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USAAMRDL Technical Memorandum 2

COMPATIBILITY STUDY OF THE
INTERFACE BETWEEN HELICOPTER EXTERNAL
TRANSPORT OF CARGO AND OTHER
MODES OF CARGO TRANSPORT

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This memorandum was prepared by the U. S. Army Tank-Automotive Command, Concept and Technology Division, Warren, Michigan, under the terms of Procurement/Work Directive (P/WD) 72-A33-24. The intent of the program was to identify problem areas or deficiencies in the effective interchange of cargo movement between helicopters and other modes of transport (land and water).

About midway in the planned program, it was concluded that sufficient data and information had been obtained to show that cargo handling problems, deficiencies, and limited or no-capability areas exist. Accordingly, the program was terminated so that dissemination of the results could be expedited.

Mr. S. G. Riggs, Jr., Military Operations Technology Division, served as project engineer for this effort.

SUMMARY

The objective of this effort was to identify problem areas and gaps in technology associated with cargo movement between helicopters and other modes of transport (land and water).

An extensive literature search was made and Government agencies and test sites were visited to investigate (1) the interface between helicopter lifting of cargo and cargo handling equipment and (2) the compatibility, in a combat environment, of cargo handling equipment currently being used with the UH-1, CH-47, and CH-54 and for future use with the HLH.

The major interface problem areas that were identified relate to the lack of ground vehicles with materials handling equipment (MHE) capability for use in forward operational areas.

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INTRODUCTION

The Army, because of its worldwide commitments, has the task of transporting cargo by air, land, and sea, and distributing it to its smallest entity. The cargo consists of vehicles, containers, pallets, and bulk materials of various sizes and weights, which have to be moved and unloaded under adverse weather conditions, in all types of terrain, and under possible hostile actions.

The interrelations of cargo movement by helicopter and other modes of transportation require thorough study to establish the best means of effecting interchange between the modes and optimizing system productivity. The cargo handling equipment should be capable of operating with helicopters under all conditions. Shortcomings of cargo handling and ground mobility equipment with helicopters were evidenced in Vietnam and also demonstrated during Off-Shore-Discharge of Container Ship exercises in December 1970 (OSDOC I) and in October 1972 (OSDOC II).

The purpose of study is to identify problem areas and gaps in technology associated with the arrival of military cargo in a forward area after release from a helicopter.

DISCUSSION

BACKGROUND

The Korean war, the Vietnam war, OSDOC I, and OSDOC II have demonstrated that although the helicopter is an excellent means of transportation, its use as a resupply vehicle is limited by high operating costs, weather, comparatively low cargo-carrying capability, and high vulnerability to hostile action. Despite these apparent limitations, helicopters have been used successfully as part of the logistic chain of supply; and without question, they will continue to be so used, provided no gaps in the logistic chain exist once the helicopter deposits the cargo.

The purposes of this study were to:

1. Investigate the interface between helicopter lifting of cargo and cargo handling equipment in air, marine, and land mode of transport.
2. Investigate the compatibility, in a combat environment, of cargo handling equipment in present use with the UH-1, CH-47, and for future needs with the Heavy-Lift Helicopter (HLH).
3. Identify the operational problems associated with cargo handling equipment and lifting of cargo by helicopters.
4. Investigate the interface between various transportation modes and cargo handling with helicopters in such areas as ship to shore, air terminal to field, rail to field, and ground mobile vehicles to field.
5. Identify problems associated with the interface between external transport of cargo by helicopter and transfer to surface cargo transportation equipment.
6. Determine the work being done by Government agencies and industry toward solution of problems related to the interface between external transport by helicopter and transfer to surface transportation modes.

To accomplish the purpose of this study, a search of documents and reports was made; government agencies were contacted; Army Regulations, Field Manuals, etc., were researched; and test sites were visited.

DOCUMENT SEARCH

The search of documents pertaining to the study was performed by the Defense Documentation Center, Cameron Station, Alexandria, Virginia; the Defense Logistics Studies Information Exchange, U.S. Army Logistics Management Center, Fort Lee, Virginia; and the Army Engineer Research and Development Technical Documents Center, Fort Belvoir, Virginia.

The document search resulted in a bibliography of 316 reports. Of these, 93 were ordered for further study. Only 26 of these reports (listed in Appendix I) were found to contain material relevant to this study. These documents revealed the following problem areas:

1. Lightweight spreader bars (weighing about 1,000 lb) with corner-locking mechanisms are required for lifting and externally carrying containers by helicopters.
2. To extract containers from cells of container ships, guides on the four corners of the cells are necessary.
3. The forklift tunnel feature is inherent in commercial containers, but it is not available in the current Army MILVANS. This paradox does not allow the lifting of MILVAN containers with a forklift. As such, a spreader bar, a crane, and slings are the minimum essential land-based equipment required.
4. The basic USAF cargo handling system is the 463L, which consists of conveyors mounted inside the cargo compartment of the planes, and 463L-25K loaders for placing pallets into the planes. Within the 463L system, no provisions have been made for transferring containers from the 463L-25K loader to ground vehicles. The MHE currently in the USAF inventory that could be used to transfer containers on a very limited scale are the 10,000-pound-capacity rough terrain and

warehouse forklifts. Because the undersides of existing MILVANS and commercial containers are not smooth and the corner fittings protrude 1/4 inch below the bottom surface, the containers have to be rigged to three pallets prior to transport by cargo plane. Conversely, when the containers are removed from the plane, they are still rigged to the pallets. Existing ground vehicles are not compatible with the 463L system; therefore, the container has to be separated from the pallets prior to transfer onto a trailer or other suitable vehicle, assuming that suitable MHE is available to transfer the container.

5. It is extremely difficult to place a helicopter-borne container directly on its matching trailer for further logistic movement. Efforts were made during OSDOC I to place the helicopter-borne containers on MILVAN chassis. Although the initial OSDOC II scenario called for loading of the helicopter-borne MILVAN's directly onto MILVAN chassis, this was never done, since the container could not be positioned with sufficient accuracy to engage the latches.
6. Existing nylon slings for carrying cargo deteriorate when subjected to operational environmental conditions.
7. The Field Materials Handling Equipment Family Study portrays currently available MHE that is good for depot and highway operation only. None of the ground mobile vehicles (trailers and/or trucks) in the current Army inventory are capable of rapidly moving cargo, containers, tricons, etc., from the rear areas to the forward areas (company) without the application of MHE at both terminals. MHE for containers could be eliminated at the end terminal if the ground mobile vehicles had provision, such as guides, for accepting cargo and containers directly from the helicopter; if the helicopter had improved hover accuracy; and if the container maintained a stable position relative to the helicopter.

Although several commercial container self-loading/unloading trailers, such as the GOLDHOFER, PARATOR, and KLAUS, are available, they are not suitable for military application in the forward area and do not have MHE capability as evidenced by tests and studies conducted at USATACOM.

No data addressing the interfaces between rail and field was found, nor was any evidence uncovered that a study or exercise dealing with interfaces has ever been performed. However, based on the experience with the MILVAN chassis, it is not presumptuous to state that the problem areas will be similar to those stated in paragraph 7. Although the Army possesses MHE, this has to be applied at each interface, i.e., helicopter to rail, rail to vehicle, and vehicle to forward area, resulting in an existing increase in required MHE. The existing MHE is not capable of handling containers and cargo in the forward areas. Figures 1 through 4 illustrate some of the interfaces encountered in helicopter cargo movements.

GOVERNMENT AGENCIES CONTACTED

Government agencies contacted in the course of this study are listed in Appendix II. The information obtained from these contacts reinforces the data obtained through the document search. In addition, the contacts reflect evidence and reinforce the need for the following:

1. Reliable slings with capacities of up to 25,000 pounds for the CH-5Y and CH-47 helicopters and 60,000 pounds for the Heavy-Lift Helicopter (HLH).
2. MHE ground mobile vehicles to operate in the forward areas for unloading cargo and containers from helicopters, airplanes and landing ships on the beach, and to deliver and/or distribute the cargo and containers to the forward areas without additional MHE.

LITERATURE SEARCH AND SURVEY

The literature search centered principally on manuals, Field Manuals, Army Regulations, bulletins, etc., which would pertain

to this study and to the already identified problem areas. The search did not identify any new interface problem areas. Tables of Organization and Equipment (TOE's) for Supply and Transportation Maintenance, Infantry, Artillery, and Engineer Bulletins do not list any organic MHE capable of handling large quantities of cargo. The MHE consists of 5-ton wreckers, 6,000-pound forklift trucks, light armored recovery vehicles (M578), and medium recovery vehicles (M88) in quantities and capacities too small for full-scale cargo handling operations.

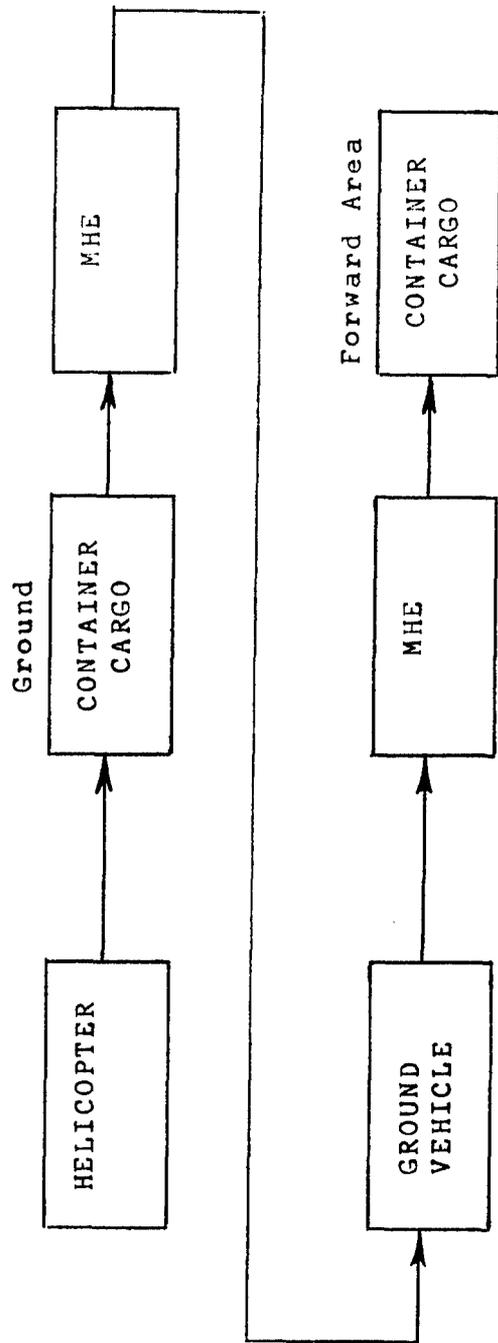


Figure 1. Helicopter - Forward Area Interface.

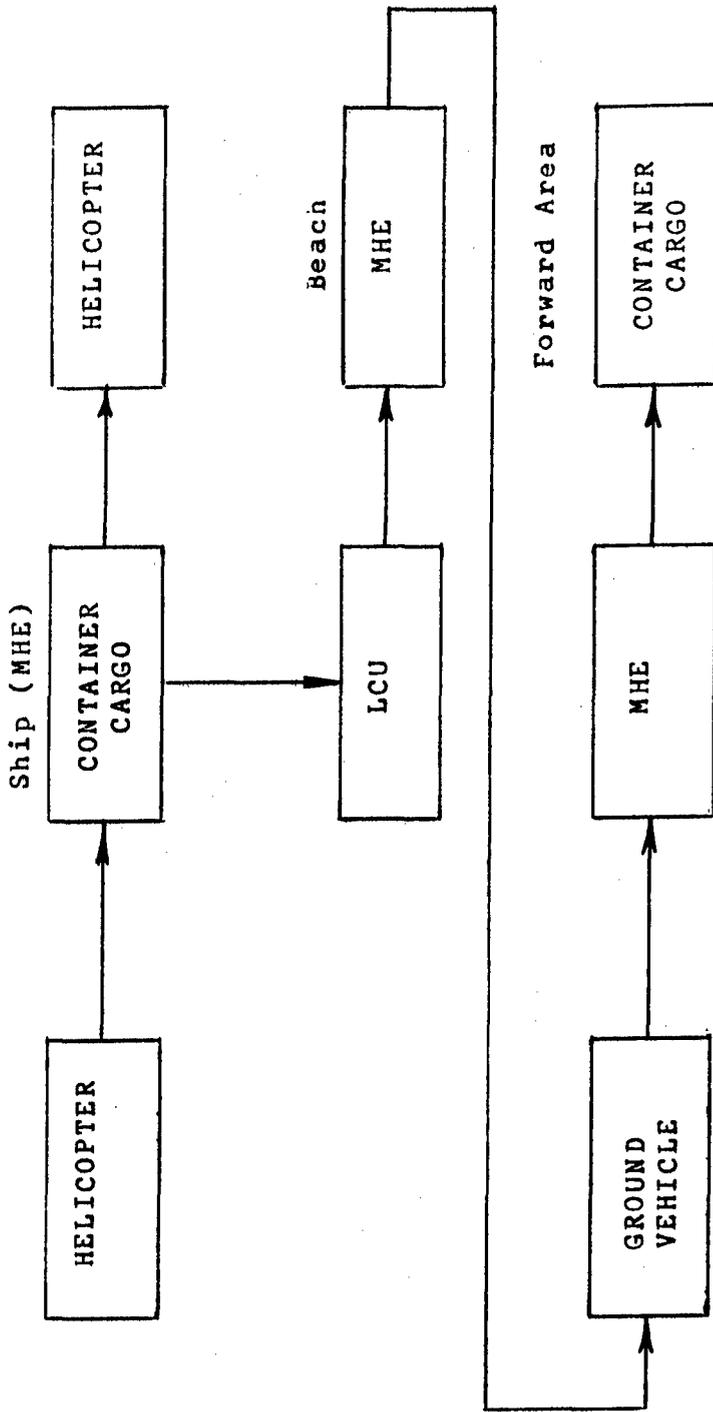


Figure 2 Helicopter - Ship - Beach - Forward Area Interface.

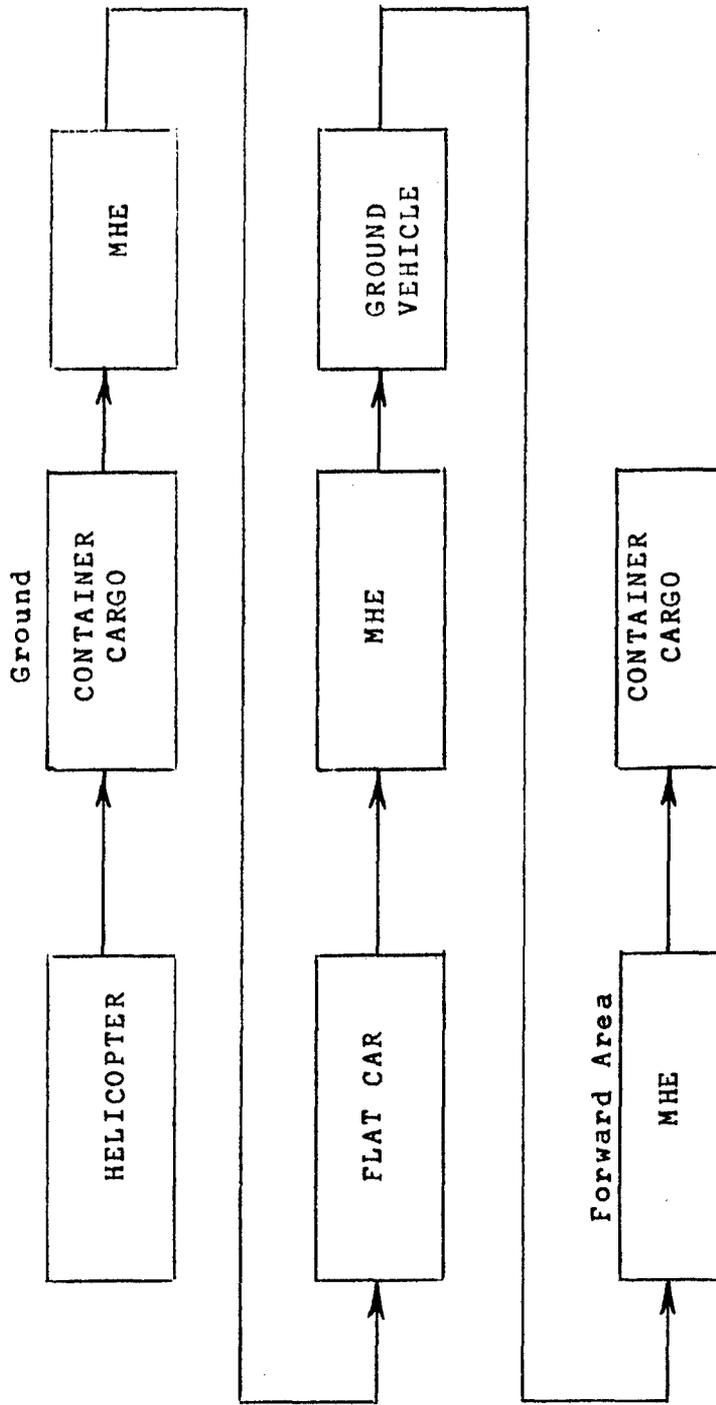


Figure 3. Helicopter - Rail - Forward Area Interface.

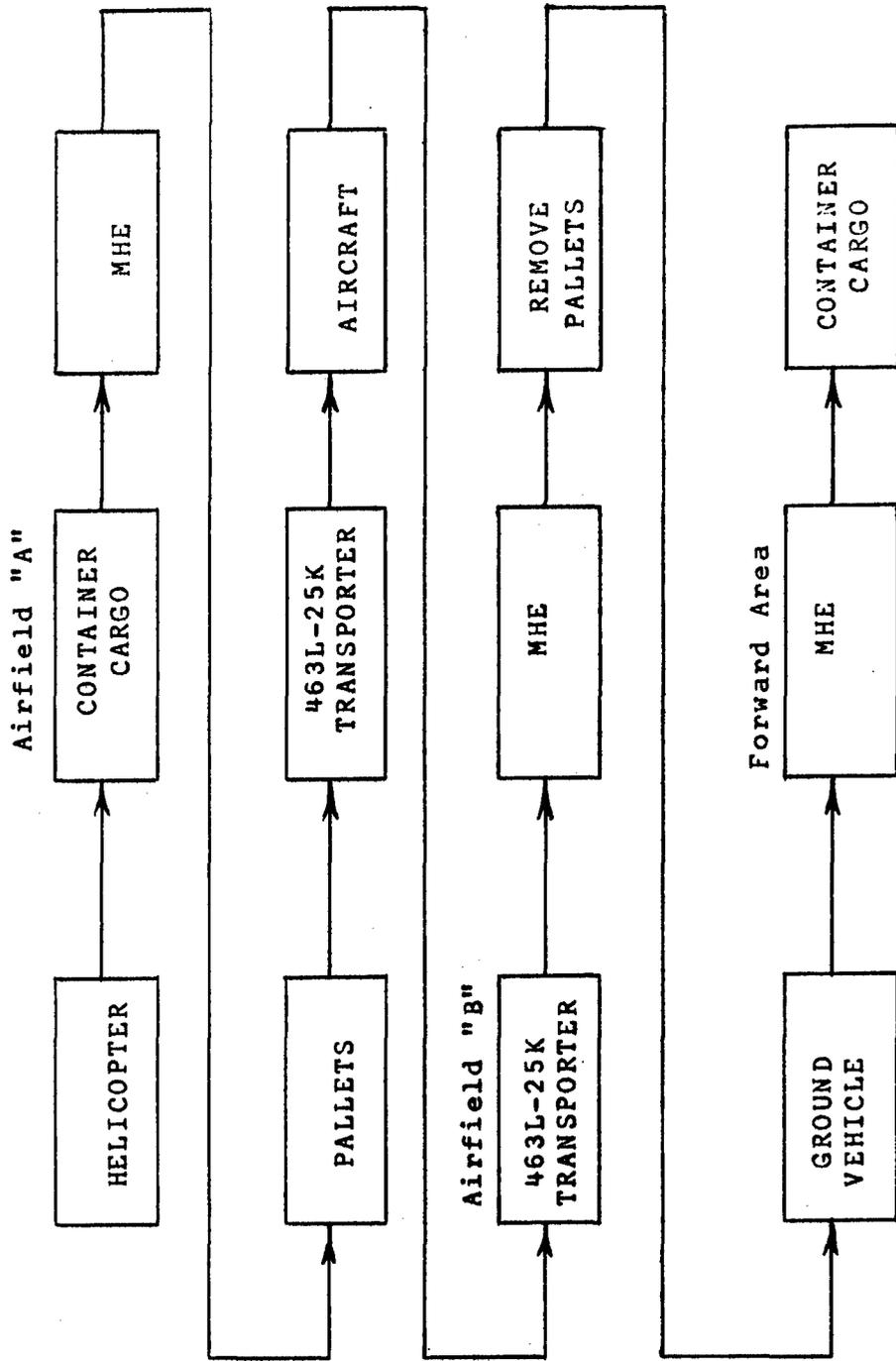


Figure # Helicopter - Plane - Forward Area Interface.

CURRENT EFFORTS RELATED TO HELICOPTER INTERFACE PROBLEMS

Current efforts by industry and Government agencies relative to the interface problem areas are as follows:

1. The Boeing Company, Vertol Division, Philadelphia, Pennsylvania, is performing a design study under contract DAAJ02-72-C-0083 with AMRDL of a container handling device to be used with fully loaded 20-foot-long containers. This work includes fabrication and testing of two prototype units. The Boeing Company will analyze the motion of the helicopter and the load, and will design and flight test a power-actuated system to stabilize the external load under various flight conditions (DAAJ02-72-C-0046).

2. Sikorsky Corporation has a development contract (DAAJ02-72-C-0008) with AMRDL to design and fabricate ten 6,000-pound, ten 25,000-pound, and five 60,000-pound-capacity nylon and steel cable helicopter lifting slings.

3. A Required Operational Capability (ROC) document for a Semitrailer, Tactical, Special-Purpose Self-Load/Unload, Breakbulk/Container Transporter, 22-1/2-Ton, 20-foot long is currently being staffed. Although this ROC acknowledges the need for a self-loading/unloading, breakbulk cargo container carrier, it does not recognize the need for cross-country capability of the carrier, since the requirement specifies limited off-road carrier mobility.

4. The Mobile Support Systems Group, Naval Ship Research & Development Center, has been tasked to identify needed requirements related to loading and off-loading containers from ships by helicopters. Although containers have been loaded on and off-loaded from ships in OSD0C II, the results indicate a lack of operational capability in full-scale use of existing helicopters.

CONCLUSIONS

1. The Army does not have the capability to do the following:
 - a. Move containers and bulk cargo from air terminals to forward areas without the use of on-site MHE at each interface point.
 - b. Effectively extract cargo from or place cargo directly on vehicles and railroad flatcars by helicopter.
 - c. Extract containers from and insert containers into ships by helicopter.
 - d. Move containers and bulk cargo from beach areas to ships or vice versa without the use of on-site MHE at each interface.
2. MILVANS are not compatible with the USAF's 463L cargo handling system without the use of pallets and MHE at each interface.
3. The USAF has no organic MHE capable of handling containers.
4. Commercial container handling devices are too heavy to be used with helicopters. The development of a container handling device under a USAAMRDL-sponsored development program will lower the penalty in cargo-carrying capacity to an acceptable level.
5. Helicopter cargo slings deteriorate under field conditions and do not have the capacity to lift fully loaded 20-foot containers. AMRDL-sponsored development should result in new slings capable of correcting this deficiency.
6. The single-point cargo suspension system is not satisfactory for bulk-cargo and container transport by helicopter. The single-point suspension is an inherent deficiency in existing helicopters.

RECOMMENDATIONS

Based on the conclusions reached in this study, it is recommended that:

1. The helicopter/ground mobile vehicle mode be tested to determine the feasibility of transferring break-bulk cargo and containers directly from the helicopter to a ground vehicle.
2. An off-road and highway trailer or truck be developed which has the capability to load and off-load break-bulk cargo and containers without the use of external MHE and also be compatible with the Air Force 463L cargo system.
3. MILVAN's with smooth undersides and forklift tunnels be developed.

APPENDIX I

LITERATURE RELEVANT TO THE STUDY

The Field Materials Handling Equipment Study, U. S. Army Combat Developments Command Supply Agency, Fort Lee, Va, AD891464 L.

Off-Shore Discharge of Containership, U.S. Army Transportation Engineering Agency, Newport News, Va, AD88608 L.

After Action Report - Evaluation of Off-Shore Discharge of Containerships, 5-9 Dec 1970. U.S. Army Transportation Center and Fort Eustis, Fort Eustis, Va, AD722796.

Report No. 1006 - Design Analysis and Trade-Off Studies OF A Lighterage System Sec. 2.1. Cargo Transfer by Helicopter, E.G. Frankel, Mmc. 40 Ance St., Cambridge, Mass. 02142 for U.S. Army Mobility Equipment Research & Development Center, Fort Belvoir, Va, AD8872706.

Air Logistic Studies - 1970 Phase II, Aircraft Cargo Systems, AD825708.

Mechanized/Automated Stack Handling in the 1990 Field and Theater Armies. U.S. Army Advanced Materiel Concepts Agency, Hoffman Bldg. 2461 Eisenhower Ave., Alexandria, Va, AD867702.

Cargo Handling Equipment for CH-46A and CH-53A Helicopters - Final Report, AD891212.

Aerial Delivery of Cargo by CH-46 and CH-53 Helicopters, Marine Corps Development and Education Command, Quantico, Va, AD839255.

Aerial Very Heavy Lift Concepts for the 1990 Army-Volume I, Basic Report, U.S. Army Advanced Materiel Concepts Agency, Hoffman Bldg. 2461 Eisenhower Ave., Alexandria, Va, AD862287.

Development of Vertical Replenishment Helicopter, Naval Air Test Center, Patuxent River, Md, AD481105.

Design Study of Heavy Lift Helicopter in the Logistical Role, United Aircraft Corporation, Stratford, Conn, AD828283.

An Evaluation of a Heavy-Lift Helicopter in the Logistical Role, Research Analysis Corporation, McLean, Va, AD839900.

Forward Area Handling of Cargo on Pallets or in Containers, CDC Supply Agency, Fort Lee, Va.

Vertrep Ordnance Load Certification Test Report, NWHL Report No. 6011.

Underway Replenishment Ordnance Handling Equipment and Transfer Units, Navord OD 44617.

Preliminary Report, Off-Shore Discharge of Containership II, 3-14 Oct 1972, OSDOC II, Fort Story, Va.

Foreign Intelligence Office (F. I. O.) Report No. 73-1 USATACOM, Warren, Michigan.

Comparative Evaluation of the End-Loading Cargo Transporter and the Goldhofer Swinglift Trailer.

Report of Observation and Evaluation of the Off-Shore Container Ship Discharge Exercise Conducted at Fort Story, Va., 5-9 Dec. 1970, U.S. Army Combat Developments Command Transportation Agency, Fort Eustis, Va., ACN M-18081 LD 264688.

U.S. Army Containerization Requirements, U.S. Army Materiel Command, Bldg. T-7, Washington, D.C., AD847769.

Off Loading Military Supplies from Cargo Ships in Unimproved Post Areas, Director of Budget, HQ, USAF, Washington, D.C. 20330, AD820274.

Helicopter External Sling & Aerial Delivery Platforms, Air Command and Staff College, Air University, Maxwell

Air Force Base, Alabama, Research Study No. 0295-71 LD
27393.

Helicopter Discharge of Containerships in Underdeveloped
Areas, Naval Supply Systems Command, Washington, D.C.,
AD385421.

Impact of Intermodal Containerization on USAF Cargo
Airlift, Deputy for Engineering, Aeronautical Systems
Division, Air Force Systems Command, Wright-Patterson
Air Force Base, Ohio, ASD-TR-72-76.

Heavy Lift Helicopter 40,000 lbs. Capacity External
Cargo Handling System, The Boeing Company, Morton,
Pennsylvania, AD 826531.

APPENDIX II

AGENCIES VISITED

As part of this study the following government agencies were visited:

1. U. S. Army Air Mobility Research and Development Laboratory, Fort Eustis, Virginia,
2. Mobility Equipment Research and Development Center, Fort Belvoir, Virginia.
3. Naval Ships System Command, Vertical Replenishment Program Manager, Department of the Navy, Washington, D.C.
4. Concepts and Doctrine Directorate, Transportation and Containerization HQ, U. S. Army Combat Developments Command, Fort Belvoir, Virginia.
5. Combat Developments Command - Heavy Lift Helicopter Office, Fort Rucker, Alabama.
6. Combat Developments Command - Supply Agency, Fort Lee, Virginia.