

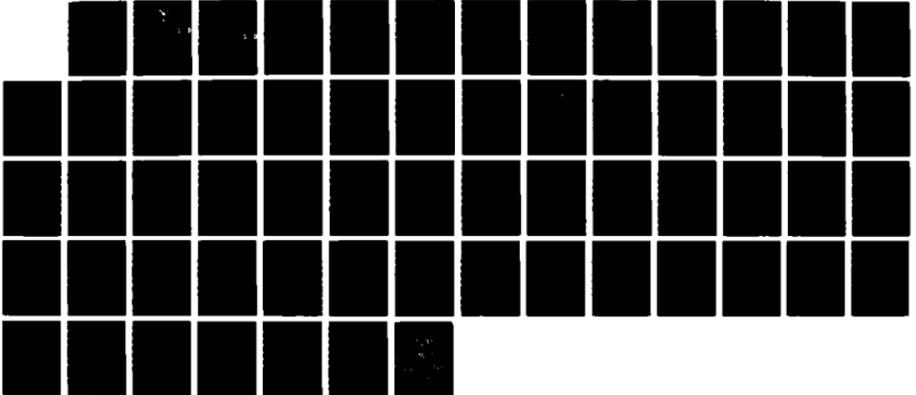
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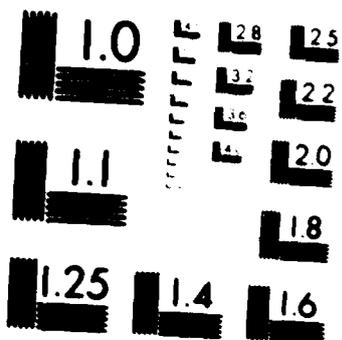
AN ANALYSIS OF THE FUTURE REQUIREMENTS FOR MATERIALS
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AN ANALYSIS OF THE FUTURE
 REQUIREMENTS FOR MATERIALS HANDLING
 EQUIPMENT IN THE MILITARY
 AIRLIFT COMMAND

THESIS

Robert J. King
 Captain, USAF

AFIT/GLM/LSMA/87S-41

DEPARTMENT OF THE AIR FORCE
 AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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AN ANALYSIS OF THE FUTURE REQUIREMENTS FOR
MATERIALS HANDLING EQUIPMENT IN
THE MILITARY AIRLIFT COMMAND

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

Robert J. King, B.S.
Captain, USAF

September 1987

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Abstract

The purpose of this study was to research and document the effects of a Materials Handling Equipment (MHE) shortfall with respect to current airlift issues and trends. The study had three basic objectives: (1) validate a previous Air University Center for Aerospace Doctrine, Research, and Education (CADRE) study, (2) research actions taken by Military Airlift Command (MAC) with respect to current issues and trends, and (3) make new recommendations regarding the enhancement of MHE capability.

The study found that the CADRE recommendations were to: (1) phase out TAC-loaders and K-loaders, (2) purchase specialized MHE to meet short-term requirements, (3) replace the current MHE fleet with a new type transporter/loader, (4) use experts from military staffs to determine specifications for new MHE, (5) use experts from civilian industry as consultants for MHE development, (6) centralize MHE management, and (7) use a formula to determine wartime MHE in-commission rates.

Research and analysis showed that the CADRE recommendations were accepted and adopted by MAC and the United States Air Force.

AN ANALYSIS OF THE FUTURE REQUIREMENTS FOR MATERIALS
HANDLING EQUIPMENT IN THE MILITARY AIRLIFT COMMAND

I. Introduction

Overview

This chapter presents the general issue that was researched in this thesis, including background information, a problem statement, research objectives and questions, and the scope of this thesis.

General Issue

The USAF Director of Transportation listed determining the quantity of Materials Handling Equipment (MHE) needed to support increased airlift requirements as one of his top nine objectives for 1986 (29:14). This level of priority is indicative of the importance of the MHE issue within the Air Force transportation community. A former Military Airlift Command (MAC) Chief of Staff stated that MHE is the "Achilles' heel of MAC" (40:1). This statement clearly demonstrates the importance of having enough MHE to handle the flow of cargo per day (an estimated 66 million ton-miles) that will be needed in Europe or the Middle-East to support a major contingency effort (38:12). MAC and the Air Force have met this challenge head-on, with several programs, including development of the 40-K loader

adapter and purchase of the Wilson wide-body loaders. The 40K-loader adapter is constructed of a welded aluminum alloy frame with commercial type warehouse rollers that is secured on a 40K-loader, allowing the 40K-loader to reach the main cargo deck of wide-body aircraft (10:A-13). Despite these actions, however, the Office of the Secretary of Defense (OSD) indicated it believes the Air Force has not quantified MHE requirements to support the 34 percent increase in intertheater airlift caused by programmed CRAF enhancements, and the introduction of the remaining KC-10 and C-5B aircraft into the Air Force fleet, planned for FY87 through FY91 (1:III-2).

Background

In 1983, the Air University Center for Aerospace Doctrine, Research, and Education (CADRE) sponsored a study entitled The Impact of Materials Handling Equipment on Airlift Capabilities. This study was performed by Lieutenant Colonel Gary B. May, a MAC Research Associate assigned to CADRE's Airpower Research Institute. This study provided a wealth of information regarding the history of MHE.

MHE shortfall problems have occurred since the system was first instituted in the early 1960s. According to May, MHE was first used in Vietnam in 1964, and by 1966 the overall condition of the equipment caused serious

concern among senior officers (32:24-25). The three major aerial ports in Vietnam reported only 40 percent of their forklifts and 37 percent of their K-loaders in operation in January 1967. Brigadier General William G. Moore, Commander of the 834th Airlift Division, stated that the greatest limitation in the airlift system at that time was the lack of MHE (32:25). The problem during the Vietnam conflict was primarily spare parts support, not necessarily an authorization versus allowance problem. Vietnam demonstrated that the Air Force tended to consider MHE as just another category of support vehicles, without considering the vital nature of its integration in the airlift system (32:30).

Current MHE problems stem from a shortfall of numbers of pieces of MHE combined with in-commission rate problems. MAC estimates a 90 percent in-commission rate for all MHE, including equipment gained from other Air Force activities (32:61). MHE in-commission rates during the Vietnam conflict ranged from 70 percent down to 40 percent (32:70). May concluded that, during a sustained wartime airlift surge, MHE will break down at a tremendous rate, and stated:

Even if MAC had the airframes necessary to eliminate airlift capability shortfalls, the nation could not deploy or sustain combat forces on a worldwide basis because of insufficient amounts of operable materials handling equipment. We could easily find ourselves in a posture where portions of combat units

are deployed with only a fragment of the supplies and munitions needed to blunt the thrust of the first Soviet blows [32:70].

May estimated that MAC was short approximately 1,150 pieces of MHE to support contingency taskings and ground time constraints in support of a European deployment of forces in 1983 (32:60). MAC currently estimates the shortfall has been reduced to approximately 850 pieces of MHE, with a majority of the shortfall occurring in the 25K-loader (271 pieces/46 percent shortfall), 25K TAC-loader (23 pieces/30 percent shortfall), and wide-body loader (71 pieces/40 percent shortfall) categories (18).

Problem Statement

The specific problem is that the effects of the MHE shortfall are becoming more acute, contrary to what raw numbers would indicate, given current airlift issues and trends. Changes in the types and numbers of aircraft participating in the Civil Reserve Air Fleet (CRAF), and types of equipment (Air Force as well as other services) that will have to be transported during a contingency, have exacerbated the problem during the past decade.

Research Objectives

The objectives of this research were to: (1) validate May's CADRE-sponsored study, (2) research actions taken by MAC with respect to current issues and trends,

and (3) make new recommendations regarding the estimation of MHE capability.

Research Questions

The MHE capability shortfall is based on historical fact. Therefore, questions about the root cause, history, and future of the problem were not considered. Specifically, the following questions were addressed:

1. What were the recommendations of the 1983 CADPE-sponsored study?
2. What issues prompted the CADRE recommendations?
3. What actions have MAC and the Air Force taken to implement the CADRE recommendations?
4. What new issues and trends effecting MHE exist?

Scope

This research effort was limited to MHE requirements within Military Airlift Command. Other military services and Air Force MAJCOMs have both peacetime and wartime MHE requirements, but they were excluded from this study since a majority of Air Force MHE is assigned to MAC as shown in Table 1.

Conclusion

This chapter presented the general issue, including background information, problem statement, research objectives and questions, and the scope of this study.

TABLE 1
MHE AUTHORIZATIONS (18)

Type Vehicle	Total Air Force	MAC Auth(1)	MAC Avail(1)	USAF Req	OPLAN Req(2)	Short-fall(3)
40K	286	235	193	255	184	+ 9
25K	492	413	259	717	530	-271
25K TAC	61	74	54	79	77	- 23
10K	1552	936	583	1783	943	-360
WBL(4)	101	93	69	167	140	- 71
LLL	16	17	13	-	0	+ 13

(1) Authorizations and available figures include WRM vehicles.

(2) OPLAN Requirements were extracted from MAC OPLANS.

(3) Shortfall computations equal MAC available MHE minus MAC OPLAN requirement.

(4) Wide-body Loaders include both Cochoran and Wilson loaders.

II. Methodology

Overview

This chapter describes the methodology used to answer the research questions outlined in Chapter I.

Steps for Answering Investigative Questions

The first two investigative questions, "What were the recommendations of the CADRE study?" and "What issues prompted the CADRE recommendations?", were answered through a literature review.

A review of the 1983 CADRE-sponsored study was conducted to answer the first question. This study was cited by the CADRE Vice Commander who stated in the study's forward, "all who are interested in the role airlift plays in the national defense of our country can learn from the words contained within these pages" (32:xi).

The second review question was also answered by reviewing literature current at the time of the study. This literature review formed the historical basis for this research effort.

The third investigative question, "What actions has MAC taken to implement the CADRE recommendations?", was answered through personal unstructured interviews, and a review of files, records, publications, and other documentation at MAC Headquarters. Unstructured personal

interviews, two-way conversations initiated by a researcher to obtain information from a respondent (12:160), were chosen because of the depth and detail of information that could be obtained (12:160). Personnel at MAC headquarters were interviewed to determine how the CADRE recommendations affected MAC operations. Use of personal interviews also yielded higher quality information than could normally be obtained through other methods of research (12:160).

Steps were taken to avoid cost and bias problems usually associated with personal interviewing (12:161). The cost problem did not arise, since MAC headquarters was readily accessible. Bias problems, such as nonresponse error, sampling error, and response error were also not encountered. Nonresponse errors, those that occur when primary respondents cannot be located or interviewed (12:165), were avoided because appropriate MAC headquarters personnel were available for interviewing. Sampling errors, those occurring when an improper sample is obtained and interviewed, were also avoided. Sufficient time and effort was expended during MAC interviews to effectively reduce the occurrence of sampling errors. Interviewing was not contained within a single Deputate, Directorate, Division, or Branch. Interviews were conducted across deputate lines throughout the Headquarters to reduce sampling errors. Errors that occur when data obtained during interviews is different from data recorded in

official files, known as response errors (12:166), were not encountered. Extreme care was taken during interviews to insure that reported information was complete and accurate. Responses were cross-checked between deputates, and a thorough research of back-up records and files reduced the possibility of response errors occurring.

Research through records and files started in the MAC Facilities and Equipment Division (TRXF). As previously stated, MAC offices were included in this research effort because a majority of Air Force MHE is assigned to MAC. This division provides technical guidance and assistance in the programming, conceptual design, and procurement of materials handling systems, and is the command functional manager for all materials handling equipment (15:81). Within the Transportation Deputate (TR), relevant records and files in the Transportation Training Division (TRQT), Mobility Operations Division (TRXM), and the Transportation Plans Division (TRXP) were also reviewed. Records and files in the Motor Vehicle Division (LGMV) were reviewed as well. This division provides technical and managerial guidance to ensure sufficient vehicles are available for the movement of cargo (15:62). Records and files in the Inspector General's Transportation branch rounded out the research at MAC. This branch is responsible for evaluating transportation functional areas during inspections, and highlighting MHE shortfalls to the MAJCOM staff (15:53).

The fourth investigative question, "What new issues and trends effecting MHE exist?", was answered through a review of current literature and personal interviews. Literature was obtained from the Air Force Institute of Technology libraries, Military Airlift Command sources, Air Staff sources, and a Defense Technical Information Center (DTIC) search. This literature was reviewed for information that impacted MHE operations, capability, and availability. Personnel at Headquarters MAC, AFLC, the Air Staff, and Southwest Mobile Systems, Inc. were also interviewed concerning MHE issues and trends.

Conclusion

This chapter presented the methodology that was followed in the course of this research effort. The literature review that was conducted as a part of this methodology is presented in the following chapter.

III. Literature Review

Overview

This chapter presents the results of the detailed literature review that was conducted to answer the investigative questions outlined in Chapter I, using the methodology discussed in the preceding chapter.

Development of MHE Systems

According to May, transport aircraft were not included in the United States pre-World War II air order of battle (32:9). During World War II the Air Transport Command (ATC) was tasked with ferrying aircraft, transporting personnel, material, and mail, controlling, maintaining, and operating terminals along air routes, and evacuating sick and wounded personnel (32:10). The National Security Act of 1947 designated Military Air Transport Service (MATS) as the global air transport service for the DOD (32:11). MATS, like ATC, was tasked with maintaining a core of personnel, facilities, and aircraft to meet DOD requirements. This core was to be used as the basis for rapid expansion when necessary (32:11). Materials handling equipment was not addressed during this era, because cargo handling was primarily accomplished by hand, with little or no mechanized support.

The Berlin Airlift (25 June 1948 - 30 September 1949) demonstrated the carrying capability of U.S. Air Force aircraft. U.S. forces transported approximately 1.7 million tons of food, materials, and fuel to Berlin. The C-47, C-54, C-74, C-82 and C-97A aircraft that flew airlift missions were mostly loaded by hand. Forklifts or cranes were only used to load extra heavy (over 400-500 pounds) or odd shaped pieces. This method of aircraft loading and unloading equated to a 1 hour 25 minute turnaround time at loading points, and a 49 minute turnaround time at download locations. The Berlin Airlift was one of the earliest examples of the development of airlift resources without sufficient MHE support to effectively utilize full aircraft potential (32:18-19). According to May, as the C-74 and YC-97 aircraft entered the airlift there was no suitable loading equipment to take advantage of the increased strategic airlift potential. The size of these aircraft, combined with long loading floors and high doors, created the need for mechanical loading aids (32:19).

During the Korean conflict, an average of 17 forklifts and 7 of the early model K-loaders were required to offload 625 tons of cargo per day at division airfields. An average of 6.6 forklifts and 5.6 K-loaders were considered combat losses during the first 75 days of combat in Korea. This amounted to nearly a 100 percent turnover in equipment at some locations during the 75 day period, and was the

first demonstration of the vulnerability of MHE in the combat environment (46:33-34).

Early in 1957, the Department of the Air Force issued a Specific Operational Requirement (SOR 157) for a Materials Handling Support System. This was the first official recognition that Air Force cargo handling procedures and practices were unsatisfactory. The objective of SOR 157 was to:

. . . provide a complete cargo handling system compatible with the various modes of transportation required in accomplishing the air logistics mission--to standardize methods, techniques, and equipment used in packaging, marking, documenting, and handling [32:20].

In response to SOR 157, Air Force Systems Command performed a study entitled "System Package Program for Materials Handling Support System, System Number 463L." This 463L system was comprised of four related families. The first was the terminal, and intermediate trans-shipment point for cargo. The second family was cargo preparation, including all equipment associated with the palletization and restraining of cargo (pallets, nets, coupling devices, and containers). The third family consisted of the cargo terminal handling equipment to include K-loaders, forklifts, trailers, and other pieces of equipment used within the aerial ports such as the 25K TAC Loader shown in Figure 1. The final aircraft systems family contained all items installed aboard aircraft which related to cargo handling including the rails, rollers, and locking systems (32:21).

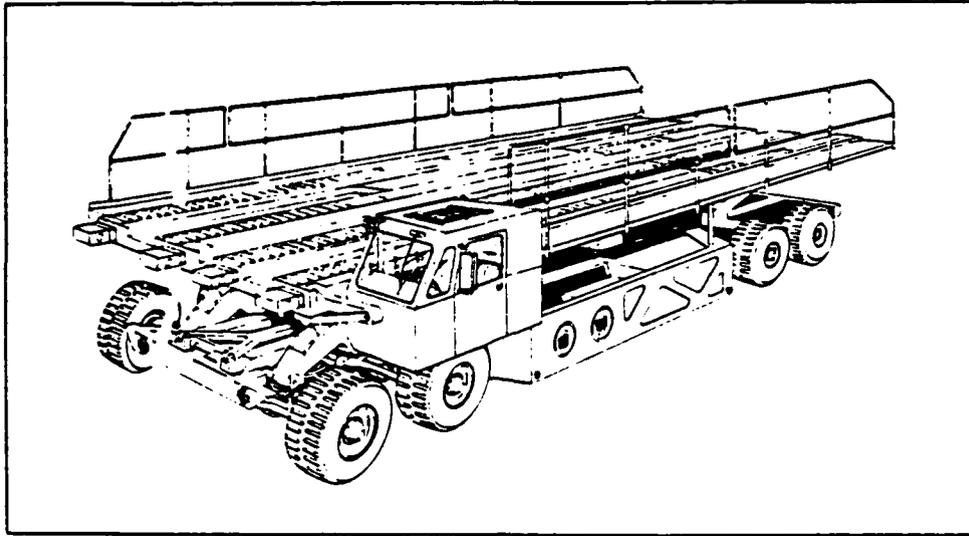


Fig. 1. 25K TAC-Loader [11:2-60]

A Douglas Aircraft Company MHE study in 1960 determined the key to an effective cargo loading system was the pallet used to transport the cargo. The Douglas study concluded that the material handling pallet and associated cargo net set, shown in Figure 2, was the controlling element of the entire 463L system. The Douglas study also recommended development and implementation of a ground handling system capable of moving cargo to and from aircraft, and stressed the procurement of a single vehicle that could be used in conjunction with any aircraft (32:22).

A 1965 Marine Corps report recommended the procurement of a material handling system for the KC-130 aircraft, which would result in savings in time and effort and promote efficiency in reducing turnaround time in cargo

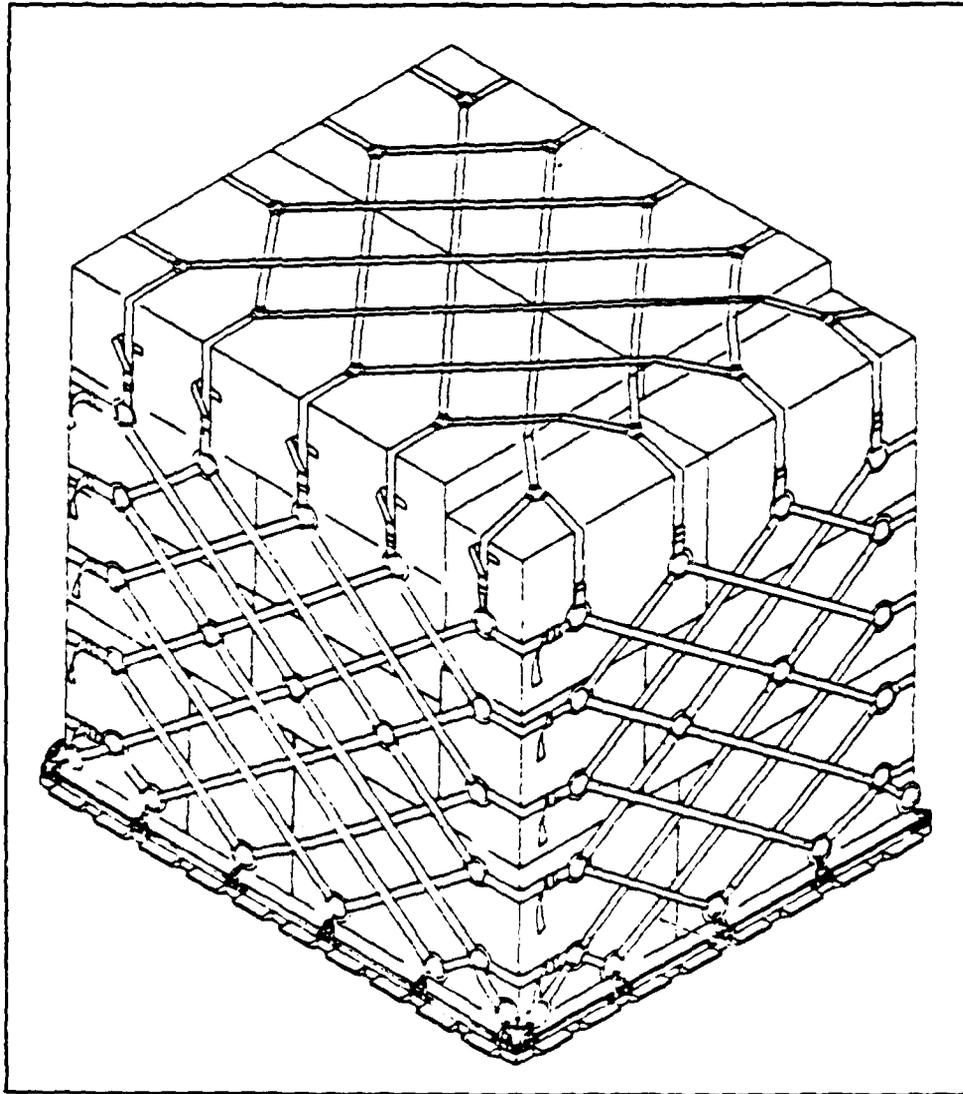


Fig. 2. 463L Pallet and Net Set [11:2-26]

operations. The recommended system included a 40-foot self-propelled flatbed trailer, a wheeled pallet, and a terminal system consisting of rollerized conveyor sections coupled to a center turntable. The Marine report recognized the need for a completely integrated materials handling system for use with the C-130 aircraft (31).

The 463L MHE system first utilized in Vietnam was expected to exploit the full potential of aircraft in the MAC inventory (C-130, C-141, and ultimately the C-5A). The system did not perform as expected, and tended to reduce the effectiveness of the airlift system, due to low in-commission rates and a lack of spare parts.

In-commission rates for MHE sometimes dropped as low as 50 percent during periods when the North Vietnamese were on the offensive, such as the Tet offensive of 1968. Spare parts often took as long as 30 days to arrive in Vietnam, increasing vehicle deadlined for parts rates (32:25). Much of the equipment used in Vietnam is the very same equipment the Air Force would use today if pressed to respond to a breakout of hostilities (32:26).

A 1968 MAC Project final report stated that 1,500 tons of cargo could be offloaded by one 40K-loader in 68 hours (7:18). The report also noted that the effectiveness of aerial port operations in support of the airlift mission was directly related to MHE in-commission rates (7:1).

Taylor's 1974 Air Command and Staff College research study stated that Congress had permitted the expansion of air terminals to accommodate the new generation of heavy logistics aircraft (C-5A and C-141), but noted that there had not been any significant improvements in MHE systems. Taylor quoted Lieutenant General Ruegg, former USAF Deputy Chief of Staff for Systems and Logistics, who said,

The 463L system is now approaching operational capacity and will be severely overtaxed by the increase in ton-mile capability to be produced by the airlift fleet [41:62].

1983 Current Issues

Several key issues had an impact on the development of May's 1983 study. Initiatives underway at MAC at that time had long-range implications for MHE requirements. The first of 79 rewinged C-5A aircraft completed test flights in early 1983. This added the prospect of an extended increase in airlift capability to the existing MHE shortfall problem.

Ulsamer reported a requirement for an additional 25 million-ton-miles per day of airlift capacity that surfaced as a result of the 1981 Congressionally Mandated Mobility Study as shown in Figure 3. Approximately 10 million ton-miles of this added requirement was outsized cargo (43:175). This 25 million ton-mile per day gap in wartime airlift capability also exacerbated the existing MHE shortfall problem.

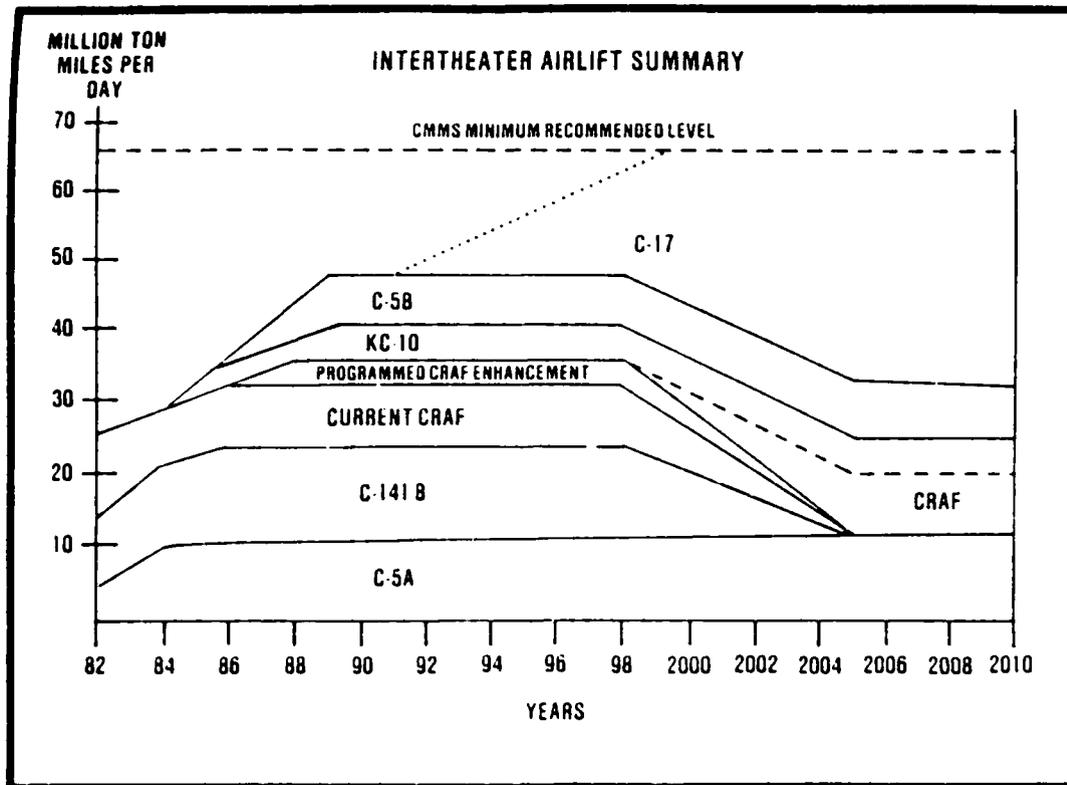


Fig. 3. Intertheater Airlift Summary [13:81]

In response to this new requirement, the DOD and the Air Force signed contracts for the production of an additional 50 C-5B aircraft with initial delivery scheduled in December 1985 (28:5). Ulsamer stated that the C-5B would provide flexibility by combining outsize cargo capability with "drive-on/drive-off and truck-bed loading features not available with commercial aircraft" (43:175).

Ulsamer also reported that MAC favored immediate purchase of forty-four KC-10 aircraft to "furnish cargo

capability while simultaneously serving as a tanker for aerial refueling" (43:174-175). Acquisition of these wide-body aircraft would require additional wide-body loaders at both MAC and SAC bases throughout the world, since existing 25K and 40K-loaders were not capable of reaching the main cargo decks of the wide-body aircraft as shown in Table 2 (11:2-65).

TABLE 2
 COMPARISON OF AIRCRAFT CARGO BED HEIGHTS
 AND CARGO LOADERS' CAPABILITY (6:10)

Aircraft Type	Cargo Bed Height (Ft/In)	Loader Type	Loader Capability (Ft/In)
B-747 UL	18 1	WBL	18 4
DC-10 UL	17 2	25/50K	13 0
707/DC-8	10 10	Commercial	12 4
B-747 LL	10 2	-	-
DC-10 LL	9 4	-	-
C-5A	8 8	25K TAC	6 4
C-5A (Kneeled)	4 6	-	-
C-141	4 2	-	-
C-130	3 5	-	-

Additionally, MAC was planning to enhance the Civil Reserve Air Fleet (CRAF) program with additional funding in the 1984 program objective memorandum (POM) (32:95). The additional CRAF capability would provide significant increases in oversize cargo capability, boosting the NATO scenario 30-day airlift capability by approximately 90,000 tons (4:47).

The C-141 "stretch" program was also expected to add the equivalent of 90 standard C-141s to the Air Force inventory, and was expected to increase airlift capability by 19,000 tons (4:46).

All these increases in airlift capability translated directly to an increase in requirements for MHE, and the Air Force planned to procure a mix of existing military and commercial MHE to match peacetime and wartime airlift requirements (32:103).

May's Recommendations

The conclusion of May's report provided recommendations that have been broken down into the following seven categories for the purposes of this thesis:

1. Phase out TAC-loaders and K-loaders.
2. Purchase specialized MHE to meet short-term requirements.
3. Replace the current MHE fleet with a new type transporter/loader.

4. Use experts from military staffs to determine specifications for new MHE.

5. Use experts from civilian industry as consultants for MHE development.

6. Centralize MHE management.

7. Use a formula to determine wartime MHE in-commission rates and requirements (32:114-116).

1987 Current Issues

Many of the issues that were current in 1983 are still valid in 1987. The C-5B and KC-10 acquisition programs and the CRAF enhancement program are still in progress. Additionally, the C-17 acquisition program is also still in development.

The Air Force is currently acquiring 50 C-5B and 44 KC-10 aircraft at a total cost of \$11.8 billion (35:42). Delivery of the C-5Bs should be complete in FY89 (43:175). In their cargo role, KC-10s can carry 170,000 pounds of cargo, and still offload 127,000 pounds of fuel. Delivery of the KC-10s should be complete in FY87 (1:Atch 2-10).

The Air Force is considering two programs to fill the gap in wartime airlift capability: CRAF enhancement and the C-17 acquisition program. The CRAF enhancement program encourages airlines to add cargo-convertibility features to their wide-body passenger aircraft. The DOD pays for retrofit modification and resulting additional

operating costs caused by increased weight (1:I-1 to I-2). Each enhanced B-747 provides 154,000 ton-miles per day of capability, or the equivalent of 2.3 C-141s. The total program will provide about 3 million ton-miles per day of cargo capability by 1996 (13:81), and will add 31 aircraft to the CRAF fleet (21).

There are currently 11 CRAF carriers providing a 10.04 million ton-mile capability to MAC (22). Projections indicate that the total CRAF capability will increase to 20.5 million ton-miles per day by FY1989, and decrease to 16.7 million ton-miles per day by FY2000 (see Appendix B). The FY2000 capability is projected to exceed the 10.1 million ton-mile CRAF commitment by approximately 6.6 million ton miles (21).

CRAF enhancement will boost airlift capability, but the need for an aircraft capable of carrying outsize cargo directly to a forward operating base under a direct delivery concept remains. The Air Force, Army, and Marine Corps believe the C-17 is the airlifter of the future, and support its production by the end of this decade (36:14). The C-17 has a wing span and length approximately the same as the C-141B, but it also has wide body drive-on/drive-off capabilities and the small-field take-off and landing characteristics of the C-130 (5:402-405).

MHE Issues

Both the CRAF enhancement and C-17 acquisition programs have tremendous impact on MHE systems capabilities and requirements. As a 1978 analysis of MHE for wide-body aircraft pointed out, any increase in wide-body aircraft utilization highlights the MHE capability shortfall of the Air Force family of cargo loaders because Air Force cargo loaders are "inadequate to load or offload the wide-bodies" (6:2).

The Air Force reported a wartime requirement for 3,965 pieces of MHE in March 1985. This figure included 2,428 pieces for the largest user, Military Airlift Command. The Air Force has programmed \$219 million for FY1986-91 to eliminate this MHE shortfall, and to replace over-age equipment (45:8).

In the interim, using commercial carrier equipment to meet the shortfall has been considered. According to Robinson, CRAF carriers are equipped to support 747 cargo operations at established terminals, and some also conduct off-line operations at remote locations. Over 450 wide-body loaders, and 2,000 lower-lobe loaders, used at these locations are catalogued by Boeing (37:12). This equipment could possibly be used in contingency operations, but availability, transportability, and nonstandardization issues raise questions as to its usefulness. MAC feels that this equipment should be considered only as a secondary source,

and that MAC should continue to systematically plan for, and procure, the equipment needed to meet readiness requirements (14:5). In addition, much of the equipment is either not transportable, or transportable only on C-5 aircraft (21).

The anticipated arrival of the C-17 in the Air Force inventory in FY91 will also place additional strain on the aging MHE systems. The Army expects to use the C-17 as far forward as combat brigade rear areas (38:14). This will greatly increase the requirement for MHE deployment in a NATO or Middle-East contingency operation. Pallets will be placed aboard the C-17 with the longer (108") side running the length of the aircraft (11:2-81). This is dissimilar from existing loading methods used on C-130, C-141, and C-5 aircraft, and may possibly require new or modified MHE.

Adding to the MHE problem facing MAC is the age of the current fleet. Over half of the MAC's 40K-loaders, and all the assigned 25K TAC-loaders, will reach the end of their eight-year life expectancy within the next two years (18). A MAC Airlift Center update of a 1982 project stated that "the age and composition of MHE have made it questionable as to whether the specific objectives [of the project] can be answered" (9). These objectives were to assess the capability/reliability of MAC's 463L MHE, and

ascertain whether War Reserve Material (WRM) spares were sufficient to sustain wartime surge operations (8).

The final MHE problem uncovered during this literature review focused on MHE reliability. According to the U.S. General Accounting Office (GAO), 59 Wilson wide-body loaders were purchased to fill a MAC requirement caused by a shortfall of elevator loaders and the advanced age of the Cochran loaders in the MAC inventory in 1982. The GAO also reported that 36 of the 59 Wilson loaders purchased were provided to MAC for world-wide distribution (44:12), since 25K and 40K-loaders were not capable of reaching the upper cargo decks of wide-body aircraft.

The GAO report states that:

Since entering MAC's inventory in January 1984, the Wilson elevator loaders have continuously had operational, safety, and maintenance problems. In-commission rates have been far below the 90-percent standard for full combat readiness, and malfunctions with the loaders are causing severe problems in MAC's ability to meet even its peacetime requirements. The availability rate for 12 loaders assigned to the 22nd Air Force Pacific bases, for example, has been as low as zero, and not one loader has worked satisfactorily for sustained periods. The 21st Air Force had similar problems: its 12 Wilson loaders were available only 17 percent of the time from July through October 1985. Also, 30 of 50 attempts (60 percent) to use the loaders were aborted because they became inoperable. Personnel at the 21st Air Force told us that loader failure have required them to fly in Cochran loaders to support aircraft when the Wilson loaders were inoperable [44:12-13].

As a result of these problems, nine Wilson loaders were pulled from WRM stock at Seymour Johnson AFB, SC in November 1985. MAC, AFLC, and Wilson personnel spent 10

days, and 4,000 manhours, trying to assemble and operate these Wilson loaders at Charleston AFB, SC (16). According to GAO, not one of the Wilson loaders performed satisfactorily. Problems with hydraulic systems caused two of the loaders to "run away," and left one stuck in the mud while another became hung up on a concrete curb. The tests demonstrated the Wilson loaders could not lift 40,000 as specified in the contract, and could not survive long-term (16-month) storage. All nine loaders had varying degrees of engine crankcase and fuel tank water contamination, unserviceable batteries, rusted assembly pins, and corroded trim cylinder air vents (45:13-16). In December 1985, as a result of the Charleston test, HQ USAF/LET authorized the leasing of commercial wide-body loaders to meet operational requirements (42). In March 1986, AFLC requested authority to place the Wilson loaders in "deep" storage, pending evaluation by WR-ALC. This authority was granted in April 1986, and all owning units were advised to store their Wilson loaders (17). In April 1986, HQ MAC/LG/TR stated that the Wilson loader was "useless to this command" (20).

The GAO reported that the unreliability of the 59 Wilson loaders, purchased for about \$4.5 million, significantly reduces MAC's capability to load wide-body aircraft (45:12). In fact, the loss of the Wilson loaders has

reduced the U.S. Air Force world-wide capability to load wide-body aircraft by 58 percent (18).

463L Pallet Availability

Another problem historically facing the Air Force is the availability of 463L pallets. Only 52 percent of the needed pallets were available in 1980. Aggressive management had increased available pallets to 94 percent of the required 118,745 by November 1986. In December 1986, however, the need was increased by approximately 5,000 pallets. The current requirement of 123,730 pallets includes 22,606 operational and 101,124 WRM pallets. Because funds cannot be expended in anticipation of future requirements, pallet availability now stands at approximately 90 percent of need. The lag in funding, combined with a 3-4 year contract cycle, means that a pallet shortfall of approximately 10 percent will always exist (2).

Conclusion

The review of literature conducted in this chapter demonstrated that MHE problems have existed since the inception of the first MHE systems. Reviewing current literature indicated that many of the problems which led to May's 1983 study still plague Military Airlift Command. In the following chapter the seven recommendations made by May will be evaluated. Actions taken by MAC since 1983 are also studied, and new recommendations for enhancing MHE

capability have been formulated. These recommendations are presented in the final chapter of this thesis, along with a summary of major findings and conclusions drawn during the research process.

IV. Analysis

Overview

This chapter outlines the analysis conducted on the seven recommendations of May's 1983 study, as a result of the literature review conducted in the preceding chapter.

May's Recommendations

As previously stated, May's seven recommendations were:

1. Phase out TAC-loaders and K-loaders.
2. Purchase specialized MHE to meet short-term requirements.
3. Replace the current MHE fleet with a new type transporter/loader.
4. Use experts from military staffs to determine specifications for new MHE.
5. Use experts from civilian industry as consultants for MHE development.
6. Centralize MHE management.
7. Use a formula to determine wartime MHE in-commission rates (32:114-116).

These recommendations will be discussed in depth in the following paragraphs.

The first recommendation to phase out TAC-loaders and K-loaders has been actively pursued by MAC.

One hundred-eighteen 40K-loaders and all 54 25K-TAC loaders were eligible for replacement in 1986 and 1987 (18). MAC and AFLC are currently in the process of issuing a purchase description that

. . . establishes the requirements for manufacture and acceptance of a self propelled, air transportable (C-141, C-5, C-17), adjustable height, 60,000 pound capacity aircraft loading and unloading truck [47].

This 60K-loader is planned to replace the 40K-loaders as they are retired from MAC's MHE fleet.

Life expectancy for the 60K-loader system has been established at from 8 to 12 years, and the overall life expectancy for the basic structure (frame) has been set at thirty years, allowing for 3-4 re-manufacturings of the system (47). This is consistent with the current life expectancies of 8 years for the 40K and 25K TAC loaders (18).

The soundness of May's second recommendation, to purchase specialized MHE to meet short-term requirements, was dramatically demonstrated by the changes in the wide-body/narrow-body aircraft mix within the U.S. commercial airlines. In 1978, the Boeing Corporation and Military Airlift Command estimated that the change in the mix between narrow-body and wide-body aircraft would be characterized by a phase-out of narrow-body aircraft, and a corresponding increase in wide-body cargo aircraft as shown in Figure 4. Boeing estimated that there would only

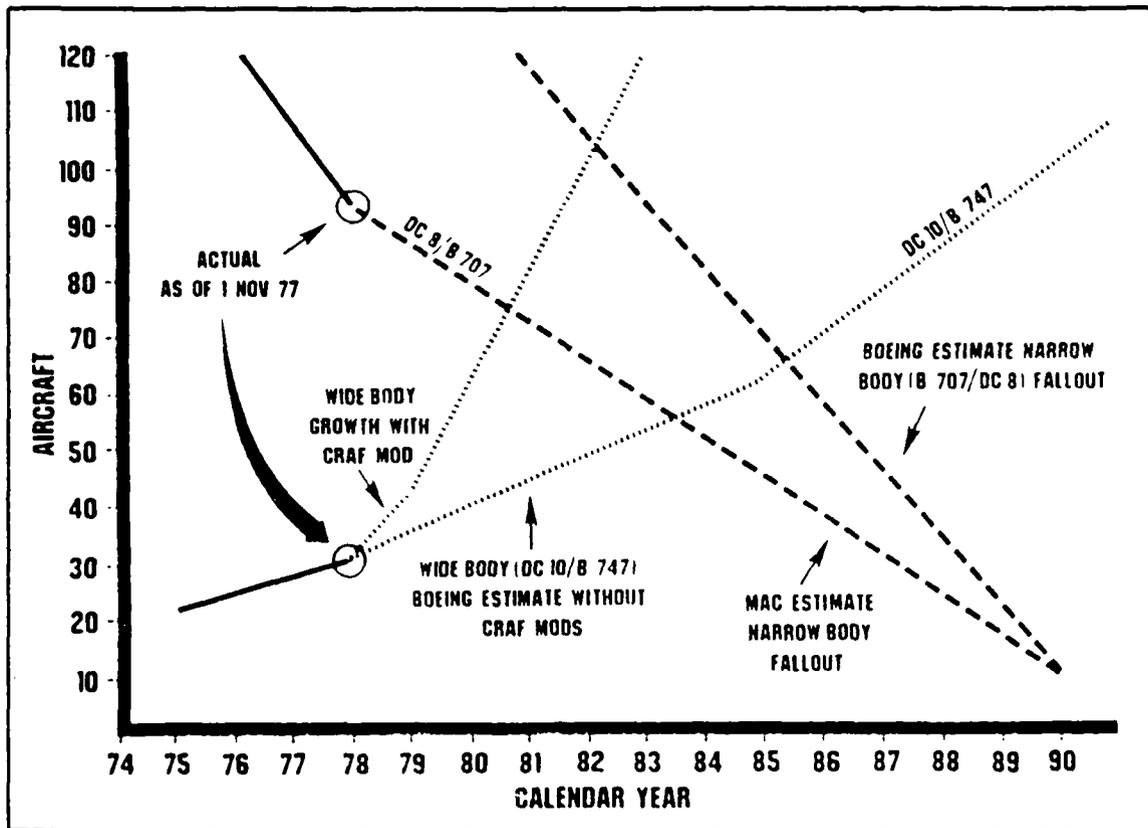


Fig. 4. Estimated Change in the Mix Between Narrow-body and Wide-body Cargo Aircraft [6:14]

be approximately 80 narrow-body cargo aircraft left, and that wide-body cargo aircraft would increase to approximately 60 by 1984 (6:14-15). In fact, there were 73 (DC-8/B-707) narrow-body and only 41 (DC-10/B-747) wide-body aircraft in the U.S. Flag cargo aircraft fleet in 1984 (30). Both Boeing and MAC anticipated that "the number of wide-bodies will increase very significantly over the next decade" (6:15). This assumption led to the purchase of the Wilson Wide-body Loaders to meet the anticipated

increase in wide-body traffic, an increase which the 1984 Census of US Civil Aircraft, published by the Federal Aviation Administration, indicates did not fully occur (30).

May's third recommendation suggested that a new transporter/loader should be purchased to meet MAC's long-range requirements, and to replace all K-loaders, elevator loaders, and lower-lobe loaders (32:114). He recommended purchase of the Avialift Limited Super Hylo 401 Transporter Aircraft Loader, shown in Figure 5, to meet MAC's needs (32:114). At that time, the Avialift loader was only in the conceptual stage, and had not started production. A prototype model of the Avialift Hylo 401 has been produced, and is currently undergoing testing in the United Kingdom (24). According to Avialift, the Hylo 401 will carry 35,000 pounds on three 463L pallets, can be transported aboard C-130 aircraft, and can service narrow-body aircraft, military aircraft, and both upper and lower decks of wide-body aircraft (25). The transportability of the Avialift 401 is critical, since current MAC Unit Type Code (UTC) listings call for the deployment of aircraft loaders (44).

May's fourth recommendation was to use experts from military staffs to determine specifications for new MHE. He recommended the assignment of design engineers at MAJCOM transportation staffs to "take an active role in preparing specifications and . . . review processes to

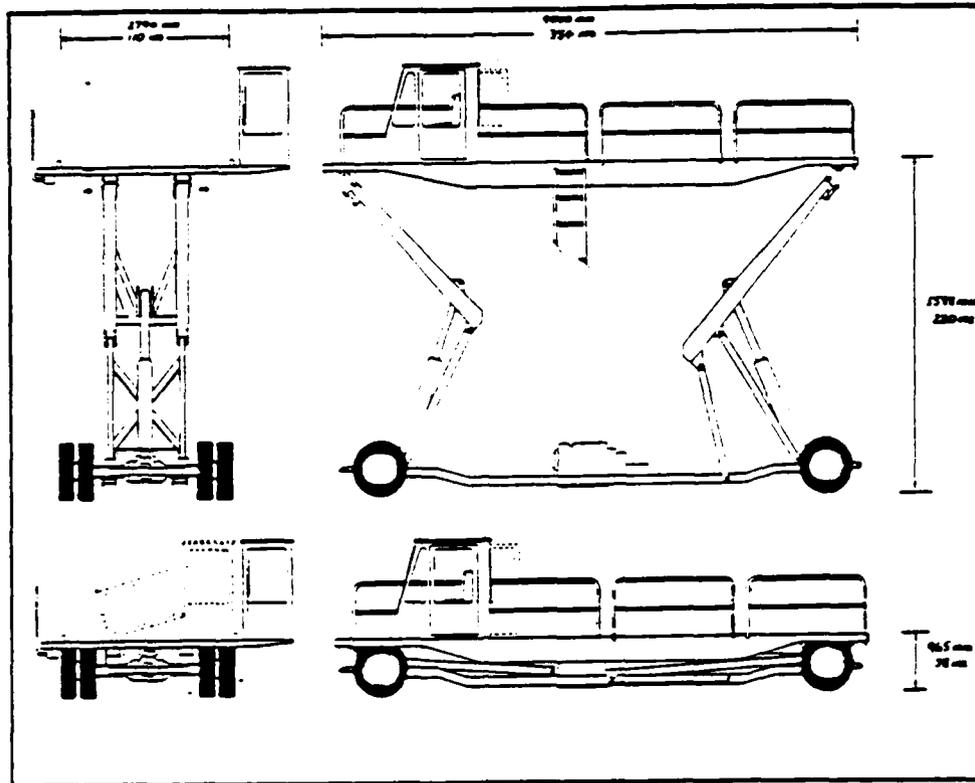


Fig. 5. Avialift Super Hylo 401 (25:3)

insure that all design criteria are met before producing a new piece of equipment" (32:114). Since 1984, MAC has been assigned an AFLC liaison officer for this purpose. This officer, assigned to HQ MAC/XP (Plans Deputate), is a logistics reliability and maintainability (R&M) analyst who insures operational R&M characteristics are front-loaded into airlift requirements before specifications are finalized (27).

HQ AFLC has also directed the formation of a group hosted by HQ AFLC/MM (Materiel Management), and chaired by

HQ USAF/LETN, to "develop an Air Force policy regarding future vehicle procurement strategies" (23). This group is tasked with studying requirements strategies, improved reliability and maintainability for off-the-shelf vehicle procurements, development of specifications, and operational command involvement in specification development, test and evaluation policies, and when and how operational commands will be involved in vehicle procurement (23). The group will include representatives from the vehicle management and testing offices at all MAJCOM Headquarters, and from Warner-Robins Air Logistics Center (WR-ALC)/MM, AFALC, HQ AFLC R&M, and Headquarters USAF/LETN/XOOR communities (23).

May also recommended using experts from civilian industry as consultants for MHE development. Experts from Southwest Mobile Systems Corporation were, in fact, used in the early stages of design and development of the new 60K-loader. Southwest Mobile Systems Corporation has a long history of defense contract work dating back to the early 1950s. They have provided towed vehicular systems (trailers) to the Army, and have extensive experience in mobility equipment. As a wholly-owned subsidiary of Emerson Electric Company, a \$6 billion dollar company performing 12-15 percent of its business in the defense contract arena, Southwest also had the ability to draw on Emerson's accumulation of related knowledge. Emerson

performed a major overhaul on three hundred 25K-loaders between 1982 and 1986, and also had experience in developing high-speed package sorting devices and ammunition feed systems for cannons and machine guns (26). The combined experience of the two companies led Southwest to bid on MAC's contract to "identify future cargo handling equipment needs and specifications that will enable the Air Force to procure an advanced state-of-the-art aircraft transporter loader" (11:1-1). Southwest Mobile Systems was recently awarded the contract to produce one hundred fifty-two 25K-loaders for the Air Force at its West Plains, Missouri facility (26).

May recommended the centralization of MHE management. The Vehicle Management Division (MMV) was established at WR-ALC in February 1986 to "provide management attention to the Air Force vehicle program" (48:1). Responsibilities of this division include participation with AFSC during the acquisition phase, computing requirements, establishing repair sources for recoverables, distributing available assets, evaluating reliability and maintainability performance, developing tables of allowances, and reviewing items for disposal/retention (48:7). Within the Division, the Requirements and Distribution branch is responsible for managing replacement, investment, and stock fund items, computing buy/budget/repair requirements, initiating procurement actions, making distribution

decisions, and recommending retention and disposal actions (48:10). The Equipment Allowance Branch is responsible for managing tables of allowance for support equipment, reviewing and evaluating contractor-prepared support equipment requirements, and providing support equipment allowance assistance to MAJCOMs (48:12). The Rapid Deployment Force Program Management Branch is responsible for managing all assets for the Air Force Rapid Deployment/Bare Base Program (48:15). The Production Management Branch is responsible for establishing a depot level repair overhaul capability, negotiating overhaul requirements, managing vehicle modifications, and managing contract engineering proposals. The Engineering and Reliability Branch is responsible for working with AFSC in an advisory and assistance role in the process of acquiring new systems and equipment. Branch responsibilities include determining how a vehicle will be maintained throughout its life cycle, and evaluating first articles from new production sources to "insure we have a good quality item with adequate technical data and test equipment" (48:19). The final MMV Branch, the Air Force Vehicle Systems Program Management Branch, has system program management responsibility for the entire Air Force Vehicle fleet, and is the key proponent for all vehicle matters. The Branch interfaces directly with the Air Staff, HQ AFLC, MAJCOMs, other Services, the Department of Defense, civilian agencies, and

foreign governments on issues ranging from acquisition to disposition. The Branch ensures a full spectrum of logistics support is provided to vehicle users including programming and procurement of new vehicles, identification and resolution of vehicle deficiencies, acquisition of vehicle data, and repair capability information (48:21).

May's recommendation to use a formula to determine wartime MHE in-commission rates and requirements was not the first such recommendation. Carson and Munson suggested using a forecast technique to determine requirements for aircraft loaders (3:117-119). Sampson and Hare developed mathematical formulas to determine MHE requirements, and recommended their use for determining 25K and 40K-loader requirements as well as 10K forklift requirements (39:10-12). May also later developed a computer model for the Zenith Z-100 computer to determine MHE requirements. This program can be used to determine MHE requirements using TA-101 terminal classifications, unit type codes (standardized or tailored), OPLAN evaluations, aerial port peacetime criteria (nonsurge), command post exercise criteria, and unknown (surge) environment criteria (33).

Conclusion

This chapter provided an analysis of May's seven recommendations, and the actions taken by MAC since the recommendations were published in 1983. Recommendations

for further study, and the conclusions drawn during research for this thesis, will be presented in the final chapter of this thesis.

V. Conclusions and Recommendations

Overview

This chapter outlines the recommendations formulated as a result of the research performed during work on this thesis, and the conclusion of the thesis.

Recommendations

The following recommendations were developed during the course of performing the literature review for this thesis:

1. Further research should be performed to insure that advances in technology are built into the next generation loaders. According to May, we have to insure that they do not become just an updated version of the old 25K and 40K-loaders built on a 1960's technological base (34). New composite metal and plastic components can increase the capability of the next generation loader without sacrificing weight or strength. Hardening against the effects of electro-magnetic pulse from a nuclear detonation should also be considered in the future generations of MHE.

2. Computer programs for determining wartime in-commission rates and requirements should be combined with the exercise planning and execution process. MHE can be a serious limiting factor on the capability of an aerial

port to perform during contingency operations, and every method available to test the adequacy and availability of equipment should be employed in exercise scenarios.

3. Further study should be conducted, as the mix of wide-body aircraft and narrow-body aircraft changes over the next decade, to determine MHE requirements into the next century. In addition, CRAF aircraft should be included in exercise scenarios to ensure that accurate planning factors (conversion times, onload/offload times, and support equipment/MHE requirements) are available.

4. MHE/463L equipment procurement should be tied directly to the major system it supports. When the Air Force purchases a C-17, for example, it should also purchase all required MHE under the same procurement. Materials Handling Equipment is the only equipment that is not currently tied to a major weapon system for procurement purposes, a lesson that should have been learned from our Vietnam experience.

5. Continued emphasis should be placed on the development of future procurement strategies. The current initiatives within AFLC are good, but may be too little and too late. We currently have warehouses, flightline ramps, and sub-motor pools full of equipment that is often marginal at best. All 59 Wilson loaders are in deep-storage, and will require major modification to be even minimally acceptable. The capability of the Wilson

loaders after modification will only be 35,000 pounds, not the 40,000 pounds originally specified. Recent warehouse tug purchases have equipped us with vehicles that break down at a higher rate than those they replaced. Some re-manufactured 25K-loaders had to have their cabs repositioned by local transportation squadron personnel to keep them from striking C-141 petal doors.

6. In the case of the Wilson loaders, MAC believes that

. . . had operational testing been performed on the loaders prior to granting production approval, it would have disclosed the extensive problems found after the loaders were placed in service [45:15].

HQ USAF/LET has recognized the importance of adequate testing in the case of the 60K-loader, and has called for a "procurement strategy that should embrace the policies set forth in AFR 80-14, with MAC participation as the QOT&E agency" (23). This means that full-scale testing of the 60K-loader will be accomplished under the auspices of MAC before final acceptance of the loaders from the manufacturer takes place. This is a step in the right direction, and should be pursued in all future MHE acquisitions.

7. The research conducted in this thesis should be continued in a follow-on study. Many of the issues researched in this thesis are currently undergoing rapid change. The procurement of the 60K-loader, remanufacture of the Wilson loaders, procurement of new 25K-loaders, and

the change in procurement strategies (including QOT&E testing) are all in a current state of flux. Future research should include the results of the changes in HQ USAF and AFLC procurement strategies.

Conclusion

Research has shown that Lt Col May's recommendations were accepted and adopted by Military Airlift Command and the United States Air Force. MAC has taken, and is taking, steps to phase out TAC-loaders and K-loaders, and replace them with a new type transporter/loader. MAC has also recognized the need for a 60K-loader that will eliminate the necessity of specialized MHE to handle wide-body aircraft, and is actively pursuing procurement of this new K-loader. Military and civilian experts were involved in the design process of the new loader, and will have an active part in its procurement. Management of MHE has been centralized in the Vehicle Management Division at WR-ALC. And finally, formulas have been developed to determine wartime (and peacetime) MHE in-commission rates and requirements.

Appendix A: Definitions

AFLC--Air Force Logistics Command

AFSC--Air Force Systems Command

ALC--Air Logistics Center

Contingency--an event that is possible but uncertain

CRAF (Civil Reserve Air Fleet)--commercial aircraft used by MAC to augment organic airlift capability

463L--a system of cargo movement developed by Douglas Aircraft Company in the early 1960s, based on utilization of the cargo pallet and net set

In-commission rates--percentage rates that indicate a vehicle or type of vehicle is fully operable

Inter-theater airlift--airlift between theaters of operation

K-Loaders--aircraft loading/unloading trucks (includes 40K, 25K, and 25K TAC loaders)

LL (Lower lobe)--lower cargo deck of wide-body aircraft

Lower-lobe Loader--loader used to load/unload cargo aboard the lower decks of wide-body aircraft

MHE (Materials Handling Equipment)--a family of cargo handling equipment used for the movement, loading, and unloading of cargo. Included in this grouping are forklifts, K-loaders, and wide-body and lower-lobe loaders.

MTM (million ton-miles)--airlift cargo measurement obtained by multiplying tons of cargo times miles carried

Pallet--platform on which cargo is placed to minimize manual handling, provide a rigid structure for rapid handling, and provide a standard system for restraining and locking cargo on roller conveyor systems (on both MHE and in aircraft)

Rolling Stock--vehicle driven or winched aboard aircraft

Support Vehicles--vehicles that directly support the Air Force mission

TAC Loader--25K loader specifically designed for use in tactical situations

UL (Upper lobe)--upper cargo deck of wide-body aircraft

VPD (Vehicle Deadlined for Parts)--any vehicle that is not operable due to a lack of available parts

WBL (Wide-body Loader)--a family of loaders used to load/unload cargo aboard wide-body commercial aircraft (B747, DC-10, L-1011, etc.)

Wide-body Aircraft--large commercial and military aircraft (B-747, DC-10, KC-10, L-1011, etc.), usually having a main cargo floor or deck at least 18 feet above ground level

War Reserve Material (WRM)--material that is stored in reserve for use during contingency operations

Appendix B: CRAF Cargo Projections (17)

YEAR	CAPABILITY	COMMITMENT	EXCESS CAPABILITY
FY1986	15.4	8.9	6.5
FY1987	17.4	10.5	6.9
FY1988	18.7	12.1	6.6
FY1989	20.5	13.7	6.8
FY1990-4	No Change	-	-
FY1995	18.6	12.5	6.1
FY1996	No Change	-	-
FY1997	18.2	12.1	6.1
FY1998	17.7	11.2	6.5
FY1999	16.8	10.2	6.6
FY2000	16.7	10.0	6.6

REASON FOR CHANGE IN PROJECTION BY YEAR:

FY1987:

Capability - Add three B-747-200C and one B-747-100C

Commitment - Add CRAF enhancement B-747C

FY1988:

Capability - Add three DC-10-30F and six B-747-100C

Commitment - Add four DC-8-73F, four B-707-300C, one DC-10-30F, and six B-747-100C

FY1989:

Capability - Add three B-747-100C, two DC-10-30F, and 13 DC-8-71F

Commitment - Add three B-747-100C, one DC-10-30F, and 13 DC-8-71F

FY1990 - 1994:

No anticipated change

FY1995:

Capability - Lose 18 DC-8 and eight B-707

Commitment - Lose 12 DC-8 and five B-707

FY1996:

No anticipated change

FY1997:

Capability - Lose three B-747-100C

Commitment - Lose three B-747-100C

FY1998:

Capability - Lose three B-747-100C and one DC-10-10CF

Commitment - Lose three B-747-100C, two B-747-200C, and one DC-10-10CF

FY1999:

Capability - Lose six B-747-100C

Commitment - Lose six B-747-100C and one B-747-200C

FY2000:

Capability - Lose five B-747-100C

Commitment - Lose five B-747-100C

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Vita

Captain Robert John King was born in Buffalo, New York, on 13 September 1950. He attended Royalton-Hartland Central School, Niagara County Community College, and the State University College of New York at Brockport, before enlisting in the U.S. Air Force in 1971. Captain King attained the rank of Staff Sergeant, performing in various transportation-related assignments, while attending the University of Delaware, Delaware State, and the University of Guam. He received an Associate of Arts degree in Transportation from the Community College of the Air Force, and a Bachelor of Science degree in Business Management from Baptist College of Charleston, South Carolina, in 1979. Following graduation he attended Officer Training School prior to an assignment to Dover AFB, Delaware. Captain King married the former Constance Amelia Vandermarliere of Detroit, Michigan, in 1980. After assignments to Robins AFB, Georgia and Andersen AFB, Guam he served on the Military Airlift Command Inspector General Team, until entering the School of Systems and Logistics, Air Force Institute of Technology, in 1986. The Kings have three children: Cristen, 17; Robert, 11; and Carolyn, 6.

Permanent address: 1304 DeSoto Drive

O'Fallon, IL 62269

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Block 19. Abstract

The purpose of this study was to research and document the effects of a Materials Handling Equipment (MHE) shortfall with respect to current airlift issues and trends. The study had three basic objectives: (1) validate a previous Air University Center for Aerospace Doctrine, Research, and Education (CADRE) study, (2) research actions taken by Military Airlift Command (MAC) with respect to current issues and trends, and (3) make new recommendations regarding the enhancement of MHE capability.

The study found that the CADRE recommendations were to: (1) phase out TAC-loaders and K-loaders, (2) purchase specialized MHE to meet short-term requirements, (3) replace the current MHE fleet with a new type transporter/loader, (4) use experts from military staffs to determine specifications for new MHE, (5) use experts from civilian industry as consultants for MHE development, (6) centralize MHE management, and (7) use a formula to determine wartime MHE in-commission rates.

Research and analysis showed that the CADRE recommendations were accepted and adopted by MAC and the United States Air Force.

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