and external information directly effects the efficiency and customer service levels achieved through the order processing system. Together, order entry and order processing form the largest portion of the pipeline that is "controlled" by the supplier. (34:500,505)

The third component of the order processing system, order picking and packing, involves retrieving materials from inventory and preparing them for use at other locations (35:132). "Unless material is stored ready for shipping, [a supplier] must pack the item for protection against movement hazards," as well as mark the item with appropriate shipping data (35:133). "Warehousing and packaging can substantially reduce problems related to speed and ease of movement through the system" by storing products in a manner that requires the least amount of handling (2:25). Reduced

handling increases the efficiency of the total physical flow of a product and, thereby increases the efficiency of the pipeline (2:25).

The fourth component of the system, order transportation, involves the physical movement of the product from the supplier to the customer and contributes place utility to the pipeline (3:7). Order transportation accounts for the largest portion of the time an order spends in the order processing system (34:500). "Transportation is [also] the highest single cost area in most logistical systems" (2:157). Because of the large portion of pipeline time and costs associated with transportation, it is essential to consider all transportation strategies when conducting a total cost analysis of the supply pipeline (3:42). A reduction in either transportation time or cost can have a dramatic effect on the order processing system and the pipeline (35:169)

The fifth and final component of the order processing system is customer receiving. Receiving includes the physical handling of incoming shipments, identification of material, verification of quantities, and the routing of the material to the location or department where the item is needed (35:129). This last component is primarily controlled by the customer; but, any change in the order processing system that increases the ease of in-checking an item contributes to the level of customer service provided by the pipeline.

### Order Entry and Processing Computers

Order entry and order processing have benefitted greatly from the application of electronic and computer technology (34:506). So when conducting total-cost analyses, pipeline managers should evaluate the capabilities of the three major types of processing systems: batch, on-line, and computer-to-computer (CPU-to-CPU) systems (21:33).

Batch entry processing systems encode all order data transmissions on a magnetic tape for mass order processing at a time beyond when the actual order is recorded (21:33). Using batch systems has two major drawbacks. The first drawback involves the batch order entry process. This process does not allow "up-front validation, of customer order information." Without up-front validation input errors and product availability status are not known until orders are processed by the next batch input cycle. The second drawback involves the inherent processing delays of batch processing systems. Depending on the frequency of the batch entry cycles, an order may be held on record but not processed for hours. This drawback can delay customer order feedback on order errors and product availability for hours or days. Thus, the outdated methods of data capture and transfer used in batch processing systems reduce the efficiency and service levels of the total order processing system (21:33).

On-line order entry and processing systems improve both internal distribution efficiency and customer service

levels. On-line systems allow for immediate entry of incoming customer orders. Each order is entered immediately upon receipt eliminating delays inherent in batch entry systems. On-line systems feature:

On-line ordering; validation at the time of input for stock items and customer information; real-time inventory update--when an order is processed, inventory is adjusted immediately; on-line access to order, customer, and inventory data;...and communications from distribution centers to the central processing computer for access and maintenance to order, shipping and inventory data.  
(21:33)

On-line systems also enable a supplier's customer service representatives to provide quick and accurate over-the-phone order status, inventory checks, and shipping data to any customer inquires (21:30). Overall, on-line systems for "order placement and entry have the potential for significant reductions in order cycle times," as well as, significant increases in customer service levels (21:33).

The most advanced order entry and processing systems combine order preparation, transmission, entry, and processing by using computer-to-computer, CPU-to-CPU, order processing systems (34:506-517). These systems locate computer terminals in customer establishments which provide customers with interactive access to a supplier's main inventory and order processing computers. CPU-to-CPU systems enable customers to directly interrogate a supplier's inventory to determine product availability, place and modify orders, and obtain up-to-date order status. (34:506-517) In all, CPU-to-CPU systems can increase

customer service levels and lower total system costs by increasing customer-supplier interaction, and eliminating order entry and processing redundancies (34:510,511).

#### Order Cycle

The order cycle is the elapsed time from when a customer prepares an order to the time the customer in-processes the product. Order cycle statistics reflect the average flow times and time variations orders encounter as they pass through each of the five components of the order processing system, as well as the system as a whole. The purpose of these statistics is to provide pipeline managers with a quantitative method for evaluating the performance of the order processing system and its components. (2:46,47,95)

A 'good' system not only provides rapid delivery times but also consistent delivery times (37:39). Customers frequently value consistent delivery times over fast delivery since it is commonly accepted that rapid delivery provides little value if it can not be achieved consistently (10:17; 2:27). Because customers prefer consistent delivery, one of the goals of pipeline managers is to reduce order cycle variability (2:46).

Order cycle statistics enable pipeline managers to determine if and where variations in the order processing system occur. Figure 5 illustrates a typical example of how order cycle statistics are reported.

Each component of the system has its own unique time distribution. These distributions represent the average and

range of processing times an order can experience as it passes through the respective components. These statistics, allow managers to evaluate the effect of each component on total system performance. With this information, managers can identify problem areas in the system and concentrate their efforts toward reducing order cycle time and variation. (2:274,275)

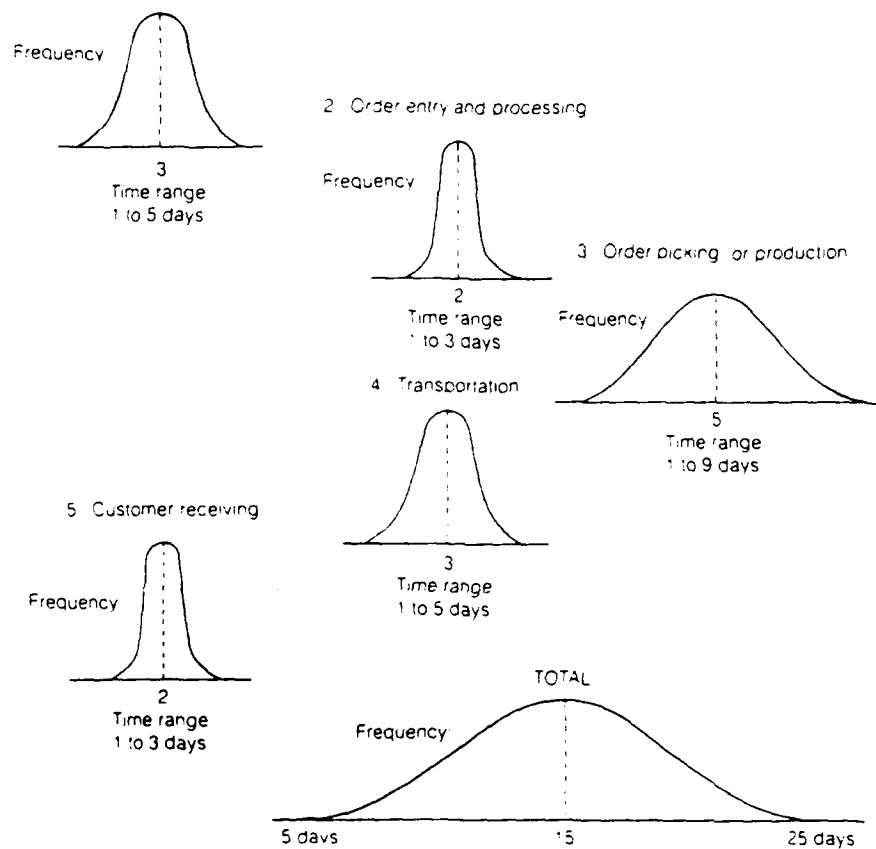


Figure 5. Order Cycle Distributions (34:502)

## Summary

This literature review provided information focused on explaining the make-up and purpose of the supply pipeline. The review began by explaining how the military supply pipeline parallels what commercial literature refers to as the logistics system. Then the function of the supply pipeline was explained along with its relationship to customer service. Subsequent discussion focused on explaining the functions and components of order processing system along with thier relationships to the pipeline. The review then described the three types of order processing computer systems and their drawbacks and capabilities. Finally, the review concluded with a description of the order cycle and its reflection of the performance of the order processing system.

### III. Methodology

#### Introduction

This chapter describes the techniques used in collecting the data required to answer the investigative questions posed in Chapter I. These questions stem from the research objective of analyzing the 463L equipment spare parts pipeline.

#### Background

"Before determining what a logistics system should be, we need to find out what it is." (19:269) Oscar Goldfarb, the Air Force Deputy for Supply, Maintenance, and Logistics Plans, posed a similar statement in a memorandum concerning pipeline studies. Mr. Goldfarb suggested the first step in studying supply pipelines is "to collectively define the pipeline and piece together what information is now regularly collected and used by managers" (12). This information would provide the insight as to what the pipeline is, and provide an indication as to what the pipeline should be. (12; 19:269) This thesis provides the first step in determining what the pipeline is now. Rather than trying to document a generic supply pipeline, this thesis concentrates on documenting a specific pipeline within the supply system, the pipeline for 463L equipment spare parts. The goal in attempting to document this particular pipeline is to address the specific issue presented in Chapter I, that of, "What organizations and

processes make up the current spare parts pipeline for 463L equipment, and how do these organizations and processes affect the availability of 463L equipment?" Documentation of this pipeline provides one step in the direction toward describing and documenting the Air Force supply pipeline as a whole.

The approach to the pipeline research conducted in this thesis follows Gomes' total system/conceptual approach described in his article, "A Systems Approach to the Investigation of Just-In-Time." This article presented a 2x2 matrix describing the approaches and analytical levels of research conducted in Just-In-Time (JIT) systems (14:78). This model was specifically applied to JIT delivery systems, but it also can be extended to pipeline studies in general. (See Figure 6)

|                         |              | Research Approach |           |
|-------------------------|--------------|-------------------|-----------|
|                         |              | Conceptual        | Empirical |
| Level<br>of<br>Analysis | Non-System   |                   |           |
|                         | Total System |                   |           |

Figure 6. Pipeline Research Matrix (Adapted from 14:79)

"This matrix suggests that research can be categorized according to two factors, (1) the researchers' approach and (2) the level of analysis used." (14:78) The researchers' approach refers to either a conceptual, concept building

study or an empirical, hypothesis testing study. These studies are conducted at either of the two levels of analysis described in Chapter I: the micro-analytical/non-systems level, examining the functioning of system parts; or, the macro-analytical/total systems level, focusing on both the parts of a system and their interactions (14:78). As discussed in Chapter I, the total systems approach provides the most effective means of analyzing the complex processes of today.

This thesis uses the total system/conceptual approach to describe the pipeline for 463L equipment spare parts. The framework for conducting this pipeline research follows the generic flow of requisitions through the order process described in Chapter II and illustrated in Figure 7. This research begins in the base vehicle maintenance section, where the customer initiates the order, and progresses through the order process back to vehicle maintenance, where the part is delivered. The flow of the order through each organization involved in the order process is documented to illustrate the path of a requisition from start to finish. When describing and documenting a process, like the pipeline for MICAP parts, several key questions must be asked:

- 1) What is the flow of the process?
- 2) What are the boundaries of the process?
- 3) Who owns the process?...
- 4) What are the objectives of the process? How is the success of the process in meeting objectives being measured?
- 5) Are the measurements being taken on the process valid? (11:42)

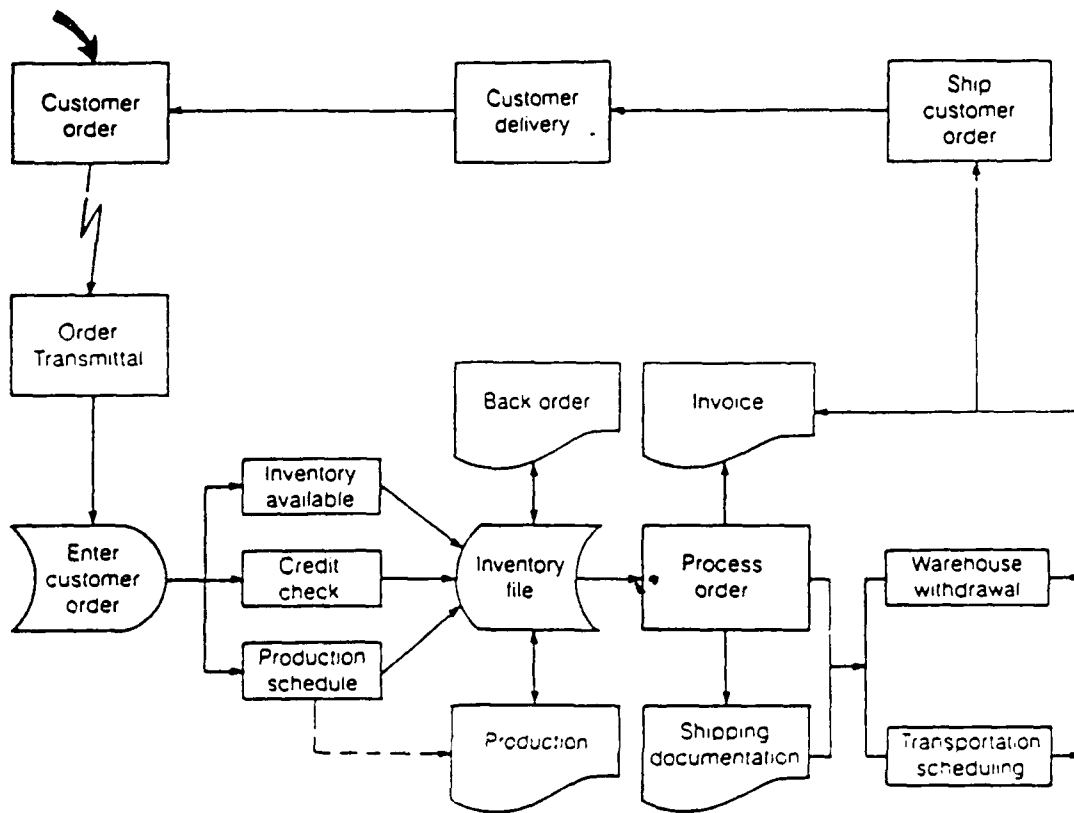


Figure 7. Generic Order Processing Flow (34:504)

Responses to these questions provide descriptions of the organizational responsibilities, relationships, and procedures required to better understand and improve the documented process (11:41-42,52-53; 19:294).

The following investigative questions were presented in Chapter I.

1. What offices, sections, and organizations are involved in the spare parts pipeline for 463L equipment?

2. What are the procedures followed by each section or unit of the pipeline in the processing of spare parts requisitions?
3. Who is responsible for monitoring the data collected for the unit and for the system as a whole?
4. How are processing times recorded and what reports reflect and summarize these times?
5. What are the average processing times and time distributions for each section of the pipeline? How do changes in the times and distributions impact the pipeline time as a whole?

They correlate well with the key questions posed by Gitlow. Therefore, by integrating Gitlow's questions with the investigative questions of Chapter I the research will document the pipeline process and provide managers of the 463L spare parts pipeline with a better understanding of the system in which they operate and control. Most importantly, the research provides an answer to the specific issue presented in Chapter I. The specific methodology used to answer the investigative questions follows.

#### Research Technique for Investigative Questions One, Two, and Three

The first three investigative questions posed in Chapter I,

- 1) What offices, sections, and organizations are involved in the spare parts pipeline for 463L equipment?
- 2) What procedures are followed by each section or unit involved in the pipeline in the processing of spare parts requisitions? and
- 3) Who is responsible for monitoring the data collected for the unit and for the system as a whole?

were answered through a combination of literature review and personal interviews.

Since the objective of answering the initial investigative questions was to define and outline the spare parts requisitioning process, the research began with a review of base level transportation and supply manuals, AFM 77-310 and AFM 67-1 series manuals, respectively. These manuals provided information concerning functional operations and requisitioning procedures. Review of the regulations was followed by an in-depth examination of the base level organizations involved in the spare parts pipeline.

Personal interviews were conducted to provide the detailed information needed to fully develop the flow of MICAP requisitions through base level pipeline organizations. These interviews were conducted with technicians and supervisors in the vehicle maintenance section and base supply squadron of Charleston AFB, SC. Charleston AFB was chosen for study because it provided an example of the spare parts pipeline developed by the primary user of 463L equipment, Military Airlift Command (MAC). Personal interviews were used as the primary method of data collection because this survey technique provided an interactive format for probing into the topic (9:160). Further, use of this technique provided the most in-depth and detailed information about the topic under study (9:160).

All depot level processing information was received through personal interviews with experts at both the Warner-

Robins Air Logistics Center (W-R ALC) for details on the Air Logistics Center depot system, and the Defense Construction Supply Center (DCSC) and Defense Electronics Supply Center (DESC) for details of the Defense Logistics Agency depot system.. Interviews conducted were with the following: Branch Chief, Materials Support Branch, Section Chief, MICAP Support Section, Supply Systems Analysts, and Equipment Specialists at W-R ALC and with the Supervisor, USAF Expedite Section, Emergency Supply Operations Center (ESOC) at both DCSC and DESC. The information gathered through these interviews were the sole sources of information concerning depot level processing procedures. No literature reviews supporting the interviews were conducted because the highly technical publications governing depot processing were far too vast to be adequately reviewed during the course of this research.

The locations chosen for the personal interviews were selected on the basis of their involvement in the 463L MICAP pipeline. Charleston AFB incurred a relatively large number of MICAP requirements, with respect to other Air Force bases, as reported in the Military Airlift Command's weapon support computer system. DLA depots satisfied approximately 85 percent of the MICAP requisitions reported in that same MAC system. Finally, W-R ALC was chosen for both their depot support for 463L equipment as well as their responsibility as the primary servicing ALC for vehicles.

Once the data was collected, flowcharts were developed, using the EasyFlow software program, to illustrate the processes, procedures, and organizational interactions involved in the spare parts pipeline. The flowchart provided "a pictorial summary of the sequence of operations that made up the [order] process." (11:45) Flowcharting also provided a means for breaking down the requisition process into its component parts and highlighting the interactions necessary to successfully document the pipeline (11:53).

The flowchart and processing information developed from literature reviews and personal interviews were then validated. Validation was achieved through feedback. After each section of the pipeline was constructed through flowchart and narrative constructs, the constructs were reviewed by the expert technicians and supervisors to ensure the flows and procedures were represented accurately. Each flow was reviewed by more than one expert to limit the amount of personal bias that may occur during any personal interview survey (9:166).

The validated flowchart was used to analyze the MICAP pipeline. As indicated in Chapter I, the macro-analytical systems approach breaks a system into its components and then reassembles the parts to provide a better understanding of the system, concentrating particularly on the interactions between and within the components. Documenting the pipeline through flowcharting provided the means to

analyze this system using the macro-system approach and better understand its operation for use in improving the process (11:53). In accomplishing this analysis, the experts were asked to point out any differences between the official pipeline, as described by regulation, and the actual pipeline, the process used in daily operations. The responses of the experts were combined with the recognized differences between the official pipeline and the "ideal" pipeline outlined in Chapter II, and reported in Chapter V of this thesis.

#### Research Technique for Investigative Question Four

The fourth investigative question, "How are processing times recorded and what reports reflect and summarize these times?" was researched through the same personal interview method used for questions one through three.

The research examined the reports cited by the pipeline technicians and managers as being the primary management tools used in managing the pipeline for MICAP requisitions, and any other reports which isolated 463L MICAP requisitions from other types of requisitions. The reason for selecting these reports was to focus the research on only those reports used in the actual management of the 463L spare parts pipeline.

#### Research Technique for Investigative Question Five

The fifth and final investigative question was broken into the following two parts: "What are the average

processing times and time distributions for each section of the pipeline?" and "How do changes in the times and distributions impact the pipeline time as a whole?" Each part was addressed separately, but the answer to the second question was dependent on the answer to the first question.

Determining the processing times for each section of the pipeline was dependent on finding supporting documentation which would provide a sufficient database from which to develop analytical charts. These charts were designed to reflect a distribution of order processing times for each section involved in the order process. These distributions were to be combined into a simplistic simulation model to be used to determine the impact of changes in the individual processing time distributions on the processing time distribution of the pipeline as a whole. The simulation model then would have provided pipeline managers with a tool for evaluating the affects of changes in the individual sections' processing times on total pipeline flow.

The random, disaggregated, and functionally oriented methods of data collection failed to produce a complete set of time distributions as desired. However, analysis of the pipeline time distributions developed from the processing times available was conducted to illustrate the difference in distributions developed from the different data sources.

## Summary

This chapter began by restating the investigative questions posed in Chapter I and compared these questions to a set of questions whose answers are considered essential to documenting any type of process. It was shown how the two sets of questions were similar, and that by addressing both sets of questions simultaneously the 463L spare parts pipeline process would be adequately documented.

The chapter then provided the techniques and methodologies used to research and document the 463L spare parts pipeline. As explained, the primary technique for researching each of the investigative questions was to conduct personal interviews with knowledgeable technicians and managers of each section of the pipeline. The information gathered was used to develop a flowchart and process description outlining the entire order process of the spare parts pipeline, particularly the processing of MICAP requisitions.

Each of the key pipeline measurements and management tools was then determined, again through personal interviews. These interviews also provided insight into what factors were actually being measured and recorded in the pipeline management reports. This information was used to evaluate the performance measurements themselves.

Finally, this chapter presented the intended technique for developing a management tool that could have been used

to evaluate the affects of changes in the order processing time distributions of each individual pipeline unit and the pipeline as a whole.

Chapter IV takes the first part of this methodology and develops the actual flow of a MICAP requisition through the 463L spare parts pipeline. Chapter V addresses the performance measurement evaluation and presents an analysis of the pipeline order processing time data collected during the course of this research.

#### IV. Process Description

##### Overview

This chapter provides the first step in conducting a macro-analytical analysis of the 463L equipment spare parts pipeline. The chapter begins with a general diagram of the organizations that constitute the 463L parts pipeline and illustrates how the different parts of the pipeline interact through their inputs and outputs. Following the general pipeline diagram is a series of flowcharts and process descriptions of the major components of the pipeline. These charts and descriptions illustrate the different routes parts requisitions follow as they flow through the components of the pipeline.

In describing the flow, this chapter also addresses the first two investigative questions posed in Chapter I:

--What offices, sections, and organizations are involved in the spare parts pipeline for 463L equipment? and

--What are the procedures followed by each section or unit involved in the pipeline in the processing of spare parts requisitions?

These two questions closely parallel the first of Gitlow's key questions to documenting a process, "What are the boundaries of the process?" and "What is the flow of the process?" (11:42) As a result of the similarity of the two sets of questions, providing an answer to the investigative

questions also provides the first step in documenting the 463L spare parts pipeline.

#### Background

This analysis primarily concentrates on the portion of the 463L equipment spare parts pipeline involving the flow of requisitions for vehicles in Vehicle Deadlined for Parts (VDP) status. This status signifies that vehicles cannot perform their intended mission because of broken or missing parts which are not available from on-base stocks or resources. Thus, any 463L equipment in VDP status reduces the air cargo handling capability of the Air Force.

The Air Force realizes the critical nature of 463L equipment and lists this cargo handling system as a Mission Capability (MICAP) reportable system. As a MICAP reportable system, any requisitions for parts causing a VDP condition for 463L vehicles or equipment receives a MICAP reportable Standard Reporting Designator (SRD) code. This code identifies requisitions as high priority and facilitates processing of the requests through a series of specialized procedures designed to expedite the handling of the order and reduce the total down time of the equipment. MICAPs essentially create a special channel within the spare parts pipeline through which high priority requisitions flow. This channel provides the focus for the following description and analysis.

### Pipeline Overview

The 463L MICAP pipeline consists of four major organizational components: Vehicle Maintenance, Base Supply, and two depot systems - the Air Logistics Centers (ALC) and the Defense Logistics Agencies (DLA). All of these components combine to form the spare parts pipeline. Figure 8 illustrates the general flow of requisitions through the pipeline.

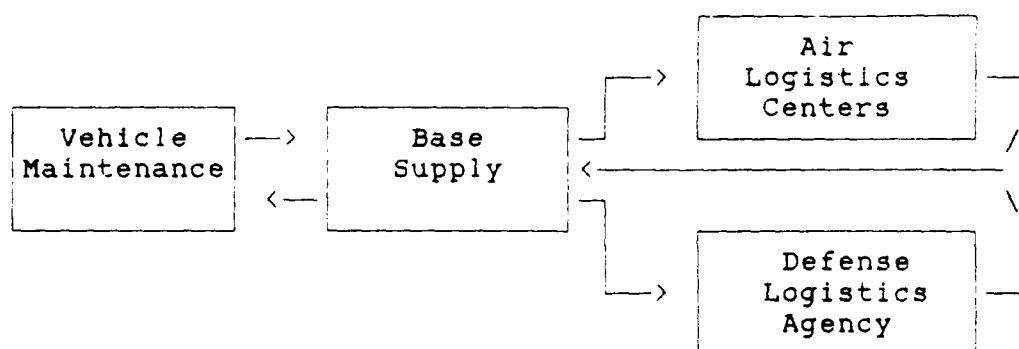


Figure 8. Spare Parts Pipeline - General Flow

As shown, requisitions originate in Vehicle Maintenance and are passed to Base Supply. Supply then processes the requisitions and transmits them to either an ALC or DLA depot. The depots further process these requisitions and either send the requisitioned parts or transmit requisition status back to Base Supply which, in-turn, passes the parts and/or status on to Vehicle Maintenance to complete the order cycle.

Using this general flow as a reference, the next four sections of this chapter describe the internal flows and processes of each of the major components. To best follow

and understand the process descriptions of the components, it is suggested the reader follow the flow diagram in the referenced figure for each component. Following the path of the flow provides a visual frame-of-reference for the processes described in subsequent sections.

#### Vehicle Maintenance Processing

Spare parts requisitions for 463L vehicles are initiated in the vehicle maintenance shop, but a number of processes and decisions must take place prior to submitting a MICAP requisition. The determination as to whether or not a vehicle is placed in VDP status and an accompanying MICAP requisition initiated depends on the need and availability of parts from local or base resources. The processes used to determine part availability and eventually initiate VDP/MICAP conditions are flowcharted in Figure 9 and follow the logic outlined in the process description which follows.

The entire process begins when a piece of 463L equipment enters the maintenance shop in an out-of-commission condition. When a vehicle is checked into vehicle maintenance, Maintenance Control and Analysis (MCA) initiates a AF Form 1823, Vehicle and Equipment Work Order, to document the labor and parts required to repair the vehicle. At this time, MCA also assigns the vehicle a Vehicle-Down-for-Maintenance (VDM) coding. A vehicle mechanic then receives the work order and analyzes the vehicle to determine the cause of vehicle failure. If the

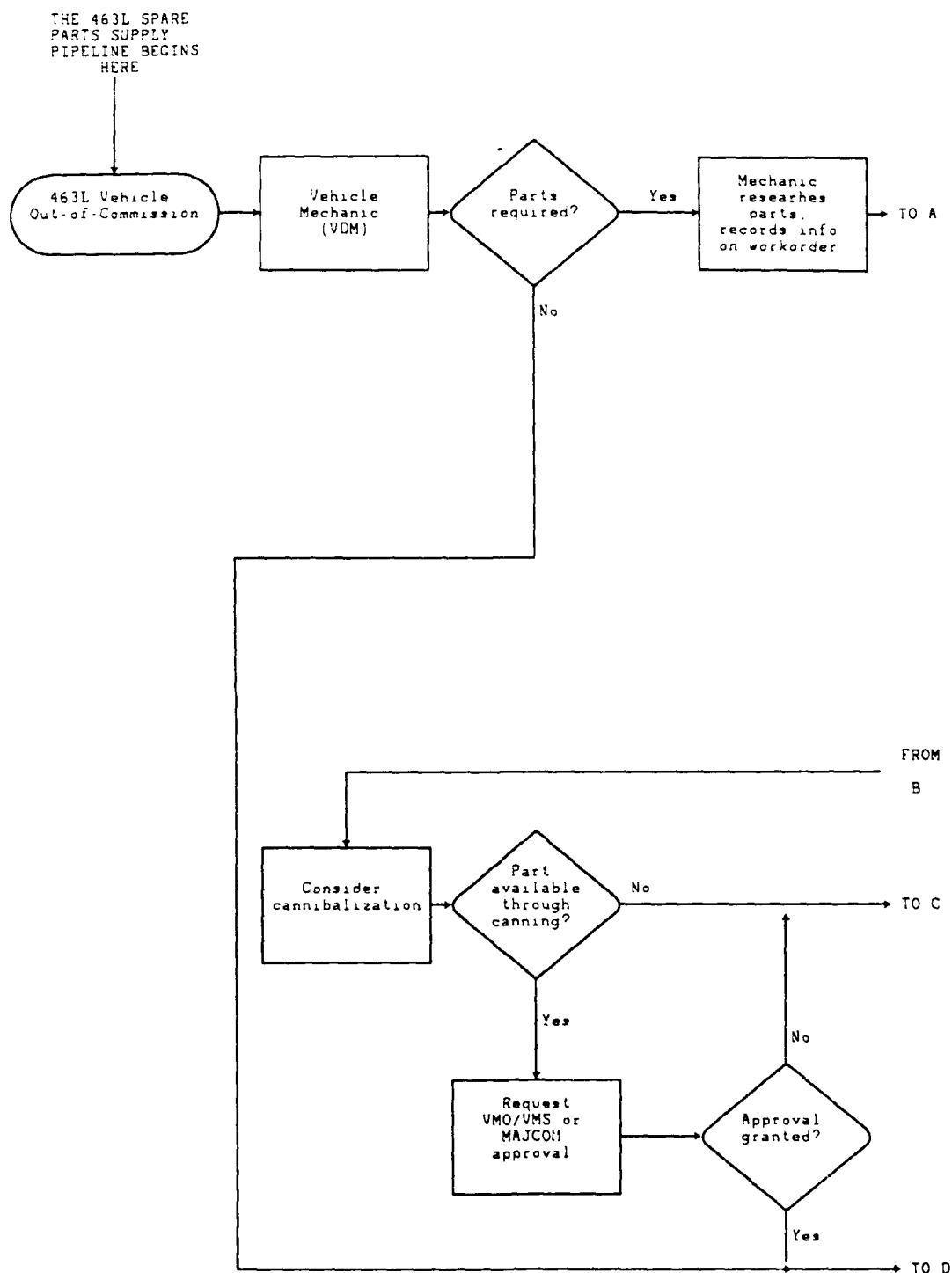


Figure 9. Flowchart - Vehicle Maintenance

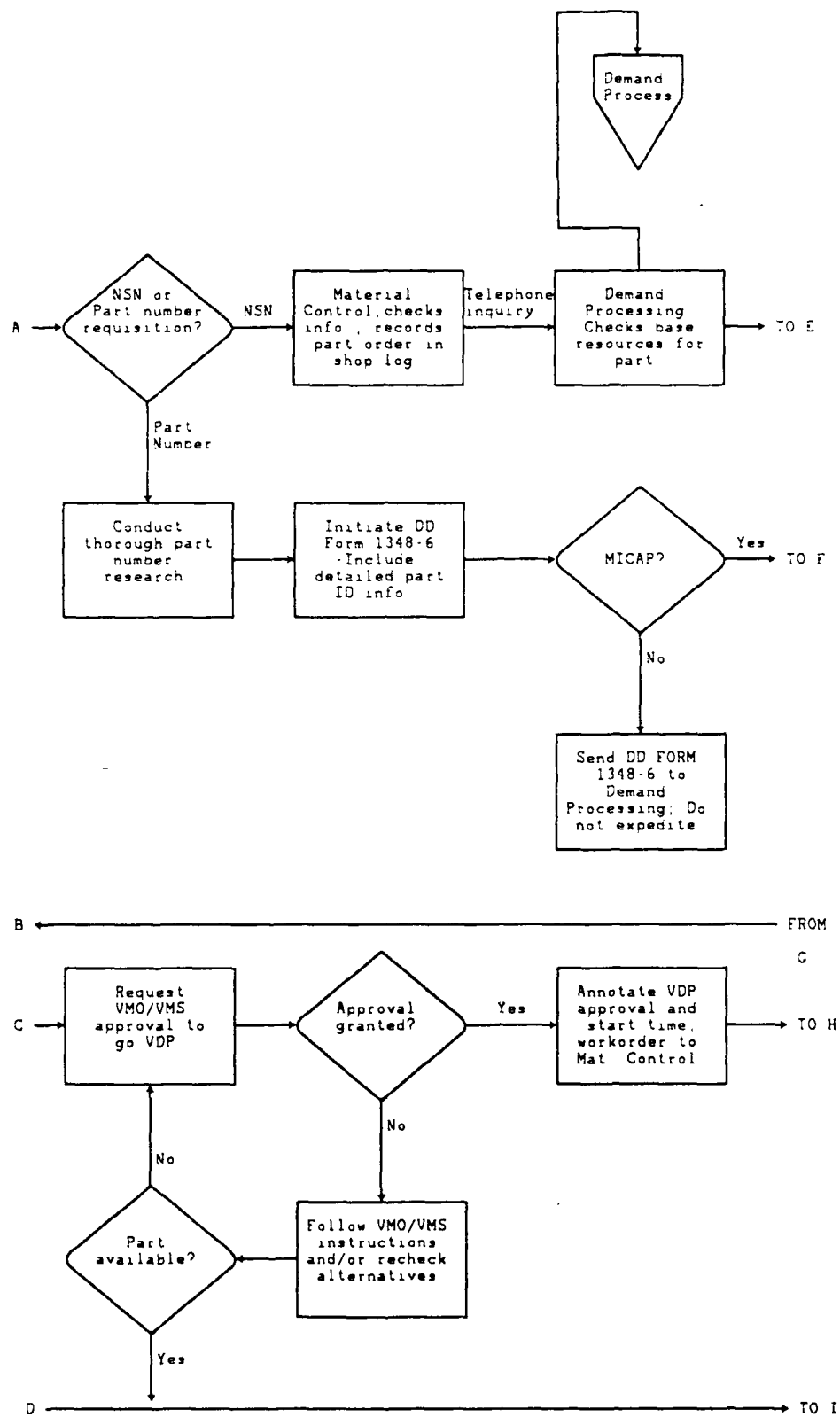


Figure 9. Flowchart - Vehicle Maintenance (Cont.)

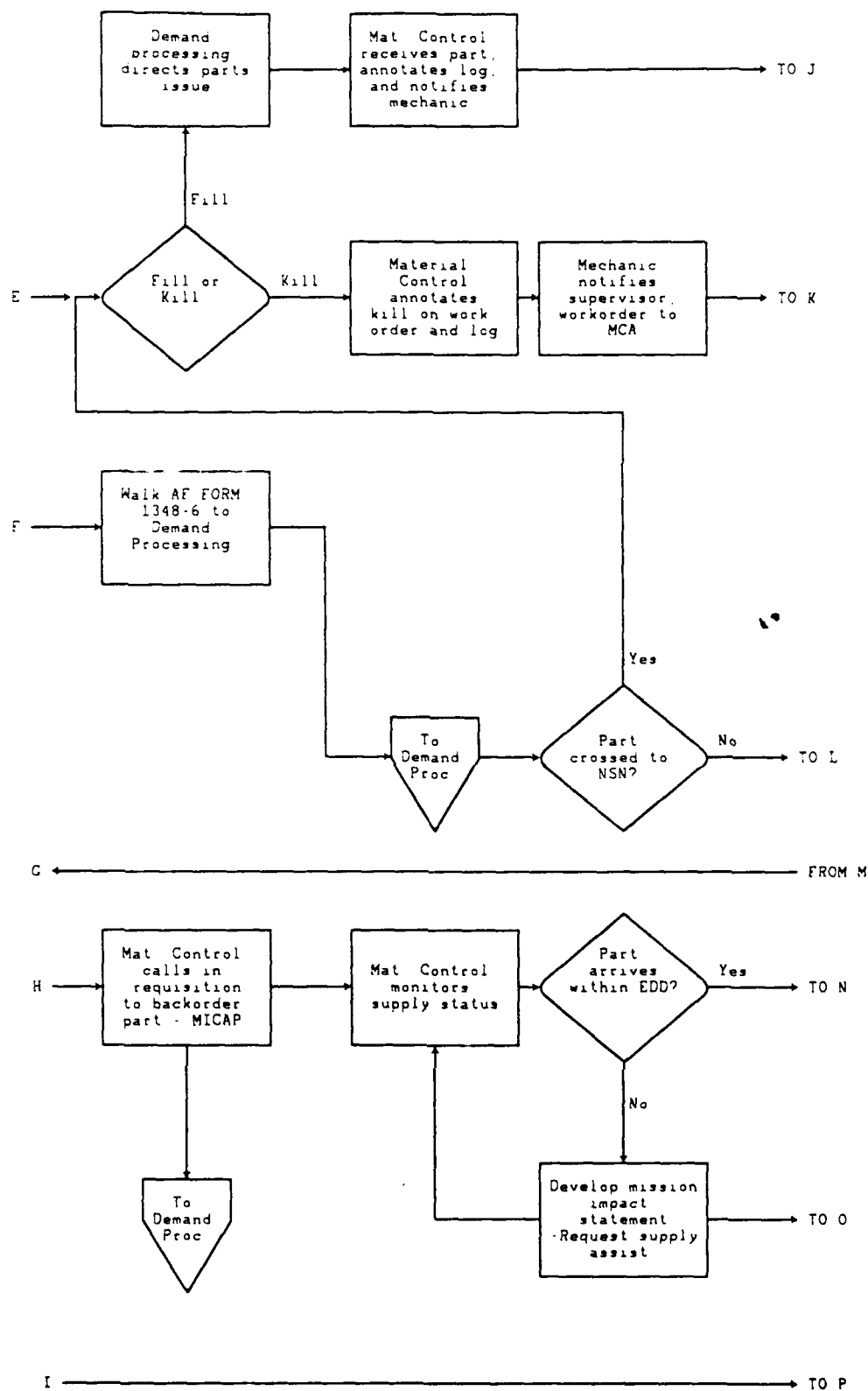


Figure 9. Flowchart - Vehicle Maintenance (Cont.)

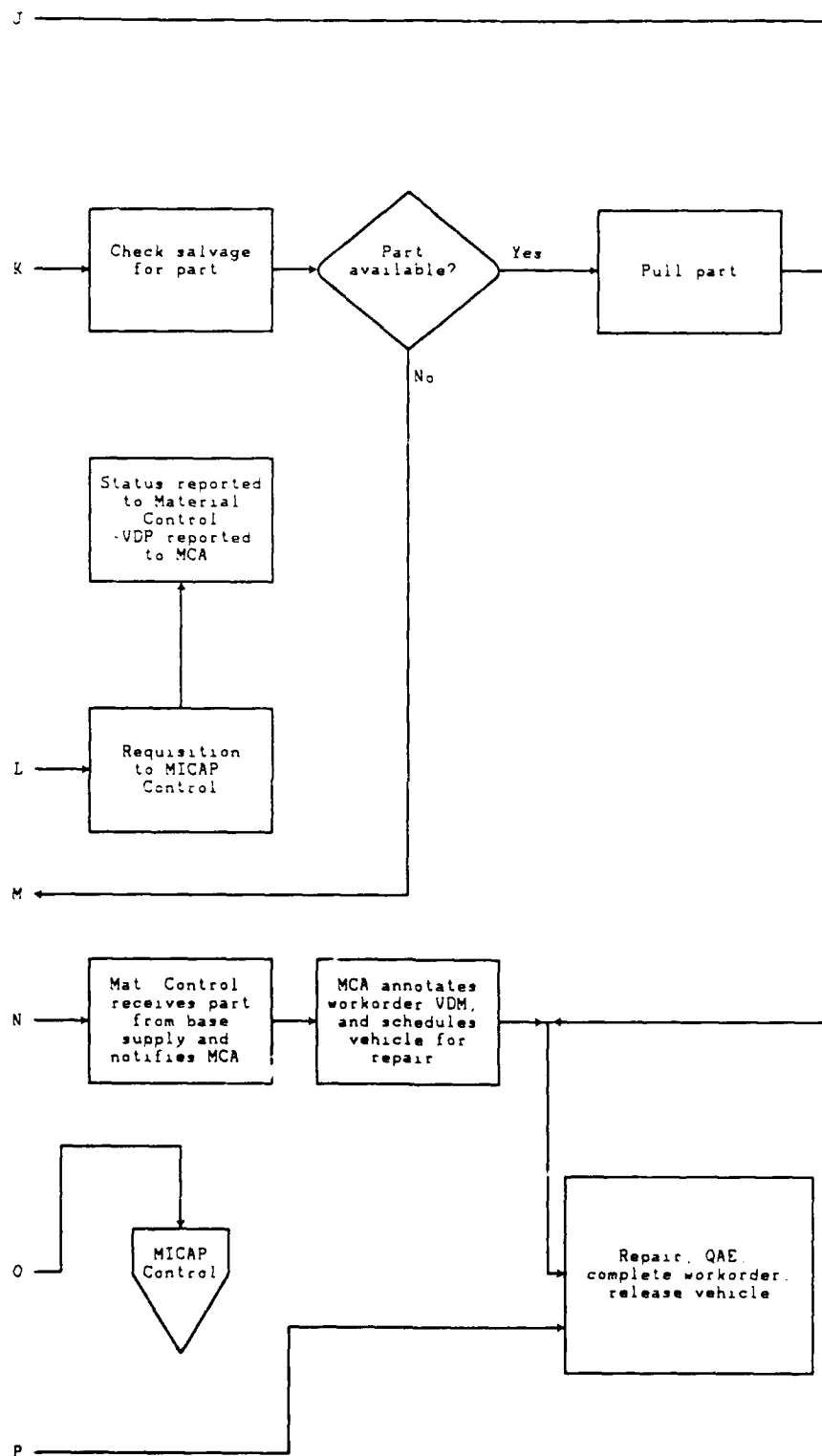


Figure 9. Flowchart - Vehicle Maintenance (Cont.)

failure repair does not require parts, the mechanic makes the repair and returns the vehicle and workorder to MCA.

For repairs requiring parts, the mechanic identifies the necessary parts and researches vehicle Technical Orders (T.O.) and microfiche part number/National Stock Number (NSN) cross-reference listings to determine the correct part numbers and NSNs required to order the parts through the supply system. The mechanic records the part numbers and NSNs on the work order. If no NSN is found to correspond with a part number, the mechanic lists the part number and T.O. references on the work order. The mechanic then submits the workorder to the Material Control section of vehicle maintenance (33).

"Material control is the liaison between the maintenance and supply systems and manages supply transactions for (vehicle) maintenance." (7:47) As such, Material Control receives all parts requests from the maintenance shops on the AF Form 1823. The material controller then reviews the work order to determine whether or not all the parts required have associated NSNs.

NSN Requisitions. When workorders have NSNs listed for all of the part numbers, Material Control conducts cursory checks for any obvious errors in the NSN and calls the Demand Processing (DP) unit of base supply with a fill or kill request. The fill or kill procedure provides the material controller with an immediate response as to the availability of parts from base stockage (30). If

the parts are available, the controller records a "fill" for the requisition and orders the part (33). Material Control monitors the order to ensure the part is delivered (7:47).

If the parts requisitioned are not available through base stockage, Material Control annotates a "kill" for those parts and returns the work order to the mechanic (33). The mechanic notifies his supervisor of the "kill" and turns the work order over to MCA. MCA and Material Control then check the possibility of acquiring the part from vehicles being processed for salvage. If the part is available, the mechanic takes the part from salvage and repairs the vehicle in the shop (7:47,105).

If no parts are available from salvage, MCA checks the possibility of cannibalization. Cannibalization is the process of taking a part off of a vehicle already down for extensive maintenance and placing the part on the vehicle in the shop to make it mission capable again (7:105).

"Cannibalization is used only when the deadline of the vehicle seriously affects the user's mission" (7:10). So, if the part is available through cannibalization, MCA or the material controller submits a cannibalization request to the Vehicle Maintenance Officer (VMO)/Vehicle Maintenance Superintendent (VMS) or, in the case of 463L equipment, to MAJCOM for approval. In most cases, the VMO/VMS has the authority to approve the cannibalization of parts, but "all major components and assemblies cannibalized from critical assets" must be approved by the owning MAJCOM (7:10). 463L

equipment is a critical asset, so some requests for cannibalizing 463L parts are required to be routed through the MAJCOM before the part is removed and used. Once MCA receives approval, the mechanic cannibalizes the part and repairs the vehicle, thus averting a VDP/MICAP condition (7:27).

If all of the preceding possibilities have been considered and no parts are found to be available, MCA submits the workorder to the VMO/VMS for approval to place the vehicle into a VDP status. Upon approval, MCA properly annotates the AF Form 1823, Vehicle and Equipment Work Order, with the VDP start time (7:27). This "VDP time starts when the VMO/VMS confirms that parts or material are not on-hand." (7:86) MCA then returns the work order to the material controller who monitors the requisition until the part is received.

Part Number Requisitions (No NSN). If only part numbers are listed, the material controller cross-checks the part number against the microfiche cross-reference lists. If the cross check does not match an NSN to a part number, the controller along with the mechanic, if necessary, lists any T.O.s, page and figure numbers, Sources of Supply (SoS), and other reference information that list or identify the part. The material controller then writes this information on a DD Form 1348-6, DoD Single Line Item Requisition System Document (Manual-Long Form), and carries the form to Demand Processing for further research and processing (33). If

Supply crosses the part to a valid NSN, DP notifies Material Control and processes the requisition as an NSN fill or kill request. If an NSN is not found, DP passes the requisition to the MICAP control section of base supply (27). Material Control then receives notification of the requisition status and annotates the vehicle workorder with a VDP status and start time, and passes the AF Form 1823 to MCA (33).

When 463L vehicles go VDP, Material Control assigns the proper MICAP reportable SRD codes to parts requisitions, and calls Demand Processing to place the MICAP part on backorder. Material Control monitors the D18 report, Priority Monitor Listing, for the status of the MICAP requisition until the parts arrive at vehicle maintenance (30). Because of the high priority and visibility of MICAP requisitions, Material Control verifies the status of MICAP parts daily to ensure the status and Estimated Delivery Dates (EDD) of the parts requisitions are consistent with the needs of the user. If Material Control receives "bad" status or notices the EDD is extended or exceeded, the controller reports the change to both the MICAP section of supply and the VMO (7:24,47). If necessary, Material Control develops a mission impact statement, with inputs from the organization owning the equipment, and provides it to MICAP Control to initiate a supply assist request on any requisitions for which the supply status and/or EDD fail to meet mission requirements (40).

When Material Control receives the requisitioned part, the controller notifies MCA, which concurrently takes the vehicle off VDP status, places it in Vehicle-Down-for-Maintenance (VDM) status, and schedules the vehicle for repair (7:27).

#### Supply Processing

Material Control provides the input to the next portion of the pipeline by either phoning or walking MICAP part requisitions to the Demand Processing section of base supply, as indicated in Figure 10. Phone-in requisitions are either NSN or part number requests.

NSN Requisitions. For NSN call-in requisitions, the Material Controller provides Demand Processing (DP) with the NSNs and SRD codes for the required parts along with other required organizational and funding information. Demand Processing records this information on an AF Form 2005, assigns the requisition a document number, and enters the demand into the Standard Base Supply System (SBSS). The initial demand is processed on a "fill or kill" basis. If the part is in-stock, DP reports a "fill" to Material Control and processes the requisition through the computer. The SBSS generates a DD FORM 1348-1, DOD Single Line Item Release/Receipt Document, with an 02 Priority which directs the warehouse to expeditiously pick the order and send it to the delivery section. The delivery section then delivers the part to Material Control within 30 minutes. (27)

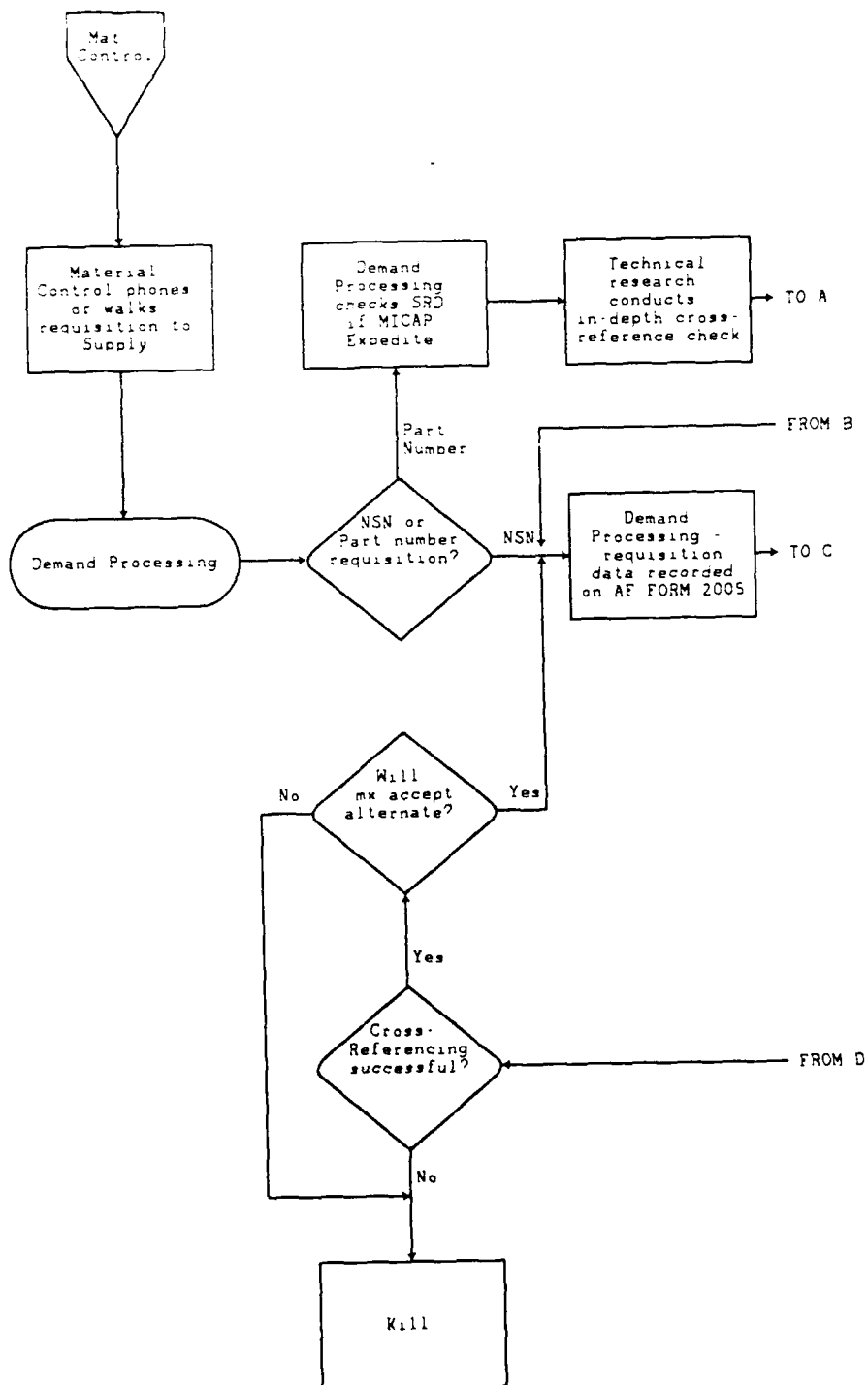


Figure 10. Flowchart - Demand Processing

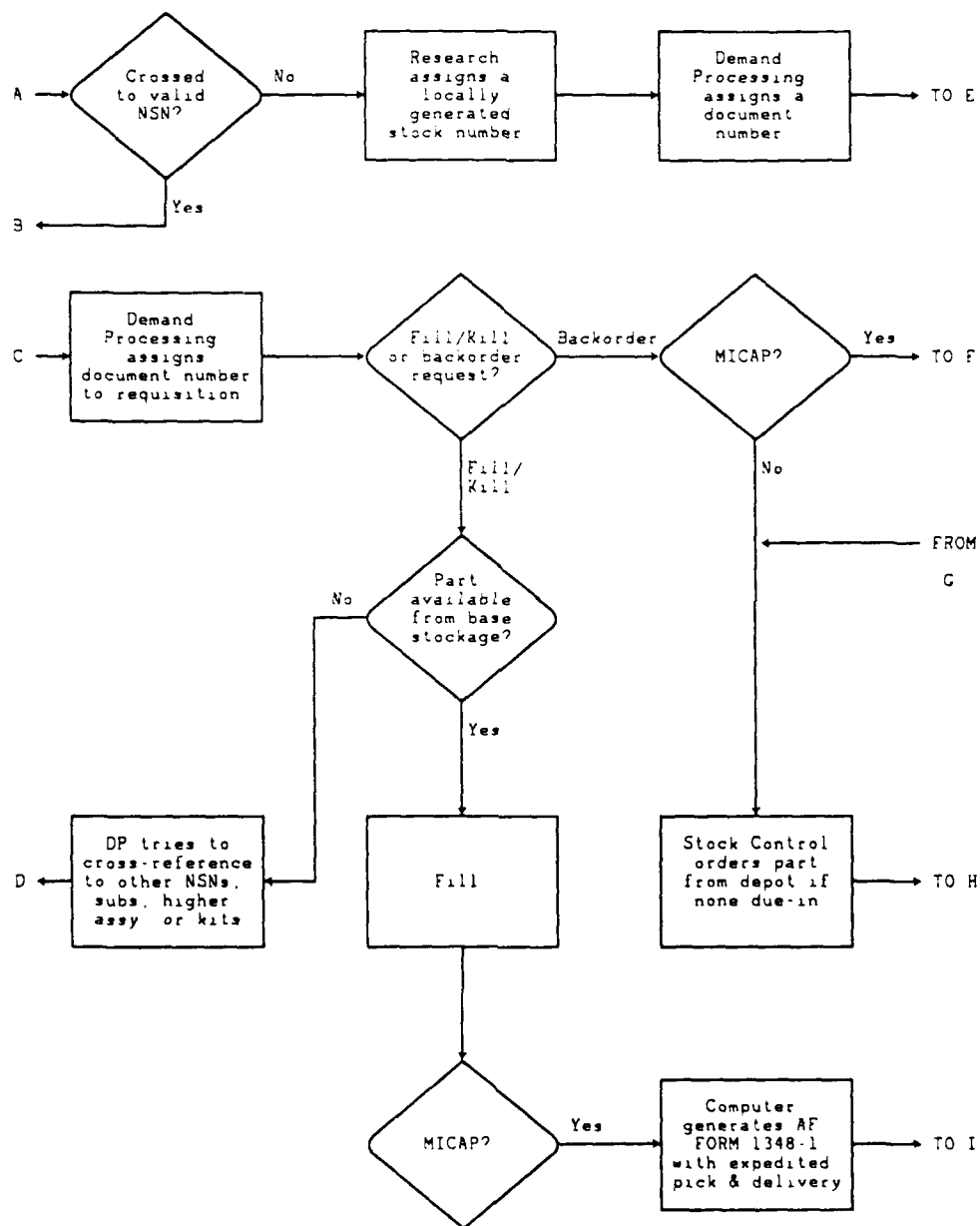


Figure 10. Flowchart - Demand Processing (Cont.)

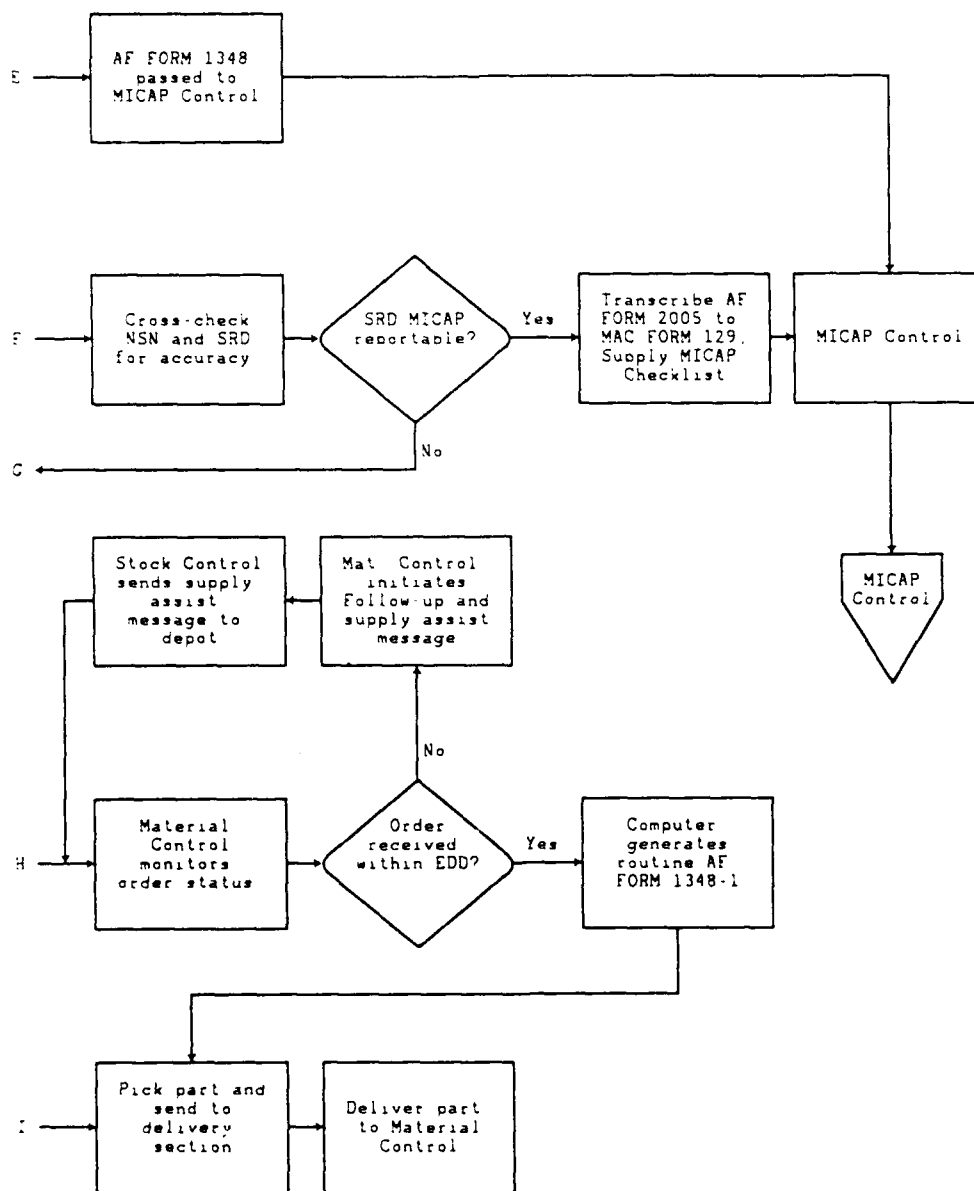


Figure 10. Flowchart - Demand Processing (Cont.)

If the part is not in-stock, Demand Processing attempts to cross-reference the NSN to a different in-stock NSN, suitable substitute part, next higher assembly, or rebuild kit that may be used to repair the vehicle. If an alternate NSN is found, DP contacts Material Control and asks if vehicle maintenance will accept the alternate part. If the alternative is acceptable, the alternate NSN is recorded on a AF FORM 2005 and processed through the computer as any other NSN requisition. If no alternate NSN is found or vehicle maintenance does not accept the alternate NSN, the requisition is "killed" and reported to Material Control.

(27)

Part Number Requisitions. For part number requisitions, Material Control conveys the request by telephone or sends a courier with a non-NSN requisition DD Form 1348-6, DoD Single Line Item Requisition System Document (Manual Long Form) to DP. If the request is received over the phone, DP requests the part number and T.O. references along with any other part information that will aid in locating and/or procuring the part. DP records this information on a DD Form 1348-6 and passes the requisition to the Research Section of supply alerting Research to any MICAP requests. The research section then conducts an in-depth cross-reference check in an attempt to find a valid, stock listed, NSN for the requisitioned part. This check includes researching T.O.s, microfiche cross-reference listings, and if available, computerized part

number cross-reference data bases that access information on all valid DoD part numbers and NSNs. If the check crosses the part number to an NSN, the NSN is recorded on the requisition and processed as an NSN request. If the in-depth check does not cross the part number to an NSN, Research assigns the part number a locally generated stock number and returns the requisition to DP for a document number. At this time, DP also initiates a MAC FORM 129, Supply MICAP Checklist, and annotates any checks already conducted on the part and its availability. DP passes the MAC FORM 129 and DD FORM 1348-6 to MICAP Control for further processing (27).

When Material Control submits NSN requisitions for backorder, DP records the request on an AF Form 2005 and again checks to ensure the SRD is valid and MICAP reportable. DP transcribes the order information from the AF FORM 2005 to a MAC FORM 129 and turns this MICAP Checklist over to MICAP Control for further processing (27).

MICAP Control receives the MAC FORM 129 and, if required, the DD FORM 1348-6 and conducts a series of checks to find the most expedient means of acquiring the parts required. Figure 11 illustrates the procedures followed by MICAP Control in processing MICAP requisitions. For part number requisitions, MICAP Control calls or sends a message to the depot's Customer Service or Part Number Requisition department and provides the part number information from the

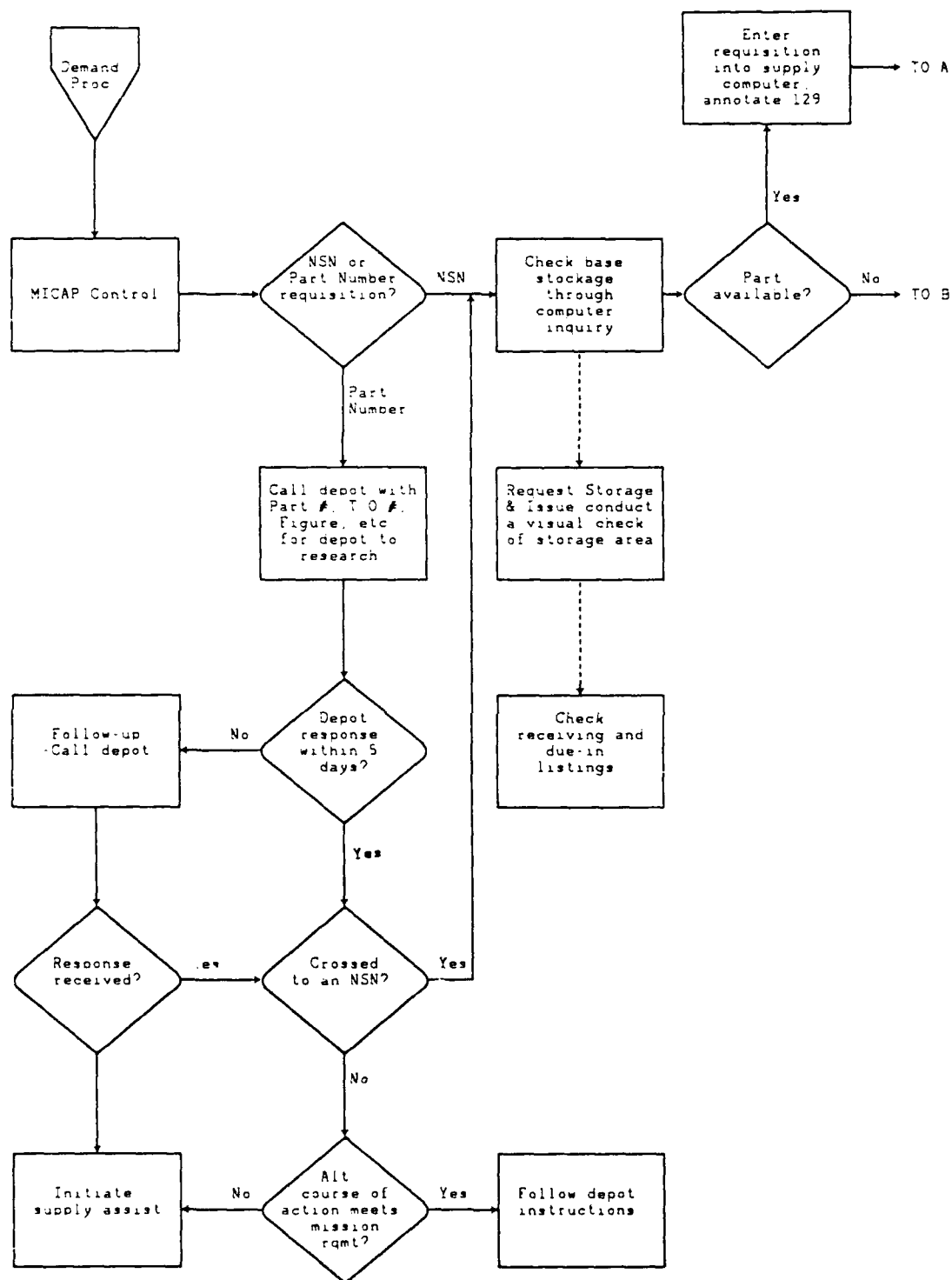


Figure 11. Flowchart - MICAP Control

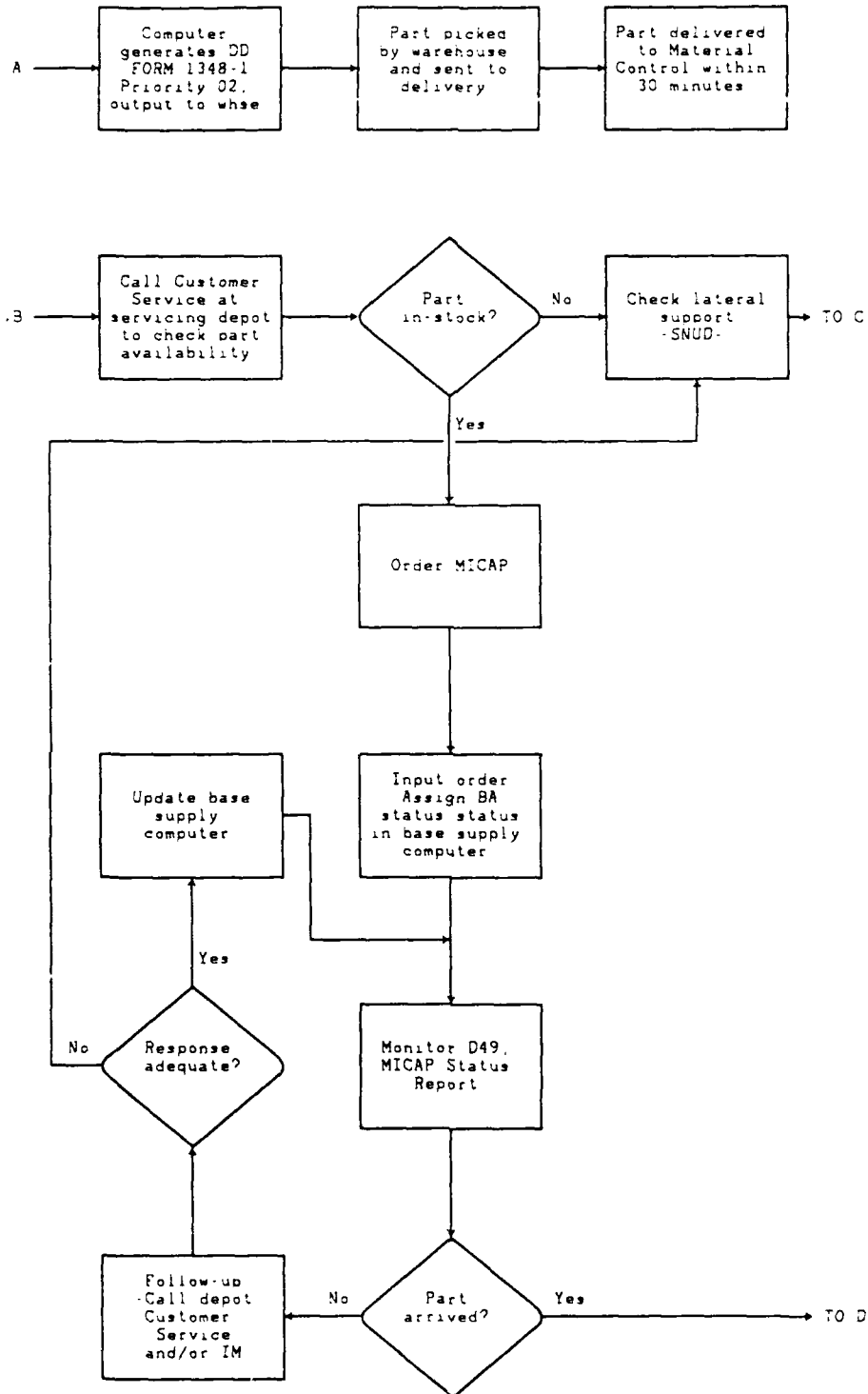


Figure 11. Flowchart - MICAP Control (Cont.)

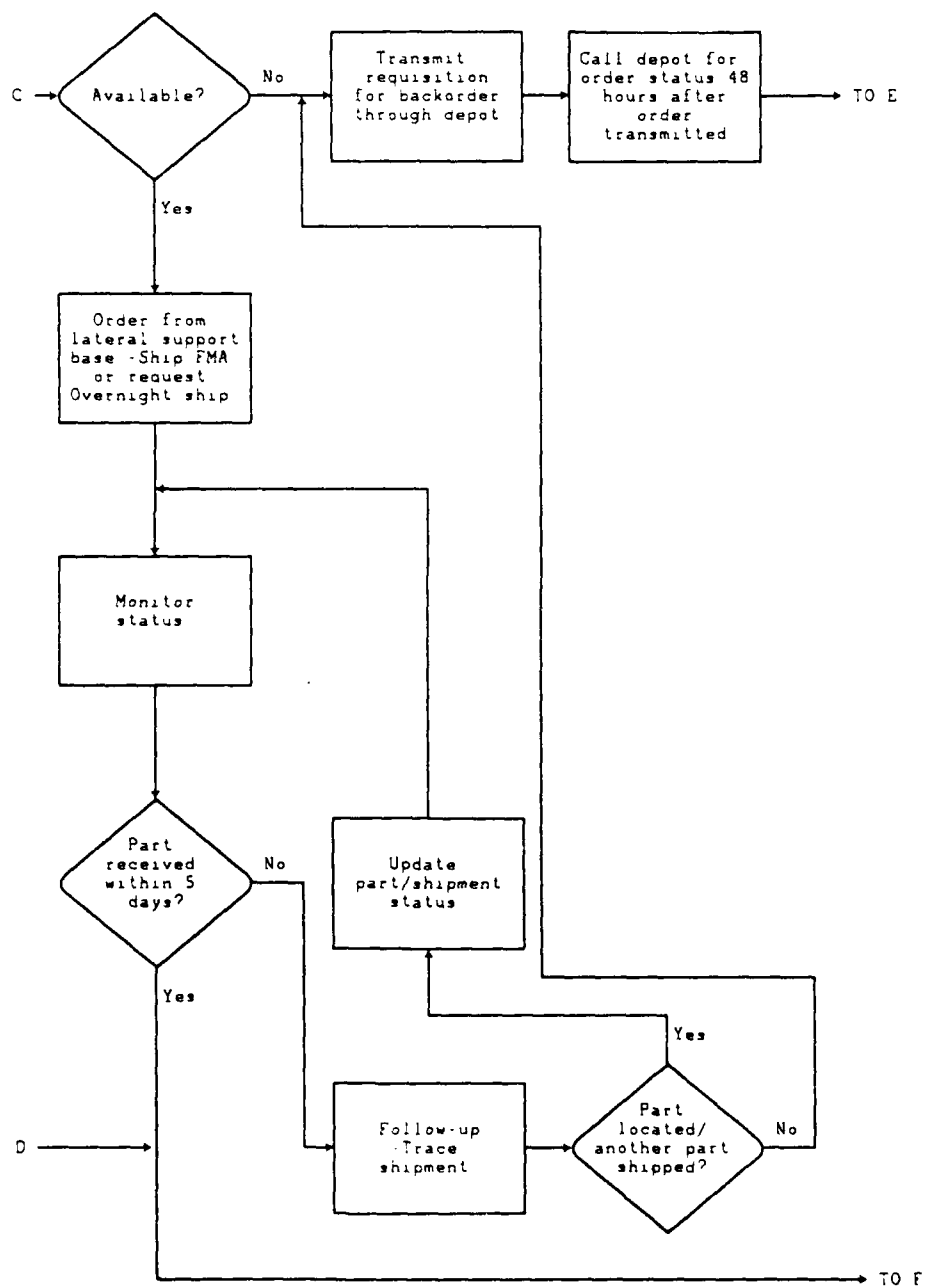


Figure 11. Flowchart - MICAP Control (Cont.)

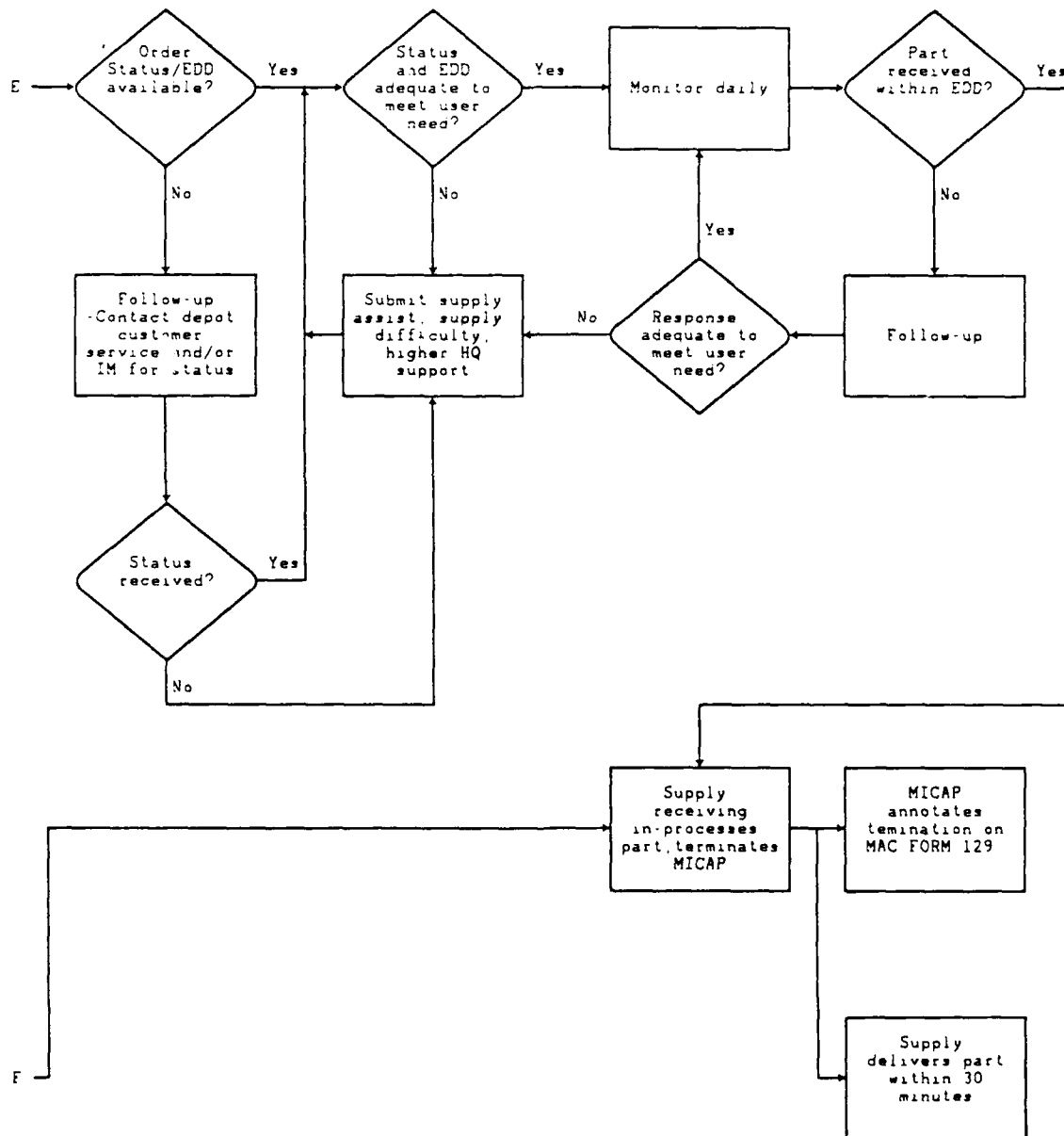


Figure 11. Flowchart - MICAP Control (Cont.)

DD FORM 1348-6 to the depot for further research. MICAP Control then awaits a response from the depot.

If the depot does not provide a message response within a specified time period, determined locally by the MICAP Control section, the MICAP controller calls the depot for follow-up information concerning the requisition. When the depot response is received, MICAP Control checks to see if the part number was crossed to an NSN. If so, MICAP Control follows the procedures for processing NSN requisitions outlined in the next paragraph.

If the part number was not crossed to an NSN, the servicing depot provides instructions detailing an alternative means of satisfying user demand. MICAP Control evaluates the depot instructions for satisfying the demand. These instructions can vary from waiting for the depot to establish a contract for the procurement of the part to cancellation of the requisition and authority for the base to locally procure or manufacture the part, if possible. If the instructions meet the requesting organization's mission requirements, MICAP Control follows the instructions that most expeditiously satisfy the requisition. If the depot instructions do not meet the mission requirements of the user, MICAP Control sends the depot a Supply Assistance message, with a mission impact statement provided by the user, requesting additional parts support or expedited delivery dates (40).

When MICAP Control receives NSN requisitions from DP, MICAP Control processes the request by first re-checking the base supply computer to ensure the part is not available through any on-base assets, including war readiness material or spares kits. This check also searches for suitable substitutes or higher assemblies that may satisfy the requisition (40). Depending on local procedures, MICAP control may request Storage and Issue to conduct a visual check of the storage area of parts normally stocked on-base but were reported as out-of-stock by the supply computer. If the required part is located, the requisition is processed through the computer which generates a DD FORM 1348-1 with an O2 priority. The O2 Priority signifies the part must be delivered to the requestor within 30 minutes after reception by the supply delivery section. (40)

When a part is not found on base, MICAP Control checks off-base parts sources. The MICAP controller begins by calling the customer service section of the servicing depot to check on the availability of the part through the depot. If the part is in-stock, the controller orders the part immediately. The controller then assigns a BA status, item being processed for release and shipment, to the requisition and inputs this information into the supply computer. MICAP Control monitors the D49, MICAP Status Report, daily until the MICAP is in-processed by the receiving section of base supply. When the part is in-processed, the computer automatically terminates the MICAP and updates the D49

report to reflect the termination. MICAP Control then annotates the termination time on the MAC Form 129 (40).

If the part does not arrive within a locally specified period of time, the MICAP controller calls the Customer Service section of the depot or the IM of the NSN to find out why the part is delayed. If the controller receives a response from depot adequate to meet mission requirements, determined by MICAP Control and the requesting organization, he updates the requisition status in the SBSS and monitors the parts arrival through the D49 report (40). If the response does not meet mission requirements, MICAP Control cancels the requisition and follows lateral support procedures. In these cases, the depot requisition must be cancelled prior to going lateral support because of guidelines presented in AFM 67-1 that state, depot requests and lateral support requests cannot be conducted concurrently for the same requisition (8:17-11).

In cases where the part is not in depot stock, MICAP Control checks the possibility of getting the part from other bases through lateral support. To check lateral support, the MICAP controller reviews the Stock Number Users Directory (SNUD). The SNUD lists all Air Force bases which use the NSNs referenced in the directory. The controller contacts the bases listed as using the required NSN. If the part is available from one of these bases, the controller orders the item from the owning base.

The lateral support base ships the part by the fastest means available (FMA). Once ordered, the controller enters the requisition status into the SBSS and monitors the D49 report until the part arrives at base supply. If the part does not arrive on base within locally determined period of time, about five days for FMA shipments, MICAP Control contacts the lateral support base to find out why the part is delayed (40). If the part has been shipped, MICAP requests the sending base trace the shipment to find out why the delivery is delayed. Once the part arrives on base and is in-processed by supply, the MICAP is terminated and the part delivered within 30 minutes (40).

When a part is not available through lateral support or lateral support arrangements fail, MICAP Control backorders the part through the servicing depot. MICAP Control normally backorders parts through a computer-to-computer autodin transmission network. MICAP Control monitors the D49 report for a status and EDD on the requisition. If no status is received within 48 hours of the order, the controller calls the depot's Customer Service section to ask for status on the requisition. If order status is received, MICAP Control enters the status and EDD into the SBSS. The MICAP controller then monitors the D49 report daily until the part is received and the MICAP terminated.

If Customer Service cannot provide an answer, the controller will contact the Item Manager (IM) responsible for that NSN for a reply. Once the controller receives a

status and EDD on a requisition, MICAP Control and Material Control evaluate the status and EDD to ensure they are consistent with mission requirements. If status and EDD do not meet mission requirements and the controller fails to receive a satisfactory reply from the IM, MICAP Control initiates a supply assistance, supply difficulty, or higher headquarters support request to explain the mission impact of the problem and request assistance in resolving the problem. (40)

When the controller receives a "good" or adequate status and EDD on a requisition, he monitors the D49 report daily. If the part is received by the EDD, the controller enters the MICAP termination time on the MAC Form 129 and files the checklist for 30 to 60 days (40). If the part is not received by the EDD, the controller calls the depot to find out where the part is and why it is delayed. If he receives an adequate reply, the controller will update the requisition status in the SBSS and monitor the D49 report daily until the part arrives or again exceeds its EDD. If MICAP Control does not receive a "good" answer, the controller initiates either a supply assistance, supply difficulty, or higher headquarters support request in an attempt to expedite the processing or acquisition of the part required (40).

In summary, the base supply Demand Processing and MICAP Control sections constitute a significant portion of the 463L spare parts pipeline. The input which initiates supply

processing is the requisition submitted to DP by the Material Control section of vehicle maintenance. Supply then proceeds with its order processes and provides either a part to vehicle maintenance or a requisition to another portion of the supply pipeline. Thus, Supply receives inputs from Material Control, processes these requisitions, and provides outputs to other parts of the pipeline. With this pipeline interdependence, any problems or difficulties within one portion of the system affects many other processes, and performance of the system as a whole.

#### Defense Logistics Agency Processing

MICAP requisitions from base level MICAP Control sections are the inputs to the depot portion of the spare parts pipeline and enter either the Defense Logistics Agency (DLA) or Air Logistics Center (ALC) depot system. Within the DLA and ALC systems, depot facilities manage specific types of parts and equipment grouped together into what are referred to as Federal Stock Classes (FSC) (24). The first four digits of an NSN identify the particular FSC of the part and specifies the depot which receives and processes the requests for the part (24). Approximately eighty-five percent of the MICAP depot requisitions for 463L parts fall under the purview of DLA depots and follow the process flow diagrammed in Figure 12. Requisitions following the ALC process flow are described in the subsequent section.

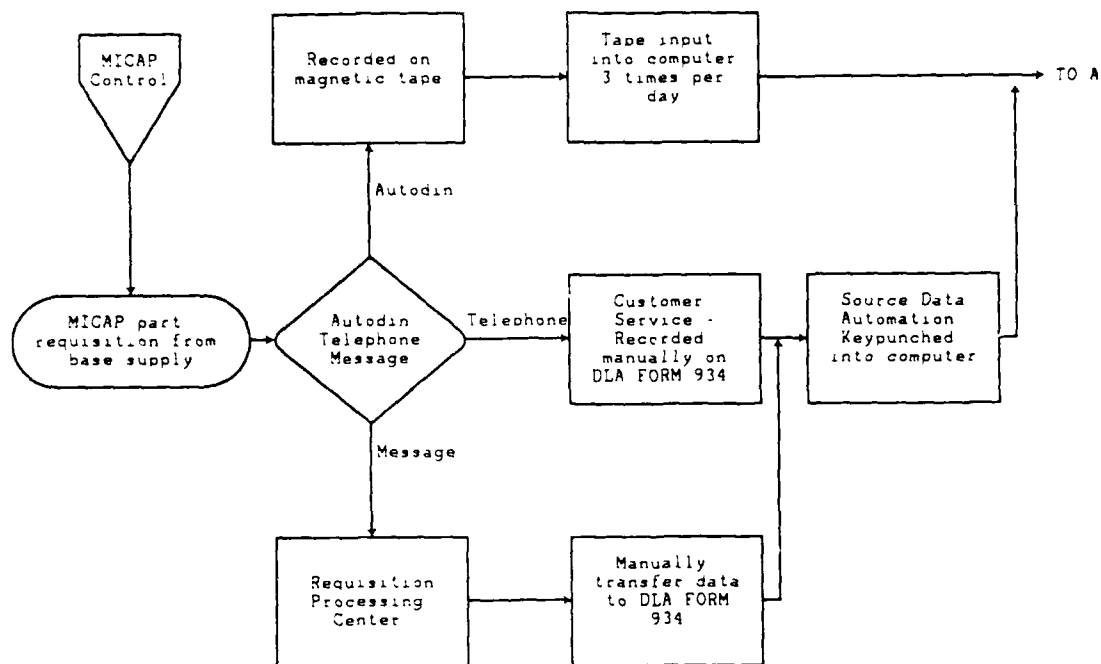


Figure 12. Flowchart - Defense Logistics Agency

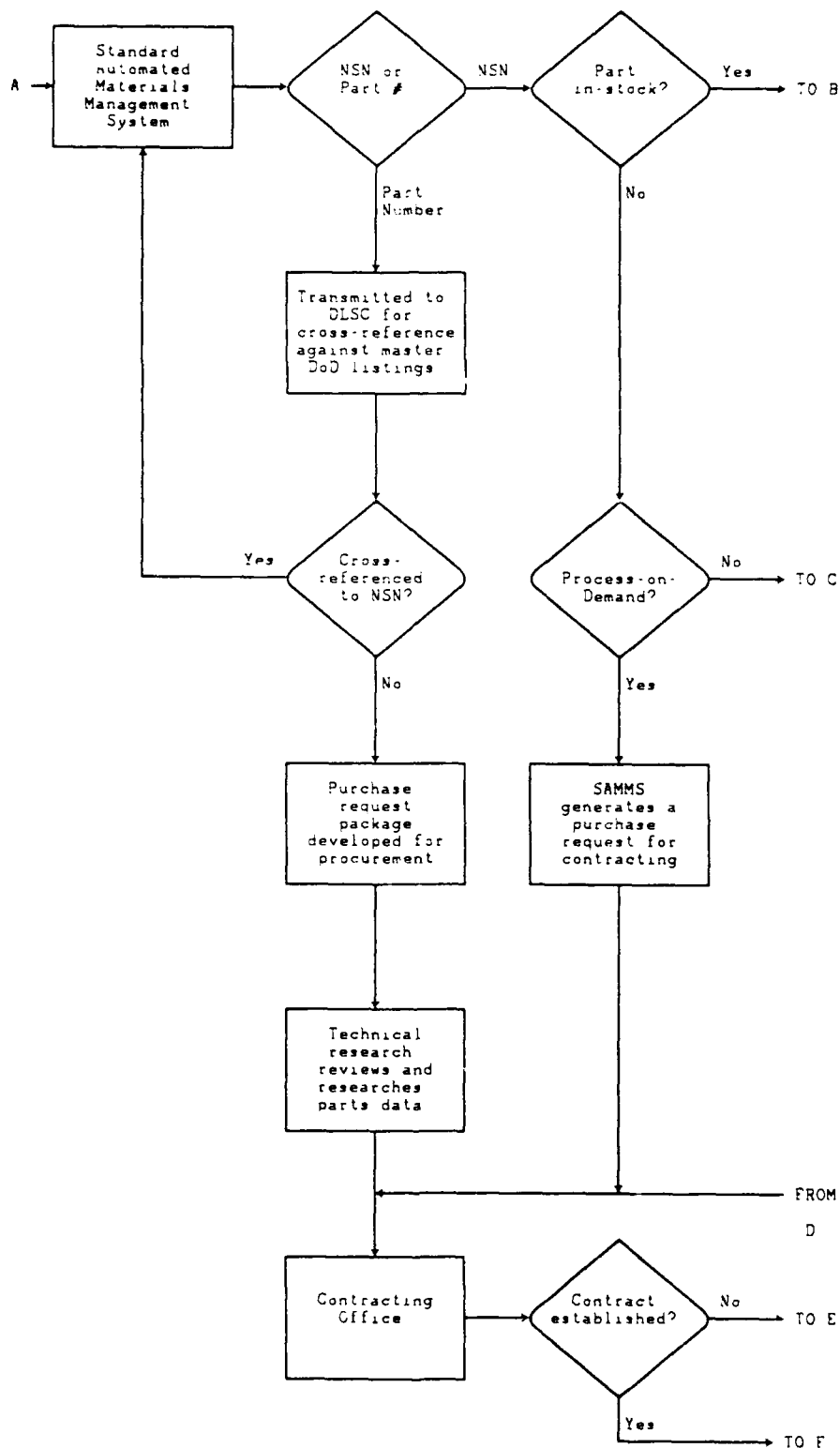


Figure 12. Flowchart - Defense Logistics Agency (Cont.)

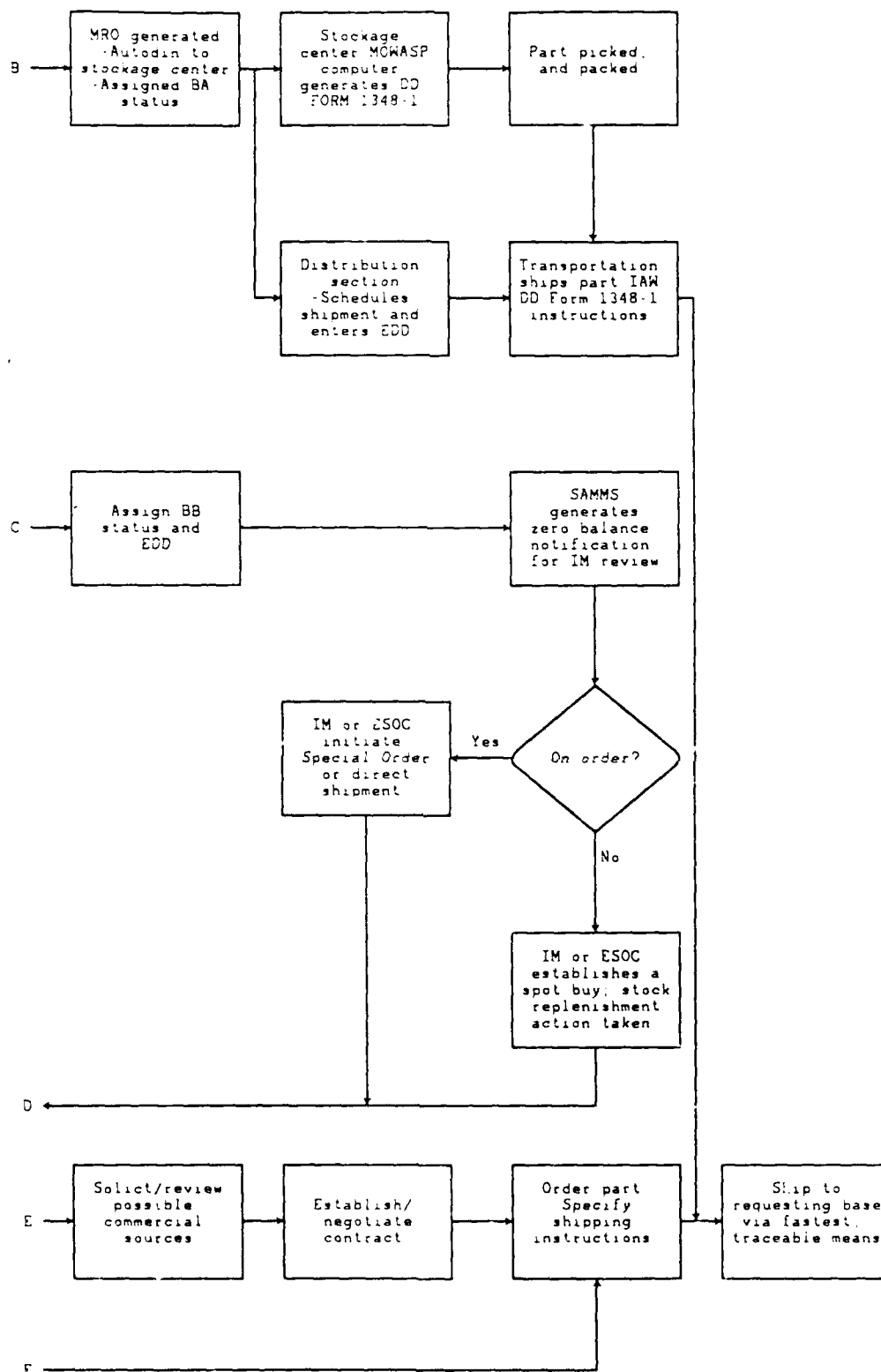


Figure 12. Flowchart - Defense Logistics Agency (Cont.)

All 463L MICAP requisitions enter the DLA depots either via autodin, telephone, or message. Most requisitions are transmitted via the autodin electronic data transfer system (24). These transmissions enter the communications section of the depot. Here, a computer receives the autodin requisitions and records them on a magnetic tape for batch entry into the Standard Automated Materials Management System (SAMMS). SAMMS is the central requisition processing computer which initially screens and processes the vast majority of the requisitions processed through the depot. (24)

DLA depots also receive telephone and message MICAP requisitions. When depots receive call-in requisitions, a Customer Service representative records the requests on a DLA Form 934, Exception Requisition Document/Data Input. The representative sends the completed requisitions to Source Data Automation for keypunching into SAMMS. Message requests enter the depots in a similar fashion except it is the Requisition Processing Center that receives the requisition message and manually transcribes the order information on to a DLA Form 934 before Source Data Automation for inputs the request into SAMMS. (24)

Once in SAMMS, the computer separates and routes requisitions according to the type and priority of the requisition. NSN requisitions account for the vast majority of parts requests and follow one path, while part number requisitions follow another (24).

NSN Requisitions. When DLA depots receive and input NSN requisitions into SAMMS, the central processing computer interrogates the retail inventory computer systems to determine the availability of the part from depot stockage. If the NSN part is in-stock, SAMMS assigns a BA status to the requisition to indicate the item is being processed for release and shipment, and automatically transmits the status to the requestor (24). At this time, SAMMS also generates and transmits a Material Release Order (MRO), via autodin, to the stockage center responsible for the part. The MRO enters the stockage center computer which then generates a DD Form 1348-1 directing the stockage center to pick and pack the required part(s) (24).

The distribution section of the stockage center also receives the MRO information. This function schedules the part for shipment and generates a shipping label for the package. The transportation section attaches shipping label and instructions to the package and ships it to the requesting base (24).

If the NSN is not in-stock, SAMMS checks the NSN for a procure-on-demand coding. This coding usually applies to high cost/low demand items and indicates any demands for these parts will be filled through procurement at the time the order passes through SAMMS (24). Through this type of procurement arrangement, depots tradeoff inventory carrying costs associated with stocking these parts for increased response or fill times for requisitions of these parts.

SAMMS automatically generates a purchase request for procure-on-demand items. Contracting receives these purchase requests and procures the item, usually through a pre-established source or contract. These contracts also specify the shipping response times and shipping instructions for various order priorities. The contractor ships the item in accordance with the contract, usually shipping directly to the requesting base (24).

If the NSN is neither in-stock nor a procure-on-demand item, SAMMS assigns the requisition a BB, backorder, status along with an estimated shipping date (ESD). The ESD provides an estimate of when the part will be released to the customer, and is based on a contract delivery date, if one exists, or on a standard delivery date, if no contract is yet established for the part (30). SAMMS generates a zero balance notification for Item Manager (IM) and Emergency Supply Operations Center (ESOC) review (24).

When the IM and ESOC receive the zero balance notification on a MICAP 01-03 priority requisition, they check the order status of the part. If the item is on order, the IM or ESOC has the option to expedite the manufacture or delivery of the part. To expedite, the IM or ESOC either requests the contractor to expedite the manufacture and shipment of the part, or initiates a special order directing the expedited manufacture and delivery of the part to the depot or requesting base (24).

The chosen expediting procedure depends on the IM or ESOC evaluation of the type of contract in existence and the estimated contractor response time. If the part is not on order, the IM or ESOC initiates a spot buy to satisfy the MICAP requisition, and the IM takes further action to replenish the stock. In either a special order or spot buy situation, the IM or ESOC contacts the contracting office to initiate a contract that most expeditiously delivers the item to the requesting base (24).

Part Number Requisitions. When part number requests are received, SAMMS electronically transmits the part number requisitions to the Defense Logistics Supply Center (DLSC) to be cross-referenced against a computerized listing of all items stock listed within any of the Department of Defense supply systems. DLSC normally receives, processes, and returns the results from the cross-check to the depots within a matter of hours. The results provide either an NSN equivalent to the part number or statement indicating no equivalent NSN was found. If the DLSC check returns an NSN, SAMMS updates the requisition with the NSN and processes the order as an NSN request (24).

If no NSN is found, SAMMS generates a Purchase Request (PR) package containing all the part information reported in the requisitioner's request and recorded on the DLA Form 934. Technical Research reviews this form to ensure as much part information as possible is included in the package

before submitting the Purchase Request to the contracting office for procurement (24).

Contracting solicits and reviews commercial parts contractors and manufacturers to locate a source for procuring the required part. If a contract already exists with a contractor able to provide the part, the contracting office directs the source to ship the part directly to the requesting base via the fastest traceable means (24).

If a contract does not exist with a contractor able to provide the part, the contracting office solicits bids from contractors who can provide the requisitioned part. If a contractor is found, the contract office establishes a contract for the manufacture and/or purchase of the part. The contract also provides the directions for shipping the part, usually instructing the contractor to ship directly to the requesting base by the fastest, traceable means available. If a contractor is not found or if a reasonable or economical price is not available, DLA sends MICAP Control a message stating the reason for not filling the requisition, and authorization to procure locally, if possible (24).

#### Air Logistics Center Processing

MICAP requisitions also provide the inputs to the ALC depot system. The ALC depots process MICAP requisitions in much the same way as the DLA depots. The following process descriptions reference the DLA processes to avoid repetitious descriptions of identical functions. The major

difference between the DLA and ALC systems results from the different FSCs managed by the two systems. ALC depots primarily process requisitions for major assemblies and sub-assemblies of the 463L equipment rather than the smaller components and parts managed by the DLA system. The result of this division of responsibility is that the ALC processes manage approximately fifteen percent of the MICAP requisitions entered into the depot system. This section presents the ALC depot procedures for processing MICAP requisitions and describes the process flow diagrammed in Figure 13.

MICAP requisitions enter the ALC by either autodin, telephone, or message. Autodin requisitions enter the ALC requisition processing system through the M024 computer in the Communications Center of the depot. The M024 computer receives the incoming autodin transmissions on a magnetic tape for batch input into the D035, Stock Control and Distribution System, six times daily or every four hours. The Customer Service section of the depot receives all telephone requisitions and inputs the request directly into the D035 system, eliminating the inherent processing delays of the autodin batch processing system. Data automation receives message requisitions and keypunches these requisitions into the D035 system again avoiding the batch processing delays incurred in transferring autodin requests between the M024 and D035 systems (18).

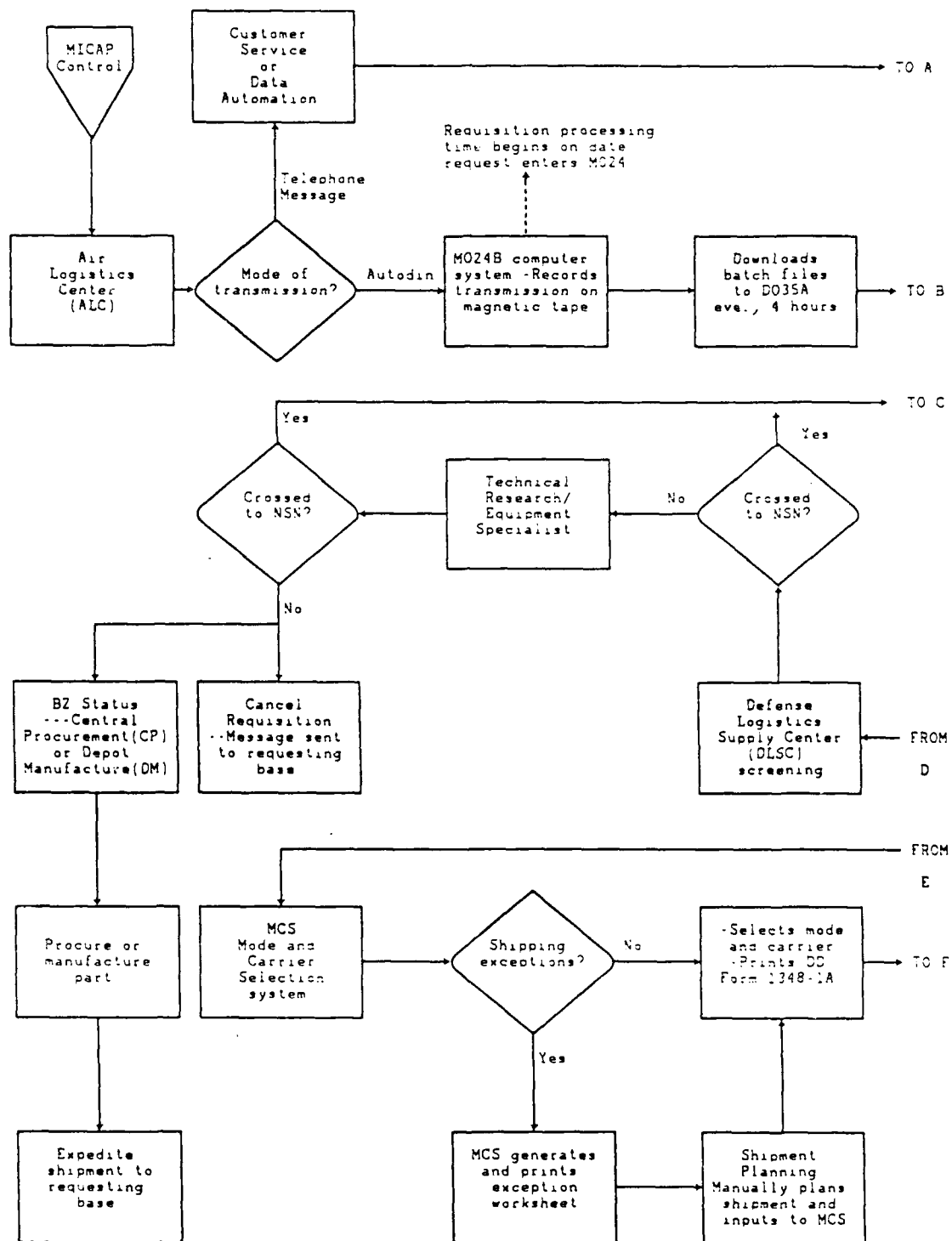


Figure 13. Flowchart - Air Logistics Center

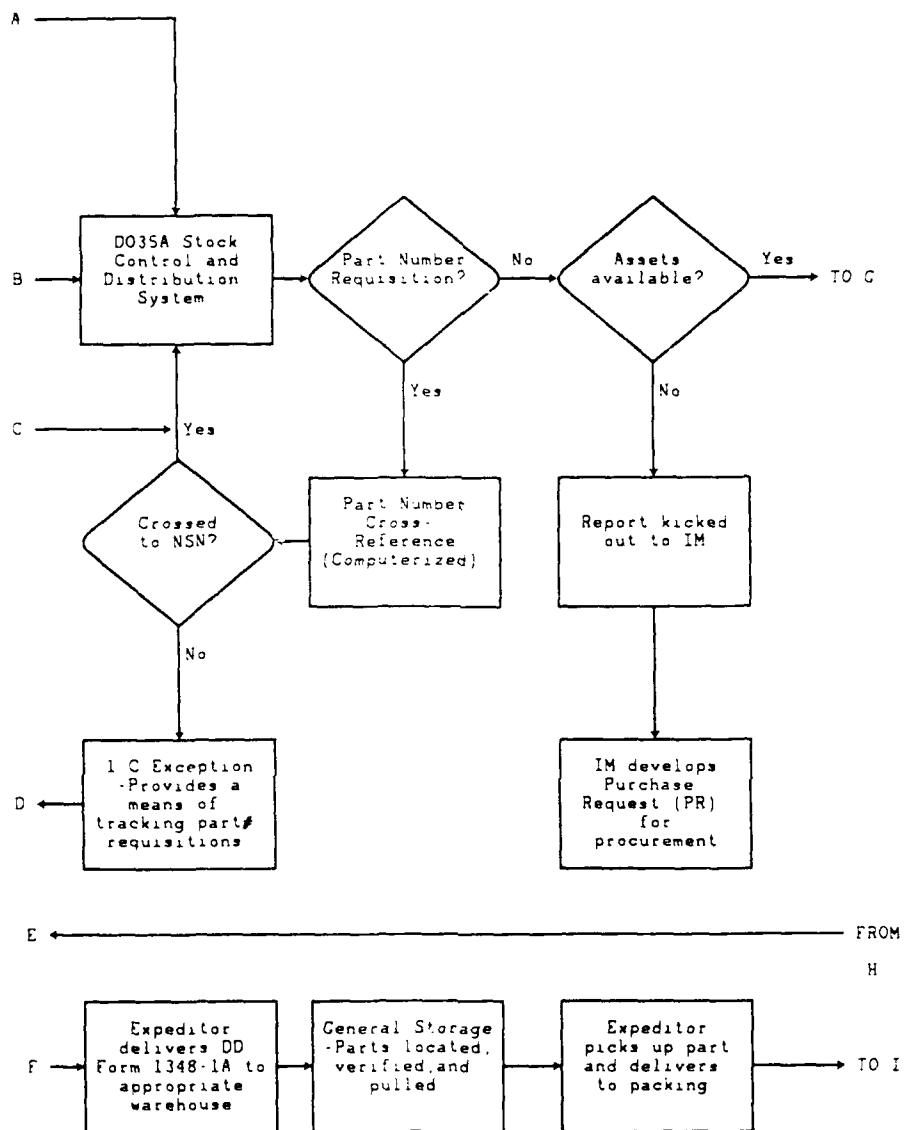


Figure 13. Flowchart - Air Logistics Center (Cont.)

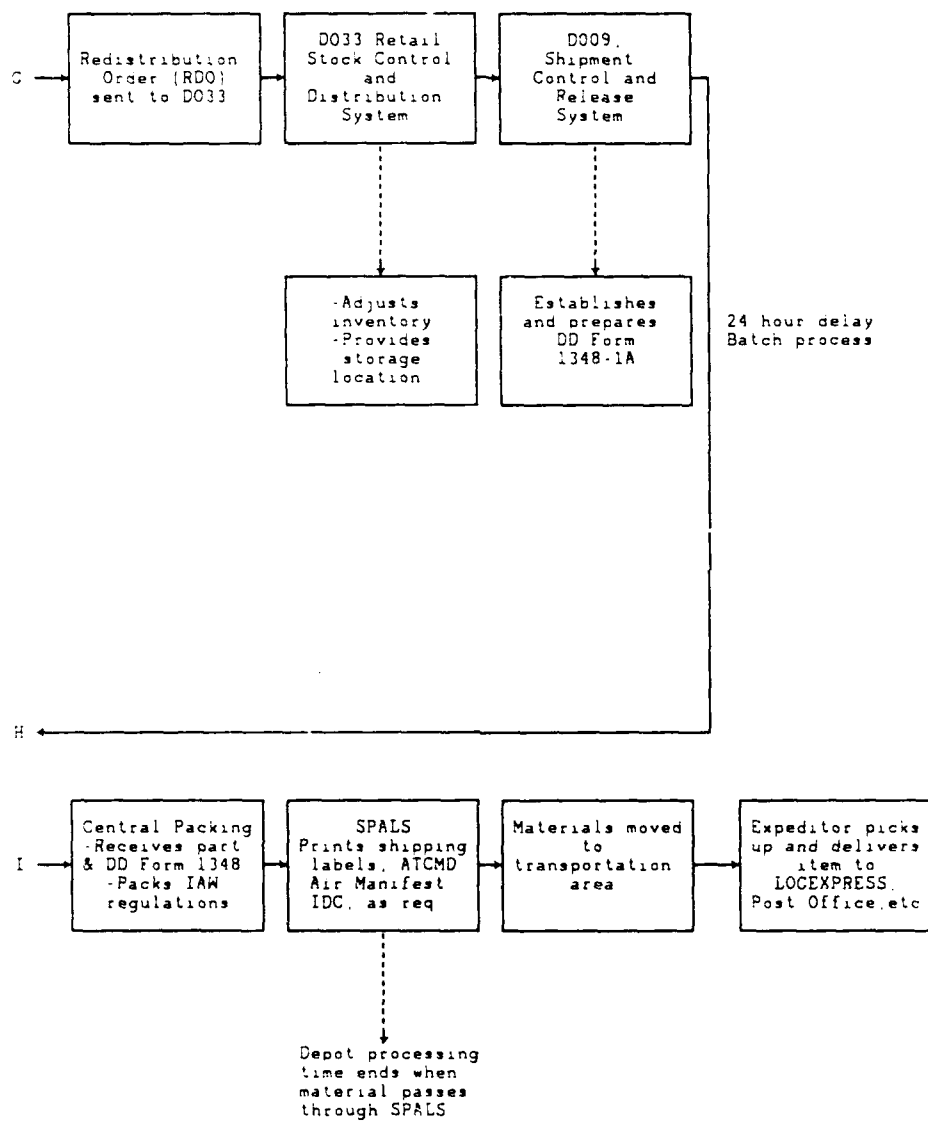


Figure 13. Flowchart - Air Logistics Center (Cont.)

NSN Requisitions. Once in the D035 system, the computer separates part number requests and NSN requisitions for further processing. NSN requisitions undergo the following processes. The D035 begins by interrogating its database to determine whether or not the NSN is available from depot stocks. If the part is not in-stock, the computer generates a report for Item Manager review. The IM takes the computer report and checks on the status of the part. If the part is on-order, the IM expedites the delivery of the part, if possible. If the part is not on-order, the IM uses the MICAP requisition to develop a purchase request for the contracting office to use in procuring the part. Both the expedited delivery and purchase request processes follow the same guidelines outlined in the DLA process description above (18).

If the NSN part is in-stock, the D035 generates and transmits a Redistribution Order (RDO) to the D033, Retail Control and Distribution System. The D033 adjusts the inventory information to reflect the reduction of on-hand stockage because of the order fill action. The D033 system provides storage location data for the parts required. The D033 then transmits the RDO and storage location data to the D009, Shipment Control and Release System (18).

The D009 gathers packing and shipping instructions from the 0013 Packaging/Transportation Data Maintenance System and specific warehouse storage location data from the D103 Central Material Locator System. "The [D009] system then

performs its own logic and edit checks to verify that the requisitions are in compliance with the Military Standard Requisitioning and Issue Procedures (MILSTRIP)" (18). Once this check is completed the D009 passes the issue release and location data to the MCS, Mode and Carrier Selection System. The transfer of information from the D009 system to the MCS system only occurs once a day between 0001 and 0300 hours in the morning. This once a day batch processing creates an inherent delay in the processing of MICAP requisitions of up to 24 hours, depending on when the requisition is received by the M024 system (18).

The MCS uses the shipment priority together with the shipping instructions from the D009 system to select the appropriate mode and carrier for moving the MICAP part to the requisitioning location. The MCS prints out a DD Form 1348-1A, Issue Release/Receipt Document, containing all the shipping data unless specific shipping exception data accompanies the MICAP requisition (18).

In cases where requests for special, non-routine expedited shipping action accompany MICAP requisitions, the MCS generates exception worksheets for manual shipment planning. The Shipment Planning department manually plans the shipment and enters the shipping instructions into the MCS computer which prints the shipping instructions on to a DD Form 1348-1A. An expeditor picks-up and delivers the DD Forms 1348-1A to the warehouse in which the requisitioned part is stored (18).

Once DD Forms 1348-1A arrive at the storage warehouse for the part, a warehouseman takes the forms, and, using the warehouse location printed on the forms, locates the part. He/she ensures the stock number of the part matches the number listed on the DD Form 1348-1A and pulls the part for routing to the packaging section. An expeditor picks up the part and DD Form 1348-1A and delivers them to Central Packing. Central Packing prepares the part for shipment in accordance with the 0013 packaging data listed on the form and forwards the part to the SPALS, Shipment Planning and Address Labeling System (18).

The SPALS work area receives the package and DD Form 1348-1A and enters the shipment information into the MCS/SPALS computer. The computer selects the final mode and carrier for the shipment and prints the shipping labels along with any required Advanced Transportation Control Movement Documents, and Intransit Data Cards and releases the packages for shipment. The packages move to the transportation area for onward movement to the final destination (18).

Part Number Requisitions. When ALC depots receive part number requisitions, the requests enter the D035 system. The D035 identifies the request as a part number requisition and submits the request to a computerized ALC part number cross-reference check. If the check crosses the part number to an NSN, the requisition is updated to reflect the NSN and the request re-enters the D035 for processing as

an NSN requisition. If the part number is not crossed to an NSN, the requisition receives a 1C exception code and is sent to the Defense Logistics Supply Center (DLSC) for a DOD part number/NSN cross-reference check.

The 1C exception code provides a positive means for tracking the requisition while it is outside of the depot processing system. If DLSC crosses the requisition to a NSN, the requisition re-enters the D035 system as an NSN request. If DLSC did not cross the part number to a NSN, the requisition enters the technical research section of the depot for further research. (18)

Technical research personnel along with Equipment Specialists use T.O.s and manufacturer data to locate a source for the part. If in their research the specialists cross the part to a stocked item, the requisition re-enters the D035 System for processing as an NSN request. If a source for the part is not located, or the process results in a decision that the part is uneconomical to procure, the depot sends the requestor a message reflecting the results of the research. This message may authorize the base to locally procure or fabricate the part if possible. If the research identifies a source of supply or is able to find the part specifications, the requisition receives a BZ status indicating that contracting actions are being conducted to procure the part. The depot sends this status to the requestor who may wait for the part to be procured or look elsewhere for a source of supply.

## Summary

The flow charts and process descriptions presented in this chapter described the processes and procedures followed by each of the major functions operating within the pipeline for 463L MICAP spare parts. In so doing, the chapter described each of the different pathways a parts requisition may follow as it flows from vehicle maintenance through base supply and on to the Air Force and DoD depot systems. The flowcharts also provided a visual reference of the requisitioning process illustrating the complexity of the process as well as, the interrelationships of the different sections of the pipeline.

The interrelationships of the functional areas within the pipeline are integral to this process description. This description brings together in one document, one interconnected flow, process and set of procedures which are normally developed and evaluated separately and in isolation. By drawing together the processes of the entire pipeline, this flow enables pipeline managers to evaluate their individual functions in relationship to the pipeline as a whole. In essence, this chapter provides the tool for conducting a macro-system type analysis, as described in Chapter I, on the 463L spare parts pipeline.

The 463L supply pipeline described in this chapter also provides the basis for the analysis in the following chapters. Chapter V looks at the "ownership" and management of the pipeline and analyzes the measurements and reports

used in evaluating pipeline, while Chapter VI analyzes the pipeline against the "ideal" order process described in Chapter II.

## V. Analysis

### Introduction

This chapter addresses the last three investigative questions posed in Chapter I. The answers to these questions, along with the process descriptions and flow diagrams of Chapter IV, combine to provide an answer to the specific issue for which this research was conducted, "What organizations and processes make up the current spare parts pipeline for 463L equipment, and how do these organizations and processes affect the availability of 463L equipment?"

### Overview

The analysis presented in this chapter focuses on answering the following investigative questions:

- Who is responsible for monitoring the data collected for the unit and for the system as a whole?
- How are processing times recorded and what reports reflect and summarize these times?
- What are the average processing times and time distributions for each section of the pipeline? How do changes in the times and distributions impact the pipeline time as a whole?

To ensure these answers logically document the pipeline process, the analysis also addresses the last of Gitlow's process documentation questions posed in Chapter III as key to understanding processes. These questions are:

- Who owns the process?
- What are the objectives of the process?

- How is the success of the process in meeting the objectives being measured?
- Are the measurements being taken on the process valid? (11:42)

The answers to these questions, along with the flowcharts and process descriptions from Chapter IV, provide the basic information required to initially document the 463L pipeline process. This information provides managers with a logical and complete understanding of the process they manage, and, with this understanding, managers should be able to improve the system they control and operate (11:42). Thus, answering the investigative questions and Gitlow's questions together establishes the initial step to improving pipeline performance.

This chapter is divided into three major sections. The first section responds to the questions regarding ownership and responsibility of the pipeline process. The second addresses the issue of pipeline management measurements and reports. This section presents the measures used in evaluating the performance of the 463L pipeline and discusses the validity of these measurements. The third section presents 463L pipeline time distributions developed from data collected throughout this research.

#### Ownership of the 463L spare parts pipeline

This section addresses the investigative question, "Who is responsible for monitoring the [pipeline] data collected for the unit and for the system as a whole?" as well as Gitlow's question, "Who owns the process?"

Monitoring and managing the 463L spare parts pipeline was found to be split between each one of the sections and units involved in the processing of MICAP requisitions. Each section evaluates reports reflecting its own performance measurements relating to either pipeline processing times or functional objectives. The difference between processing time and functional objectives centered on the time factor.

Functional measurements and reports reflecting supply status and Estimated Delivery Dates (EDD) act to maintain the integrity of the pipeline process by monitoring the status of requisitions as they progress through the pipeline. Functional measurements, like fill rates and backorder notifications, ensure requisitions are not lost or ignored within the pipeline and, in so doing, help maintain the pipeline flow. In essence, functional measurements effect pipeline processing times, but do not monitor the overall processing times of the pipeline as do pipeline time measurements and reports. Table I, Functional Objective Measurements, and Table II, Pipeline Time Measurements, include the performance measures and reports found to be the key management tools for each section of the pipeline. These measures and reports are discussed in detail in the next section of this chapter.

Only the vehicle maintenance and depot organizations within the pipeline monitor reports which reflect summary

Table I. Functional Operations Measurements

| Section/Report                                                      | Functional Concern                                                                                                      | Factors Considered                                                                                                                                                       | Factors Not Considered                                                                                                                                                                                                   |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Material Control<br>-D18, Daily Priority Monitor Report             | -Supply Status and EDD of each vehicle part requisition                                                                 | -Each individual requisition<br>-MICAPs<br>-Bad status<br>-Slipping/Overdue EDDs                                                                                         | -Consolidated information recording total requisition processing times for vehicle parts                                                                                                                                 |
| Demand Processing<br>-No Pipeline Report                            | N/A                                                                                                                     | N/A                                                                                                                                                                      | N/A                                                                                                                                                                                                                      |
| MICAP Control<br>-D49, MICAP Status<br>-MAC Forms 129               | -Supply Status and EDD for all base MICAPS                                                                              | -Each requisition managed individually<br>-Bad status<br>-Slipping/Overdue EDDs                                                                                          | -Consolidated information recording total requisition processing times for base or vehicle parts                                                                                                                         |
| Depots<br><u>ALC</u><br><br>Report names and numbers unknown        | -Fill Rates<br>--By Depot & IM<br>-Backorder Notifications<br>--Daily & Weekly                                          |                                                                                                                                                                          |                                                                                                                                                                                                                          |
| <u>DLA</u><br>-Report Unknown<br>-Report Unknown<br>-Report (See #) | -Fill Rates<br>--Depot<br>--IM<br>--Weapon System<br>-Backorder Notifications<br>--Daily<br>--Weekly<br>--Weapon System | -Percent of total requisitions filled from on-hand stock<br><br>-Backorders estab. previous day<br>-Unfilled Backorders (Total)<br>-Unfilled Backorders by weapon system | -Carry over unfilled requisitions<br>#DF 112, Weapon System Summary Status Report<br><br>#F019, Daily Backorder Notification<br>F269, Weekly Backorder Notification<br>DF137A, Weapon System Backorder Listing (Monthly) |
| Reports (See ##)                                                    |                                                                                                                         |                                                                                                                                                                          |                                                                                                                                                                                                                          |

Table II. Pipeline Time Measurements

| Section/<br>Measurement/Report                              | Portion of Pipeline<br>Measured                                              | Factors<br>Measured                                            | Factors Not<br>Measured                                                                                              |
|-------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Vehicle Maintenance<br>-VDP Rates<br>--PCN0032              | From VMO approval<br>for VDP to receipt<br>of part in vehicle<br>maintenance | Total hours 463L<br>vehicles are down<br>for parts             | -Multiple parts per vehicle<br>-Vehicle mechanic and<br>Material Control parts<br>research and documentation<br>time |
| Depots                                                      |                                                                              |                                                                |                                                                                                                      |
| <u>ALC</u>                                                  |                                                                              |                                                                |                                                                                                                      |
| Pipeline processing<br>Times<br>-LOG-LO(M) 7922,<br>Part 1  | -From MICAP Control<br>requisition to part<br>receipt by base<br>supply      | -MICAPs<br>-Off-the-Shelf<br>shipments                         | -Delayed Action Shipments<br>--Shipments delayed due to<br>lack of depot stock, IM<br>review, incomplete orders      |
| Depot Processing<br>Times<br>-LOG-LO(M) 7922,<br>Part 1     | -3 measures<br>--ICP Time<br>--DS Time<br>--Total Depot Time                 | -MICAPs<br>-Off-the-Shelf<br>shipments                         | -Delayed Action Shipments                                                                                            |
| <u>DLA</u>                                                  |                                                                              |                                                                |                                                                                                                      |
| Pipeline processing<br>Times<br>-MILSTEP Highlight<br>Table | -From MICAP Control<br>requisition to part<br>receipt by base<br>supply      | -01-03 Priority<br>requisitions<br>-Off-the-Shelf<br>shipments | -MICAP/999 requisitions<br>specifically<br>-Delayed Action Shipments                                                 |
| Depot processing<br>Times<br>-Reports unknown               | -Believed to be<br>similar to ALC<br>measures                                |                                                                | -MICAP/999 requisitions<br>-Delayed Action Shipments                                                                 |

statistics for pipeline processing times. Although the reports include pipeline processing times, none of the reports provides a complete representation of the pipeline. Tables I and II also list the factors included and excluded from the reports to illustrate the capabilities and limitations of these reports. The next section of this chapter more fully explains these limitations.

During the course of this pipeline research, no single organization or office was found to either manage or monitor the entire 463L spare parts pipeline. The lack of single manager responsibility made it difficult to locate the pipeline management reports reflected in Tables I and II. Although some of the specific reports were not found, the information listed in the tables still provided a sufficient data base from which to discuss the pipeline as a whole.

The next section presents some of the measures and reports used by the different portions of the pipeline to measure the performance of different aspects of the pipeline.

#### Pipeline Performance Measurements and Reports

The investigative question addressed in this section is, "How are processing times recorded and what reports reflect and summarize these times?" In addressing this question, the remainder of Gitlow's essential questions for process documentation provided a means to evaluate the measurements and reports presented, particularly those

dealing with pipeline times and fill rates. Thus, the three questions guiding the discussion of the pipeline management tools are:

- What are the objectives of the process?
- How is the success of the process in meeting the objectives being measured? and
- Are the measurements being taken on the process valid? (11:42)

Gitlow's questions delve into the make up of performance measurements and management tools. Evaluating pipeline measurements and reports with these questions ensures that the capabilities and limitations of these management tools are fully understood and are not blindly accepted at face value.

This section presents the pipeline measurements and reports most frequently cited as key management tools used in monitoring and evaluating pipeline performance. Although this section focuses on pipeline processing time measurements and reports, it presents the key reports used to ensure the pipeline functions properly. The functional reports are used to monitor individual requisitions and fill rates, and provide pipeline organizations with information supporting the pipeline process. These reports are not directly related to pipeline processing times, but they do contribute to the timely processing of requisitions within the pipeline and thus effected pipeline performance.

The measurements and reports of each of the major sections of the pipeline are presented separately to parallel the process description presented in Chapter IV.

Each measurement and its associated report are presented with an explanation of what they represent and what they do not represent, as presented in Tables I and II. This comparative explanation is used to illustrate the limitations of the measurements and reports used to manage the 463L spare parts pipeline.

Vehicle Maintenance. The pipeline performance measurement monitored and evaluated by vehicle maintenance is the Vehicle-Down-For-Parts (VDP) rate. Although the primary purpose of this rate is to help gauge vehicle availability, it also provides a limited measure of pipeline performance as it indirectly measures parts availability. This rate represents that portion of time vehicles are out-of-service because of a lack of parts or material required to repair the vehicles (7:86). In other words, the VDP rate is a reflection of the non-availability of vehicles because of a shortage of parts from base resources.

VDP rates for 463L vehicles are computed and reported through the Vehicle Integrated Management System (VIMS), which provides VDP information on the PCN0032, Vehicle Management Report. The source data for computing the VDP rates come from the VDP start and stop times recorded on the AF Forms 1823, Vehicle and Equipment Work Orders. As explained in Chapter IV, the VDP times start when the Vehicle Maintenance Officer (VMO) approves the VDP condition and stops when the part is received by vehicle maintenance. The VDP times recorded on the work orders incorporate the

broadest pipeline measure of the 463L spare parts pipeline of any of the pipeline reports, but the measure still omits the time required to research the part, conduct the preliminary stockage availability checks, receive the VMO's approval, and prepare and transmit the order to base supply. As indicated in Chapter II, this initial part of an order process often is overlooked in the calculation of the order processing time even though it constitutes a major portion of the total order processing system.

Although the VDP rate reflects the total amount of time vehicles are down for parts, it does not reflect the total amount of time the pipeline is actually in motion. The reason for this disparity is that the VDP time only accounts for the time a vehicle is down for parts, regardless of the number of parts the vehicle requires.

There is also a difference between the VDP time as a percentage of vehicle availability and the number of MICAP requisitions as a percentage of total requisitions. The following analysis illustrates this difference. During the course of this research, the 463L vehicle AF Forms 1823 from Charleston AFB, SC were reviewed providing the information in Table III. As illustrated, over a period of 132 days the VDP rate for 463L vehicles was only 1.8 percent compared to the 5.7 percent figure for the rate of MICAP requisitions to total parts requisitions. The study also showed that 14

Table III.  
Vehicle-Deadlined-for-Parts Data

|                                                 |        |         |
|-------------------------------------------------|--------|---------|
| VDP rate calculated from source data (percent): | 1.8    |         |
| Total # vehicles assigned:                      | 58     |         |
| Total # available hours for period studied:     | 183744 |         |
| Total # of vehicles VDP during period           | 14     |         |
| Total # hours VDP:                              | 3397   |         |
|                                                 | Number | Percent |
| Total non-deferred requisitions processed:      | 422    | 100     |
| Total MICAP requisitions                        | 24     | 5.7     |

Source: AF Forms 1823 from March - June 1989  
Charleston AFB, SC

vehicles were down for a total of 24 MICAP parts illustrating that VDP rates and figures can hide or diminish problems in the pipeline.

The difference between the number of vehicles VDP and the number of MICAP requisitions becomes even more significant when cannibalization is used to secure needed vehicle parts. When cannibalization is used, one vehicle down for parts actually represents two or more vehicles and many more parts. In this case, the VDP rate significantly diminishes the problem of parts non-availability. Considering this type of situation, the 30 to 60 percent VDP rates experienced in Vietnam (25:70), as indicated in Chapter I, may have represented an even greater problem with the pipeline. The difference between VDP and parts availability also may hide parts availability problems accompanying military spending cutbacks. The VDP rates in this situation would provide a false indication of unit readiness.

Material Control. Performance measurements monitored by the Material Control section of vehicle maintenance are functional rather than pipeline time measurements. Material Control monitors the activity of the pipeline to ensure that all active MICAP requisitions for vehicle maintenance are processed properly through the supply pipeline. One of the key areas of concern for the material controller is the status of MICAP requisitions. After material control submits a MICAP request to Demand Processing and MICAP Control, the controllers monitor the D18, Priority Monitor Report, to ensure the request is processed correctly and in a timely manner (33).

The D18 is a daily report, generated by the Standard Base Supply System (SBSS), which lists the status and EDDs for all MICAP requisitions submitted by vehicle maintenance. The material controller checks the status of MICAPs daily to ensure the supply status and EDDs of the requisitions remain posted and good. If the status of a MICAP changes or an EDD slips or is overdue, the material controller contacts MICAP Control to find out why the status changed or why the part has not arrived (33). If the controller discovers a problem with receiving the part in a timely manner, he takes action to increase the visibility and urgency of the requisition by requesting supply follow-up and supply assistance actions be taken (33). Through his constant monitoring and coordination with MICAP Control, the material controller works with the MICAP system to ensure the system functions

properly, and it effectively processes each MICAP requisition submitted for vehicle maintenance.

Demand Processing and MICAP Control. As indicated in Table I, Demand Processing does not generate or monitor measurements or reports, but the MICAP Control section of base supply monitors functional measures and reports similar to Material Control.

Once MICAP Control generates and transmits MICAP requisitions to ALC or DLA depots, they monitor the daily D49, MICAP Status Report, generated through the SBSS. This D49 report provides MICAP Control with the current status of all the active MICAP requisitions generated from the base (8:6-491). 463L MICAPs make up only a small portion of the MICAPs listed on the D49, but MICAP Control intensely monitors and manages these requisitions (40). MICAP Control compares the information from the D49 report with the information recorded on the MAC Form 129 (40). If any discrepancies, problems, or unexpected delays of MICAP requisitions are found, MICAP Control initiates follow-up actions and/or submits supply assistance requests (40). These actions increase the visibility of the requisition at the depot level and emphasize the need to expedite the processing and shipment of the required part. So, although the performance of MICAP Control is not reflected directly in any pipeline performance reports, the effective and

timely processing of follow-up and supply assistance actions by MICAP Control do affect the overall performance of the pipeline.

Depot Performance Measures and Reports. Before discussing performance measures and reports used in managing the pipeline depot systems, it is important to highlight two major difficulties experienced in attempting to identify and analyze depot management tools. First, there are two totally separate depot systems responsible for providing parts support for 463L vehicles, the Air Logistics Center (ALC) and Defense Logistics Agency (DLA) depot systems. Each one of these systems has its own pipeline management system. Second, no one office or department acts as the single manager or focal point for all pipeline measurements and reports within either depot system.

The responsibility for monitoring and managing most depot pipeline operations falls into two major divisions, the materials management division and the distribution division. Within these divisions, pipeline responsibilities are subdivided further into different operational branches and sections. The division of responsibilities between and within the divisions and branches of the two depots systems made it very difficult to find the measurements and reports used to evaluate, monitor, and manage the depot functions of the spare parts pipeline. As a result, the measures and reports described below and listed in Tables I and II do not represent all of the tools used to manage the pipeline, but

do represent the most frequently mentioned measurements and reports cited by the pipeline technicians and managers interviewed.

Both ALC and DLA depots monitor similar aspects of the supply pipeline, those being stockage fill rates and pipeline/depot processing times. Fill rates are functional measurements used to evaluate depot capabilities for filling requisitions from on-hand inventory. These measures apply mainly to the performance of the Item Managers (IM) responsible for managing parts and materials. Pipeline and depot processing times measure the time it takes requisitions to be processed from order initiation to part reception by the requesting base. Both fill rate and processing time measurements provide management with very specific pipeline information with underlying caveats which must be known before one can evaluate the usefulness of the reports.

Stockage Fill Rates. Depot stockage performance is monitored in two ways, through fill rate reports and backorder notifications. Fill rates are used to evaluate the effectiveness of depot stocks. These rates represent the percentage of requisitions received by a depot and filled from depot stocks the first time the requisitions are processed through the system. In essence, fill rates measure the capability of depots to fill requisitions without having to backorder the items required.

Fill rates are measured routinely for depots and Item Managers (IM), but they are also measured for specific weapons systems, like 463L equipment. The DLA depots capture and monitor fill rates for 463L equipment through the Weapons System Support Program (WSSP). The DF112, Weapon System Summary Status Report, reflects the fill rates for 463L requisitions, but the fill rates reported in the DF112 report do not consider all backordered requisitions.

While analyzing the DF112 report, it was found the fill rates reported reflect only the number of backorder requisitions established during the current reporting period, but do not include backorders carried over from previous reporting periods. The report does list the total number of current and combined backorders, but the combined backorder total is not used in the calculation of the supply effectiveness percentage. By not including the total number of backorders in the system, the fill rates do not reflect the supply effectiveness experienced by field organizations, like vehicle maintenance, which equals the total number of parts backordered, not just the newly established backorders. Because of this limitation, the fill rates reported in the D112 provide only a partial picture of depot performance in providing weapons system support.

DLA and ALC depots use backorder notifications to help ensure backorders are identified and stockouts alleviated. As listed in Table I and II, DLA depots use three reports to monitor backorders, the F019, Daily Backorder Notification,

F269, Weekly Backorder Notification, and DF137A, Weapon System Backorder Listing. The F019 report lists backorders established during the previous day's automated requisition process. The F269 report lists all of the requisitions still on backorder at the end of each week. Together these two reports ensure IMs are aware of each backorder as they occur and remain aware of backorders until they are resolved.

The DF137A report provides the Weapons System Support section an end of month listing of all backordered items by weapon system by National Stock Number (NSN). This list focuses the attention of weapons systems monitors on the parts required to satisfy backordered parts for weapons systems, including 463L vehicles. This breakout of 463L specific NSNs enables weapons system monitors to intensely monitor and follow up the status of the contracts and orders established to procure these items. The follow up actions by the Weapon System Support section ensures the urgency and priority of these items.

Together the fill rates and backorder reports provide pipeline managers with information, although somewhat limited, required to monitor and manage depot stockage effectiveness. The daily and weekly backorder reports provide item managers with the tools required to monitor daily depot operations as they serve as "flags" alerting managers to unfilled requisitions. Fill rate reports furnish depot managers and IMs with the performance

statistics to manage stockage effectiveness. Backorder notifications and fill rate reports thus provide the day-to-day and summary data used in managing the performance of depot stocks.

#### Depot Processing Times - Standards and Reports.

Depot processing times for both the ALC and DLA depots are based on the Uniform Material Movement and Issue Priority System (UMMIPS). The UMMIPS establishes the standards for requisition order transmission and shipment times by requisition priority classifications. These classifications provide depots a priority system to record and monitor depot and total pipeline processing times for requisitions processed through their locations. The pipeline managers use these reports to evaluate their pipeline performance against UMMIPS standards.

Through the course of this research, it was found ALC depots evaluate their pipeline time performance by using Part 1 of their RCS: LOG-LO (M) 7922, Material Pipeline Time Report (By Geographical Area). This report segments pipeline processing times by depot, priority and geographical area for requisitions satisfied from off-the-shelf depot stocks. The only report found to reflect DLA pipeline processing times was the MILSTEP Highlight Table - Pipeline Performance Analysis. This table reports pipeline performance standards for DoD service depot systems as well as DLA depots. The DLA pipeline processing times reflected in this report consolidate the processing times of DLA

depots and stockage centers into average pipeline processing times for each UMMIPS requisition priority category and geographical area. Both the LOG-LO (M) 7922 and the MILSTEP Highlight Table pipeline times are used to evaluate the performance of the ALC and DLA pipeline systems, respectively, against UMMIPS standards. The focus of these management reports is analyzed in this section.

Although ALC and DLA depots collect data in accordance with UMMIPS guidelines, the ALC depots also collect and monitor data for MICAP/999 (high priority) requisitions. The DLA depots group these MICAP type orders together with 01-03 priority requests. This difference results in an ALC depot capability to specifically monitor their performance and focus their attention on the most critical requisitions, the MICAP/999 requisitions required to support mission critical systems. Since DLA depots do not segment MICAPs from other 01-03 priority requisitions, DLA managers are not able to focus on pipeline times for MICAP/999 requests for mission critical items.

The key pipeline processing time management reports for DLA and ALC depots have a major management limitation, they only measure and monitor requisitions for off-the-shelf items. Off-the-shelf requisitions are those requests processed through depot processing systems with no managerial or stockout delays. This means the only requisitions included in the management reports are for items immediately available from on-hand stockage. This

ideal off-the-shelf scenario reflects only on how well depot systems function in ideal situations; they do not represent the actual depot processing times experienced by the organizations submitting requisitions.

Requesting organizations experience and evaluate pipeline performance based on all requisitions submitted to depots, not just orders filled immediately from depot stock. This means the pipeline processing times experienced by field organizations differ from the times used by pipeline managers to evaluate pipeline performance. This difference creates a gap between the pipeline managers' perceptions of pipeline performance and the actual pipeline performance experienced by the users.

The difference in perceptions between pipeline managers and users focuses on the intent of the pipeline system. Should the pipeline be measured and evaluated from the pipeline managers' perspective or from the users perspective? As cited frequently throughout Chapter II and concisely stated by Gattorna, "The single output of any organization is customer service. Customers, not managers or products, drive the organization" (10:11). If the purpose of the depot system, specifically, and the supply pipeline, generally, is to support the customer or user, then the performance of these systems must be evaluated from the customer's perspective. From this perspective, pipeline performance depends not only on those off-the-shelf items reflected in the management reports used by depot and

pipeline managers, but on all items requisitioned by the users. This means all requisitions submitted to the depots must be included in the pipeline performance measures and reports to reflect a true picture of pipeline performance from the users perspective.

Part 1 of the RCS: LOG-LO(M) 7922 and the MILSTEP Highlight Table provide a picture of depot and pipeline performance for requisitions meeting the ideal fill rate criteria from on-hand depot stockage. As a result, the reports only reflect a portion of the pipeline the user encounters. A far better indicator of pipeline performance would include the processing times for parts out-of-stock or delayed items together with off-the-shelf items.

ALC depots have consolidated off-the-shelf and delayed action requisition pipeline time reports. These reports are found in Part 3 of the RCS: LOG-LO(M) 7922, Material Pipeline Time Report. The pipelines within these reports reflect the actual average processing times experienced in the field for all depot requisitions. These reports provide a more accurate measurement of the customer service provided by the ALC pipeline. Part 2 of this same report reflects the processing times for only the delayed items and provides a measure of the worst case scenarios, when requisitions are received for parts not on the shelf. Together Parts 1, 2, and 3 provide ALC pipeline managers with tools for more effectively measuring pipeline performance.

Although ALC depots and their headquarters at the Air Force Logistics Command (AFLC) do receive and file all three of these reports, only Part 1, reflecting the best case scenarios, is monitored (20). This report comes the closest to meeting UMMIPS standards, but it does not provide a true picture of pipeline performance.

#### 463L Pipeline Time Distributions

This section addresses the final investigative questions of: "What are the average processing times for each section of the pipeline?" and "How do changes in the times and distributions impact the pipeline time as a whole?"

As stated in Chapter 3, the 463L pipeline processing time data collected and recorded by pipeline organizations failed to provide the information necessary to develop individual processing time distributions for each pipeline function. The difficulty encountered in trying to gather processing time data for individual segments of the 463L pipeline was twofold, source documents and reports either: a) captured processing time data for the entire 463L pipeline with no breakout of pipeline times within or between pipeline organizations; or, b) captured and reported segmented pipeline times for all priority requisitions with no breakout of 463L requisitions. As a result, no meaningful 463L pipeline time distributions could be developed for each organization within the pipeline.

Although no section sources were found to provide section specific time data, three sources were found to provide processing time data for the whole 463L pipeline. These sources were the D165 weapon system computer, the MAC Forms 129, Supply MICAP Checklists, and the AF Forms 1823, Vehicle and Equipment Work Orders. Pipeline time distributions developed from these sources are presented and analyzed in the following subsections. The data presented in these examples currently is not readily available to pipeline managers and may provide insight into the pipeline that is not normally considered in pipeline evaluation.

Source: The D165 weapon system computer. The 463L pipeline data collected from the D165 system reflects the the time between when MICAP Control submits a MICAP requisition to the depot system and when base supply receives and in-processes the part requested. This period equates to the order transmittal, depot processing, transportation, and order receiving time for 463L requisitions. Frequency distributions developed from this data provide a graphical representation of the variation of pipeline processing times for requisitions reported in this system.

Figures 14 and 15 illustrate the frequency distribution of the 463L requisition pipeline times recorded in the D165 system for both DLA and ALC depots, respectively. These distributions include both off-the-shelf and delayed shipment depot requisitions for MAC CONUS bases and select

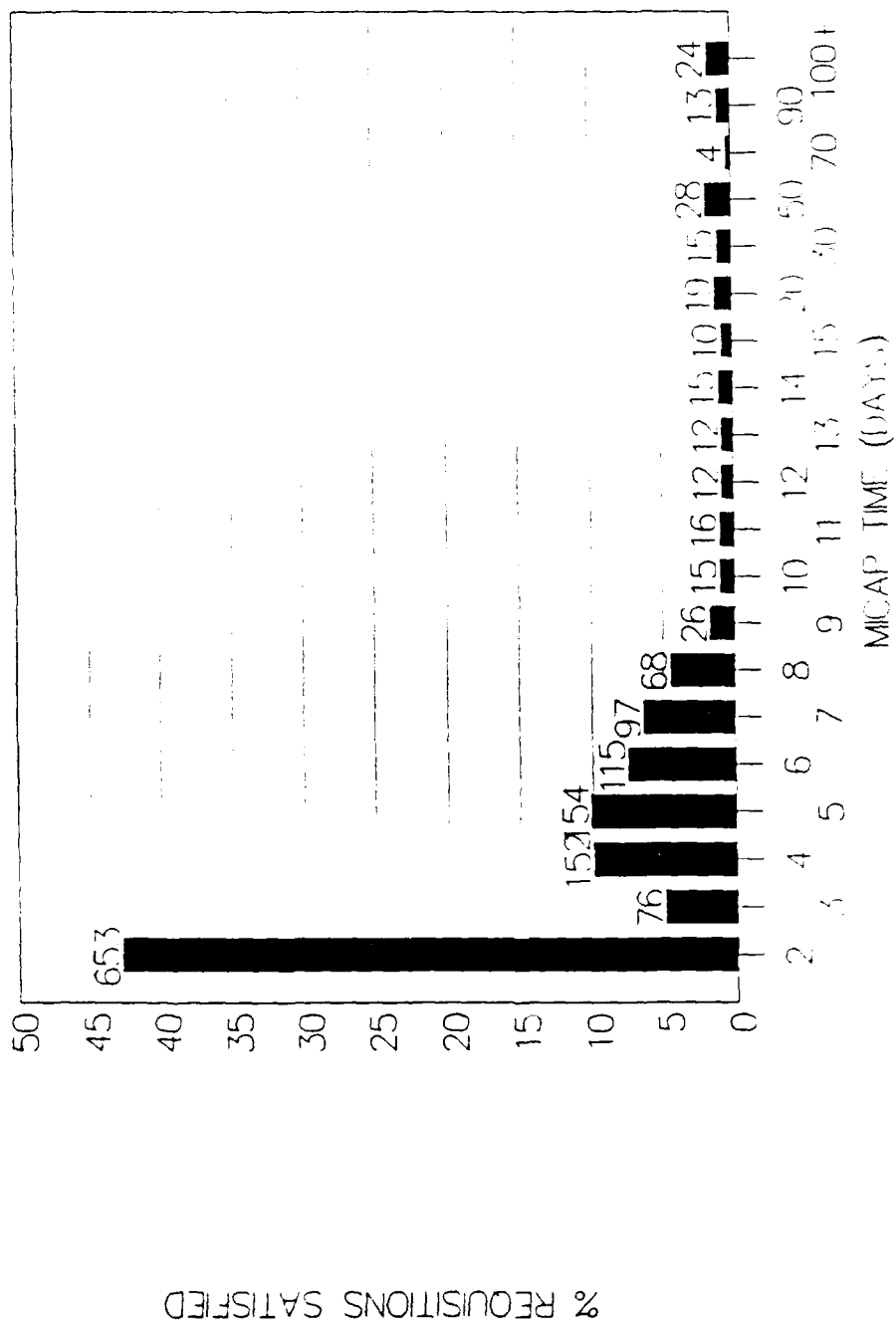


Figure 14. DLA Pipeline Time Distribution

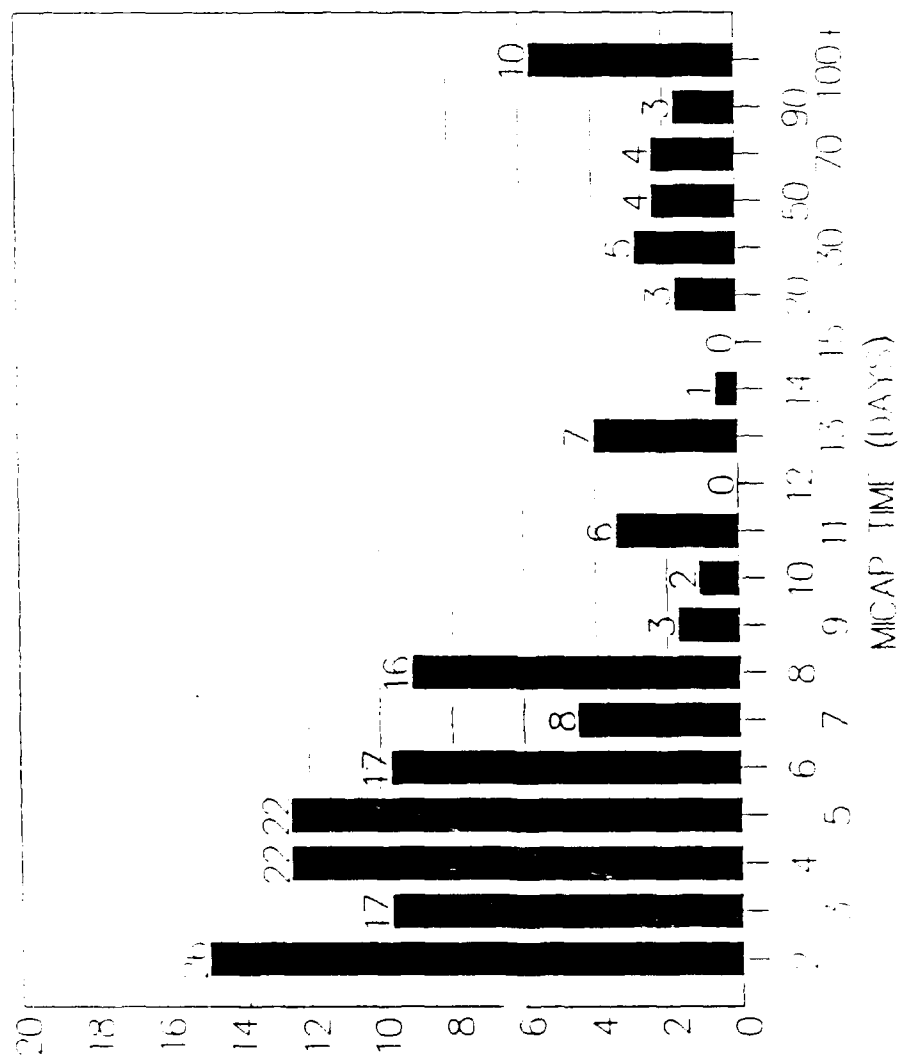


Figure 15. ALC Pipeline Time Distribution

overseas MAC units. Approximately 86 percent of both the DLA and ALC requisitions reflected in these distributions are from CONUS locations.

As can be seen in the figures, both distributions are skewed to the right meaning most of the requisitions were satisfied over the lesser time periods. In fact, 82 percent of the DLA and 64 percent of the ALC requisitions were satisfied within the seven day UMMIPS pipeline time standard for priority 01-03 and NMCS (Not Mission Capable - Supply for CONUS shipments. If compared to the more restrictive Air Force standard of 3.5 days for MICAP/999 requisitions, only 53 percent of DLA and 31 percent of ALC of the 463L MICAP requisitions were satisfied within the standard. It must again be stated that DLA depots do not recognize this Air Force standard; DLA depots measure their performance only on the seven day UMMIPS standard for NMCS and 01-03 priority requisitions.

Do these actual 463L requisition pipeline times meet Air Force mission requirements? This question cannot be answered through this analysis, but a closer look at an example of how these figures relate to the pipeline times experienced by a base provides further insight into the question.

Source: MAC Forms 129. The following example reflects the actual pipeline times recorded on the MAC Forms 129 for 463L requisitions submitted by Charleston AFB, SC. The pipeline time distribution graphed in Figure 16

represents requisition data for the months of May and June 1989. The data collected was limited because MAC Forms 129 are only retained for 30-60 days after the MICAP is satisfied (40).

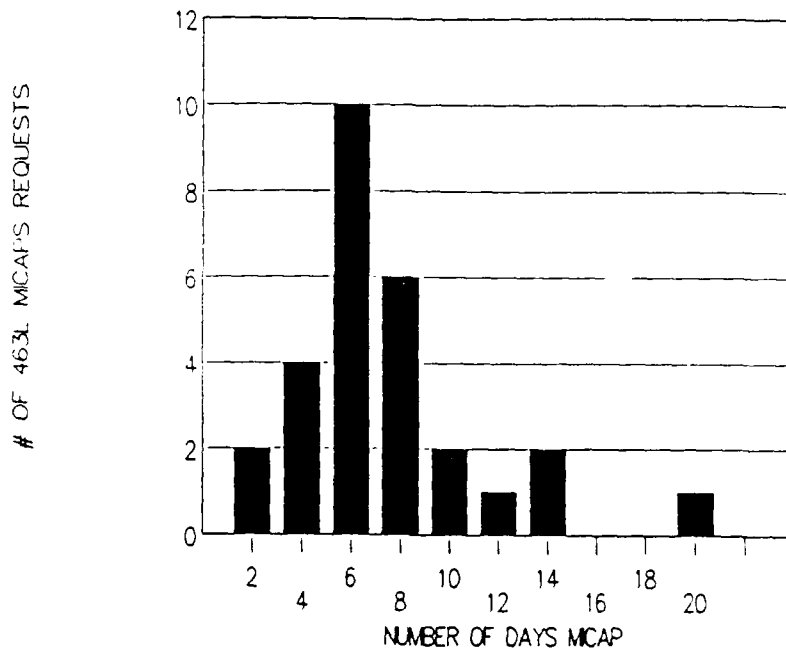


Figure 16. MAC Forms 129 - Pipeline Time Distribution

As shown, this distribution is shaped differently than the DLA and ALC pipeline time distributions. In this distribution, 10 of the 24 463L requisitions processed over this period were satisfied in five to seven days. Also, 16 of the 24 or 67 percent of the requisitions were satisfied within the seven day UMMIPS standard. This is only an isolated and limited example of the 463L pipeline times

experienced at a base, but it does illustrate that there can be a difference between the overall depot pipeline times and those experienced by a base.

The following example shows how these individual requisition pipeline times can affect the overall VDP times for 463L vehicles.

Source: AF Forms 1823. The 463L VDP times illustrated in Figure 17, reflect the VDP times recorded on AF Forms 1823 from April through June 1989 at Charleston AFB. Again, the data was limited because AF Forms 1823 are only retained for 90 days after the repair was completed.

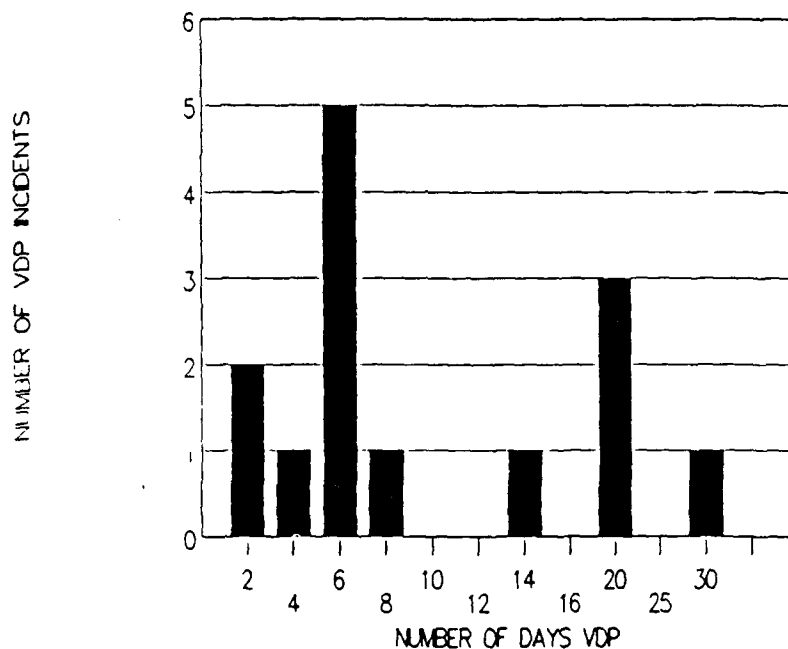


Figure 17. VDP Time Distribution

These times do not represent the processing times for individual parts requisitions, but they do reflect the total

time vehicles are down for parts. This VDP time distribution, then, does not directly reflect the spare parts pipeline, but does allow for a comparison between pipeline times and VDP times. Although this distribution was limited, it did provide an idea of how different a user's perspective of pipeline performance can differ from that of MICAP Control and especially of the depot systems.

As Figure 17 illustrates, the VDP distribution for 463L vehicles has a wider distribution than does the distribution for the MICAP requisitions at either the base or depot level. There are a number of possible reasons for this, including the limited data base, but one key reason for this difference is that vehicles are not taken off VDP status until all of the required MICAP parts are received by vehicle maintenance.

#### Summary

This chapter has addressed the last of the investigative questions. As stated, the ownership of the pipeline was found to be divided among all the organizations within the pipeline. Each section of the pipeline monitored its own measurements which were either functionally oriented, supporting pipeline operations, or pipeline time oriented, evaluating requisition processing times. This chapter also explained the capabilities and limitations of the performance measures and reports. It was found that many of the measurements used to manage the pipeline only evaluated specific portions of the total pipeline system,

and therefore, presented a biased representation of pipeline performance.

Finally, this chapter explained that the difficulties encountered in trying to gather processing time data for individual segments of the 463L pipeline. Although these difficulties prohibited the development of individual pipeline time distributions, three different sources were found to reflect total pipeline times. Four 463L pipeline time distributions were presented to provide examples of the total pipeline time distributions represented in the different sources.

Chapter VI follows with the overall conclusions of this research and recommendations for further areas of study.

## VI. Conclusions

This thesis examined the spare parts pipeline for 463L equipment in order to develop the flow pattern of spare parts requirements from the identification of need to receipt of the part. In so doing, five major investigative questions were examined.

1. What offices, sections, and organizations are involved in the spare parts pipeline for 463L equipment?
2. What are the procedures followed by each section or unit of the pipeline in the processing of spare parts requisitions?
3. Who is responsible for monitoring the data collected for the unit and for the system as a whole?
4. How are processing times recorded and what reports reflect and summarize these times?
5. What are the average processing times and time distributions for each section of the pipeline?  
How do changes in the times and distributions impact the pipeline time as a whole?

To ensure these questions were thoroughly addressed and the requisition process properly documented, this research also

addressed several questions posed by Gitlow as being necessary to the initial documentation of any process.

These questions were:

- 1) What is the flow of the process?
- 2) What are the boundaries of the process?
- 3) Who owns the process?...
- 4) What are the objectives of the process? How is the success of the process in meeting objectives being measured?
- 5) Are the measurements being taken on the process valid? (11:42)

Together, the investigative questions and Gitlow's questions guided the research for documenting the 463L pipeline.

#### Research Conclusions

This section provides a summary of the conclusions reached for each of the investigative questions.

Investigative Question One. What offices, sections and organizations are involved in the spare parts pipeline for 463L equipment? Four major divisions of the spare parts pipeline were found, vehicle maintenance, base supply, Air Logistics Center (ALC) depots, and Defense Logistics Agency (DLA) depots. Each of these divisions also had different subsections or branches responsible for the specific tasks within the divisions.

The following presents the major subsections found in the pipeline. The Material Control section performed the supply requisition and supply management functions for vehicle maintenance. The Base Supply Demand Processing section received and screened parts requisitions. Demand Processing passed all 463L MICAP (Mission Capability) requisitions to MICAP Control. MICAP Control, also a

subsection of base supply, acted as the intermediary between base supply and the depot systems. MICAP Control processed, submitted, and monitored all MICAP requisitions originating from their base, including 463L MICAPs. Depots provided wholesale storage and procurement functions for the pipeline. The Materials Management sections of the depots monitored and managed the stockage levels for Air Force and Department of Defense items. The depot distribution management sections monitored and managed the transportation functions required to ship parts to the requesting organizations. Together, all of the subsections combined to form the pipeline for 463L spare parts.

Each one of the subsections accepted inputs from and provided outputs to other subsections of the pipeline. This interaction between subsections was described in Chapter I as integral to the success of any system and the reason for conducting macro-analytical process analyses (31:7,25). The flowcharts developed to address the next investigative question focused on these macro-analytical process interactions.

Investigative Question Two. What are the procedures followed by each section or unit of the pipeline in the processing of spare parts requisitions? Chapter IV presented detailed process descriptions and flowcharts for the entire 463L spare parts pipeline, from vehicle maintenance through the depot systems. The process flow covered the full spectrum of the order processing system

described in Chapter II. In so doing, the flowcharts and process descriptions began with the vehicle mechanic identifying the requirement for a part and followed the process through the five components of the order process described by Stock: (1) order preparation and communication, (2) order entry and order processing, (3) order picking and packing, (4) order transportation, and (5) customer receiving (34:499,502). This process description provided an opportunity to evaluate the pipeline interactions from the macro-analytical perspective.

In analyzing the requisition process for 463L spare parts, two aspects concerning the information flow of the 463L pipeline contradicted that of the ideal order processing information flow described in Chapter II. These two major discrepancies involved information availability and information quality.

Information availability problems centered around the accessibility and timeliness of requisition transmission and feedback. Information accessibility was a twofold problem centering on the indirect and inefficient user-supplier computer system. First, Material Control, at most bases, was unable to make direct part availability inquiries into the main base supply computer nor directly input their requisitions into the supply computer. Second, Material Control had absolutely no direct access to the depot stockage and requisitioning computer.

As mentioned by Stock in Chapter II, order transmittal should be as direct as possible using the most accurate and rapid method, electronic transmission (34:503,505). Direct access to both the base and depot supply computers would enable the customer [Material Control] immediate feedback on parts availability, which would provide greater customer service (34: 500,505). This immediate transmission and inquiry capability would reduce both pipeline time and variability as the information and ordering delays created by the multi-level supply hierarchy would be eliminated.

Compounding the information accessibility problem was the batch processing computer system used in transmitting requisitions from base to depot and from depot computer to depot computer. It was found that delays of hours or even days were inherent in the requisition transmission and depot processing systems.

The first delay was found to be in the autodin transmission system between base supply and depots. Autodin transmission from base supply were found to delay MICAP requisitions for up to eight hours or more depending on the batch release cycles from the base to the depot. Once at the depot, the requisitions were further delayed from four to twelve hours as the requisitions awaited batch release from the communications centers to the central depot processing computers (18; 30).

Once in the depot processing systems, requisitions could be further delayed for up to 24 hours as the

requisitions were batch filed between depot computers. For example, there was up to a 24 hour delay between the ALC D009, Shipment Control and Release System, and the MCS, Mode and Carrier Selection System, solely due to the once a day batch release cycle of the D009 (18). Similar computer-to-computer delays are experienced within DLA depots (24; 30).

As stated in Chapter II, fully on-line order processing systems eliminate batch file delays and also increase customer service (21:30,33). By incorporating on-line systems and providing Material Control with computer terminals and interactive access to both supply and depot computers, the supply pipeline can achieve greater customer service levels and pipeline efficiencies. These gains can be made as computer-to-computer systems increase customer service levels and lower total system costs by increasing customer-supplier interaction and eliminating order entry and processing redundancies (34: 510-511).

The second inadequacy found in the information flow between depots and bases involved the quality of information transmitted. Frequent errors in Estimated Delivery Dates (EDD) for items on BB backorder status were found. The reason this EDD information was erroneous was because it was based on a Standard Delivery Date (SDD) established by regulation. This SDD was often assigned to BB status requisitions even though no firm contract or delivery date was negotiated with a commercial supplier for the part in question (30). The erroneous information led the requesting

organization to understand the part would be received no later than the EDD. The customer had no way of knowing whether or not the EDD was valid, and waited until the EDD had passed before submitting a supply assistance request (30).

The erroneous EDD information, as described above, reduces customer service and incorporates unnecessary delays in the pipeline as the users refrain from submitting supply assistance requests until after the EDD is exceeded. As stated in Chapter II, this type of system variation and unreliability greatly reduces customer service and detracts from a pipeline's value (10:17; 2:27,46).

Resolving the information availability and quality concerns discovered during this thesis research can decrease pipeline time and increase pipeline effectiveness. The more direct interactions between Material Control and base and depot supply systems can also increase the operational commander's readiness. Readiness is increased since enhanced accuracy of supply status enables operational commanders to more effectively plan, support, and control operations (4:3-5).

Investigative Question Three. Who is responsible for monitoring the [pipeline] data collected for the unit and for the system as a whole? As illustrated in Tables I and II, each section of the pipeline was found to collect and monitor its own specific data. This data reflected either functional objectives or pipeline processing times. The key

difference between the two areas of concern was the time factor. Also, addressed in answering this investigative question were the essential documentation questions: How is this process being measured? and Are these valid measurements? (11:42)

How is the process measured? This section describes the functional and pipeline measures used to monitor and manage the pipeline. It was found that functional measures were monitored by the Material Control and MICAP Control sections of base supply and the materials management sections of the depots. The Material Control and MICAP Control sections monitored reports reflecting the supply status and EDDs of the individual requisitions processed through their sections. Material Control monitored only vehicle requisitions while MICAP Control monitored all MICAP requisitions from the base, including 463L MICAPs. Both Material Control and MICAP Control monitored data that helped ensure parts requisitions were effectively processed through the pipeline.

The materials management sections of the depots monitored backorder notifications and fill rates. Backorder notifications alerted Item Managers (IM) of outstanding or newly created backorders. The IMs used these reports as "flags" to initiate actions to resolve stockage problems and fill parts requisitions. Fill rate reports reflected the stockage effectiveness of the stocks managed by the

individual IMs and depots. These reports were used to evaluate the performance of depot stocks in filling parts requisitions.

Pipeline time measures were only monitored by vehicle maintenance and depot units. The vehicle maintenance sections monitored the Vehicle-Down-for-Parts (VDP) rates and times. These rates provided an indirect measure of the pipeline by measuring the number of hours vehicles were down for parts, and included 463L specific information. The depots measured pipeline times for both the pipeline as a whole as well as the depot specifically. These reports provided either summary data for the processing times for all MICAP requisitions, as provided at ALC depots; or provided summary information for all Priority 01-03 and Not Mission Capable-Supply (NMCS) items including MICAP requisitions, as provided at DLA depots. Neither of these reports provided any specific breakout of 463L requisition processing times.

Are these measures valid? This section describes the capabilities and limitations of the pipeline measurements.

Most of the pipeline measurements used to manage the 463L pipeline were found to monitor only certain aspects of the pipeline. For instance, the VDP rate provided only an indirect measure of the spare parts pipeline because the VDP rate was based on the number of hours 463L vehicles were down for parts and not on the number of parts required for

the vehicle. This meant that if one vehicle were down for more than one part the VDP rate underestimated the requirements placed on the supply pipeline.

Depot level performance reports also tended to underestimate pipeline problems. Fill rates, for example, were used as a measure of the stockage effectiveness of a depot. The fill rate equalled the percentage of new requisitions filled from on-hand depot stock. The problem found with this report was that the fill rate did not consider backorder requisitions carried over from the previous reporting period. This meant the fill rate understated the total number of parts on backorder at the depot. As a result, the actual pipeline performance experienced by the customers was less than the performance reflected in the fill rate. This illustrated that depots measured their effectiveness on only part of the pipeline service provided to the customers, since customers evaluated pipeline performance on the total number of outstanding orders, not just the new ones.

Depots also overestimated their pipeline time performance for a similar reason. Depots evaluated pipeline processing times for only those parts readily available from depot stockage. If parts had to be backordered, they were not included in the measurements or reports that were actually used to evaluate pipeline processing times. Thus, the reports used to manage the pipeline overestimated the pipeline performance experienced by the users, since from

the user's point-of-view pipeline time includes all parts requisitioned not simply those in depot stocks. From a customer's viewpoint, then, the average and total pipeline times were greater than those used to evaluate pipeline performance.

The difference in point-of-view becomes even greater as the fill rates for depots fall and less of the total requisitions are evaluated in pipeline performance. Pipeline managers must keep this disparity in mind since "the single output of any organization is customer service" (10:11).

The common thread through all of these pipeline performance measurements and reports seems to be, "Tell me how you measure me and I'll tell you how I behave" (13:1). Pipeline organizations seemed to have geared their performance reports to the goals and standards by which they were evaluated. In most cases, reports and management tools reflected pipeline performance in terms of the "best case" situation and reflected only those requisitions that move smoothly through the pipeline rather than monitoring problem areas. As a result of these "best case" performance measurements, the validity of pipeline management tools was questionable.

Investigative Questions Four. How are processing times recorded and what reports reflect and summarize these times? There were only two activities that monitored pipeline processing times, as listed in Table II of Chapter V. As

illustrated in the table, vehicle maintenance indirectly monitored pipeline times through their Vehicle Integrated Management System (VIMS) PCN0032 report. This provided VDP times for 463L equipment on a monthly summary basis. As stated in the previous section, VDP times provided only a limited measurement of the pipeline, as the times recorded reflect only the number of vehicles down for parts, not on the total number of parts required. Thus, VDP times hid the total parts processing times for the individual parts requisitioned.

The pipeline times recorded by the depots also provided a limited view of total pipeline processing times. As explained in Chapter V, the pipeline management reports used in managing and evaluating the pipeline reflected processing times for requisitions satisfied from on-hand depot stocks. Requisitions for parts not immediately available for shipment were excluded from these reports. These reports included Part 1 of the ALC depot LOG-LO (M) 7922 report and the MILSTEP Highlight Table for DLA depots.

The other problem with the depot reports for the purpose of this thesis was that they did not segment pipeline times for 463L equipment. As a result, pipeline time distributions could not be developed for use in answering the fifth and final investigative question.

Investigative Question Five. What are the average processing times and time distributions for each section of the pipeline? How do changes in the times and distributions

impact the pipeline? Neither of these questions were answered in this research because no 463L specific pipeline times were available from each section of the pipeline. Pipeline time information either reflected total 463L pipeline times or consolidated 463L information together with all other requisitions of equal priority. As a result, the only 463L specific information available and collected was presented in the frequency distributions presented in Chapter V.

The frequency distributions could only be used to present an example of the total 463L pipeline processing times available found to be available. None of the information used to develop the distributions was readily available. To formulate these distributions required one of two collection methods: a specific computer retrieval program to collect the data, i.e. the D165 information reflecting the total MICAP processing times for the Military Airlift Command 463L requisitions; or manual source document-by-source document collection methods.

The frequency distributions illustrated that although most parts were received within the seven day Uniform Material Movement and Issue Priority System (UMMIPS) standard, many required more time and in some cases over 100 days. This indicated there were difficulties in the pipeline that created long parts delivery times and kept essential 463L equipment out-of-commission for extended periods.

These longer pipeline times caused field units the most problems and must be resolved to ensure 463L equipment is available to support the airlift mission when required.

#### Further Research

While conducting the research and analyzing the 463L pipeline a number of areas were found that required further research. Since this thesis flowcharted the Air Force pipeline for 463L spare parts, this flow could be compared to commercial industries using similar equipment. A comparison of this type would provide insight into the pipelines developed to support materials handling equipment in the private sector where every hour a vehicle is deadlined for parts reduces company profits as well as customer service. This comparison also may provide insight into the costs and benefits of fully computerized on-line order processing systems.

Using the flowchart developed in this thesis also enables further researchers to assess the actual processing times required for each section of the pipeline. An individual or team could physically track individual requisitions through the pipeline and record processing times. These times then could be used to develop a simulation of the pipeline. The simulation could be used to evaluate how changes in each section of the pipeline effect the pipeline as a whole. The simulation developed could fully and accurately illustrate the effects pipeline interactions have on total pipeline performance.

## Summary

This chapter provided a general overview of research results concerning the 463L spare parts pipeline by addressing each investigative questions individually. Of key importance was the actual evaluation of the information flow problems and inefficiencies which permeate the pipeline process. The discussion indicated delays were inherent in the pipeline because of the use of outdated and indirect order processing computer systems. The discussion also restated the problem inherent in the performance measures used to evaluate pipeline performance. That is, performance measurements did not reflect pipeline performance from the users perspective. The lack of was orientation resulted in pipeline managers evaluating performance from a narrow micro-analytical perspective, rather than from the general macro-analytical perspective professed in Chapter I.

In closing, this thesis presented the initial documentation and analysis of the 463L pipeline. The pipeline flows developed and the performance measurements evaluated indicated the pipeline has inherent difficulties that must be addressed to enable the pipeline to support 463L equipment in the most efficient and effective manner.

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Block 19. Abstract

"Getting the right thing to the right place at the right time," is the goal of a logistics system. With the goal of the logistics system in mind, commanders and managers are now asking, what makes up a logistics system and how does the system work? This thesis addresses this question by analyzing one of the channels or pipelines within the Air Force logistics system, the spare parts pipeline for 463L equipment. This pipeline focuses on this pipeline for two reasons: (1) parts availability for these mission assets is essential to the Air Force, and (2) individual pipelines are more manageable research topics than the logistics system as a whole.

This thesis describes through flowcharts and process descriptions pipeline responsible for processing MICAP spare parts requisitions for 463L Materials Handling Equipment. Pipeline management, measurement, and interactions are highlighted along with their impact on the function of pipeline as a whole.

The major outcomes of the thesis research were: (1) detailed flowcharts of the requisition process for 463L parts from vehicle maintenance through the depots and back to maintenance, (2) no single manager or office controlled or monitored the entire pipeline, (3) many of the key pipeline measurements and management reports monitored only limited aspects of pipeline performance and overlooked areas that detract from the customer service provided by the pipeline, and (4) the order processing computers created inherent delays in the pipeline because of outdated and indirect information systems and technology.

Overall, the value of this research was not to identify pipeline problems, but to provide the groundwork for future more detailed pipeline and logistics studies.

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